2012

Evaluating the preconstruction phase in a Construction Manager/General Contractor project

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Evaluating the preconstruction phase in a Construction Manager/General Contractor project

by

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A thesis submitted to the graduate faculty

in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Major: Civil Engineering (Construction Engineering and Management)

Program of Study Committee:

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Iowa State University

Ames, Iowa

2012

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Acknowledgements

First, I would like to thank Dr. Doug Gransberg for all the guidance and support he has given me throughout the research process. He is a great mentor, and I have learned so much from working with him.

Secondly, I would like to thank Jim McMinimee who co-authored the paper that comprises Chapter 3 of this thesis with me. His enthusiasm for improving the highway construction industry was motivating to anyone who knew him.

Finally, I would like to thank the members of my thesis committee. I would like to thank Dr. Jennifer Shane and Dr. James Alleman for the time and support they have offered to me.

Abstract

The Construction Manager/General Contractor (CMGC) project delivery method is an alternative delivery concept that many state highway agencies are interested in using in an effort to improve the deteriorating infrastructure in the United States. The CMGC method is encouraged by the Federal Highway Administration through the *Every Day Counts 2* initiative which encourages "better, faster, and smarter" construction. However, many state agencies are just now obtaining the legal authority to use CMGC in their respective states. The main difference between the CMGC method and the traditional method of delivering projects is that the contractor is involved during the preconstruction phase. The main focus of this research is the preconstruction phase of the CMGC delivery method through three research objectives.

First, an agency must want to use the CMGC method to deliver construction projects. Research on the benefits and challenges of implementing the method was conducted to give agencies the knowledge of the process to determine why they should implement the CMGC method into their program. Second, once an agency has decided to use the CMGC method, they need to determine the preconstruction services which will be required of the CMGC contractor during the preconstruction phase. Finally, research was performed for the first time on using an Independent Cost Estimate (ICE) consultant during preconstruction to validate the prices given to the agency by the CMGC contractor and to determine the extent to which the ICE consultant adds value to the CMGC process. Research for this thesis was performed using literature review, content analysis of presentations and solicitation documents, and case studies.

This research found that the main benefit of the CMGC process was the ability to achieve accelerated design and construction schedules and the main challenge was training agency personnel to provide the necessary support to achieve that goal. Furthermore, highway and non-highway agencies alike, find that the design-related and cost-related aspects of the CMGC preconstruction phase add the most value to the process. Finally, it was determined that even though the agency incurs an added cost by involving an ICE consultant, the value added to the project by the knowledge brought by the ICE consultant outweighs the added cost.

Chapter 1—Introduction

The Construction Manager/General Contractor (CMGC) project delivery method is a fairly new project delivery method in the highway construction industry (Gransberg and Shane 2010). There are three primary team members on a CMGC project: the owner, the designer, and the contractor. The CMGC contract consists of two parts: preconstruction services and construction (Anderson and Damnjanovic 2008). The CMGC method concept has been used for several decades in the building construction industry under the name Construction Manager-at-Risk. According to the Federal Highway Administration (FHWA), "CMGC is not CM@Risk [Construction Manager-at-Risk]" (FHWA 2010b). According to the FHWA, the main differences are that "self-performance requirements are typical, subcontractor procurement process is different, and CMGC relies on best-value selection" (FHWA 2010b).

Since this is a fairly new method in the highway industry and, because of its similarities yet subtle differences to the same basic concept in the building industry, this method has many names including:

- Construction Manager/General Contractor (CMGC, CM/GC, CM-GC)
- Construction Manager-at-Risk (CMR, CMAR, CM@R)
- General Contractor/Construction Manager (GCCM, GC/CM, GC-CM)
- Construction Manager as Constructor (CMC)

For the purposes of this document the term CMGC will be used to refer to the project delivery method in which the owner retains a designer and contractor under two separate contracts, and the contractor is involved in the project during the design phase through one contract and the construction phase under a separate contract.

At the time of this writing, only thirteen states (Gransberg et al. 2012) have the legal authority to use CMGC to deliver public projects; however, many state agencies are actively seeking to obtain the necessary statutory authority. Since CMGC is new to the industry, many state agencies are not familiar with the process, and thus have questions and concerns about it. The concerns range from why should the agency even use CMGC, to how does the agency choose the contractor on a basis of something other than price alone, to how do the contract documents change, to how exactly is the contractor involved in the design phase, to how can the agency be sure that the price given to them by the contractor is a fair price.

Background

In order to fully grasp the concepts of the CMGC project delivery method, an understanding of other project delivery methods is needed. This chapter provides the theoretical background and previous work with regard to the basic project delivery methods, preconstruction phase, and the use of independent cost estimates in construction projects. This information was gathered through a comprehensive literature review.

Project Delivery Methods

Project delivery refers to “the overall process by which a project is designed, constructed, and/or maintained” (Trauner 2007). There are three basic project delivery methods used in the United States for highway projects: Design Bid Build (DBB), Design Build (DB), and CMGC. Each delivery method has advantages and disadvantages. There is no one delivery method that is satisfactory to every single project. The key to a successful project is choosing the right delivery method for the project.

Design Bid Build (DBB)

The DBB project delivery method, also referred to as the traditional method, has been used by highway agencies for many years. In this method, the owner first completes the design for the project by either an in-house designer or a consultant. Under this delivery method, the owner is responsible for any errors and omissions in the design due to the “Spearin Doctrine” (Mitchell 2008). Upon completion of the design, the owner issues a solicitation for the construction. In this method, an Invitation for Bids (IFB) is issued, and the wining proposer is chosen on a low-bid basis. As can be seen from Figure 1, the owner holds two contracts, one with the designer and one with the builder. The designer and builder have no contractual relationship.

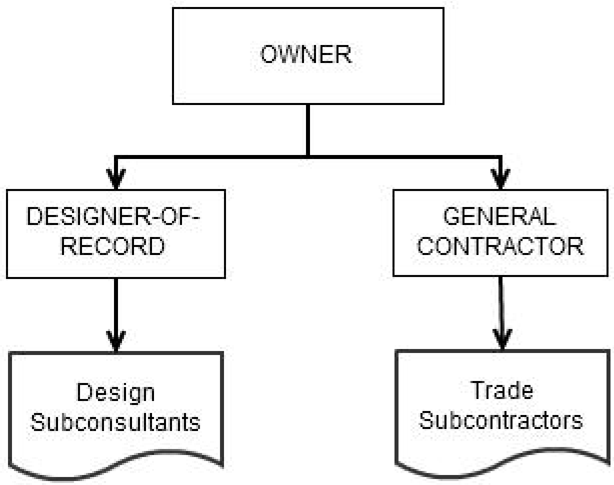

Figure 1: Design Bid Build contracts

The DBB delivery method has worked well for many years and on many projects. The owner knows the construction contract's price of the project before construction begins. The owner can choose the lowest bidder to construct the project. This is an excellent delivery method for a routine project where cost uncertainty is low. However, there are also some known problems with DBB. Thomsen (2006) noted eight major problems with the DBB process:

- Specialization—not only have designers split into specialized divisions (i.e. structural, geotechnical, mechanical, etc.) but builders have also split into various specialized trades (i.e. plumbing, wiring, etc.).
- Inaccessible technical knowledge—the designers have no interaction with the builders during the design phase.
- Wasted effort—since the construction documents are created prior to contractor selection, the designer can only try to show how manufactured items will fit into the project. The contractor will often replace some of the construction drawings with shop drawings from the manufacturer.
- Long schedules—since the DBB schedule is linear, construction cannot start until the design is completed.
- Unpredictable costs—besides inflation, market conditions will cause the price to fluctuate greatly.

- Chaotic and “unbusinesslike [sic]” procurement—prior to bid day, the general contractors (GCs) will contact many subcontractors to get quotes. not only will subcontractors will give different quotes to various GCs, but also GCs will take subcontractor bids until the last minute and, with all the rushing and last-minute details, the process is “hectic and unbusinesslike”.
- Conflict—with the use of DBB, it is assumed that the designers will create flawless plans and specifications. Claims will be filed, and can lead to budget overruns. “Disputes involve confusion over responsibility…all parties retreat to their corners…instead of collaborating”.
- Industrialization—because of industrialization, the manufacturing of products was needed. Manufacturers are the most knowledgeable about their products; however, the use of DBB does not allow the manufacturers to be involved in the design process.

Construction Manager/General Contractor (CMGC)

The CMGC project delivery method is “an integrated team approach to the planning, design, and construction of a highway project to control schedule and budget, and to ensure quality for the project owner” (Gransberg and Shane 2010). In the CMGC method, the owner retains the design services of a consultant or uses an in-house designer to complete the design work. The CMGC method is similar to the DBB method in that the owner retains the services of contractor under a separate contract. The difference between the two methods is that the contractor is brought onto the project during the design phase, and the contractor will “be at risk for the final cost and time of construction” (Gransberg and Shane 2010). The contractor is first retained under a preconstruction services contract. If the owner so chooses, the contractor can then be retained for the construction under a separate contract.

Figure 2 shows the contractual relationships in the CMGC method. As can be seen, the owner holds a contract with the designer and a separate contract with the builder. Furthermore, there is a contractual requirement for the designer and builder to communicate during the design phase. This allows the contractor to give substantial input into the design of the project.

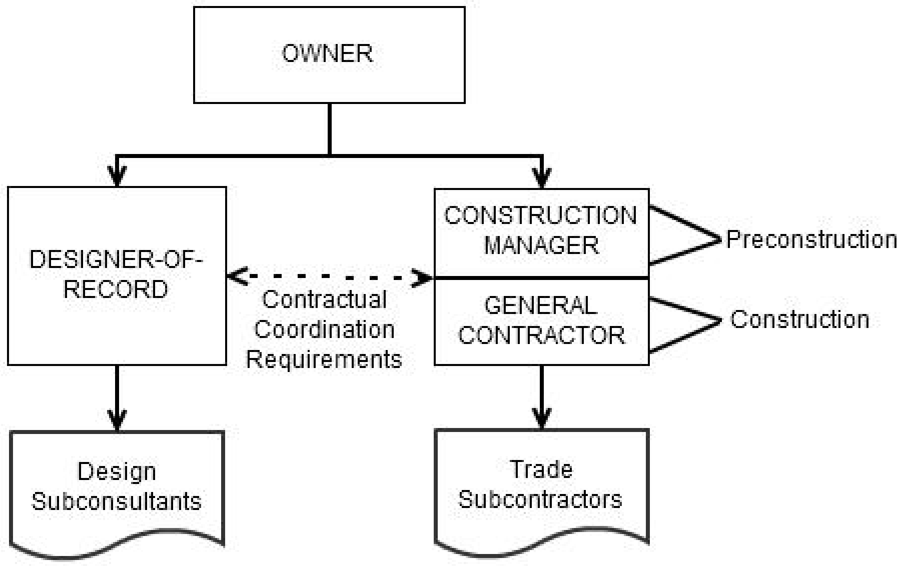

Figure 2: Construction Manager/General Contractor Contracts

There are three ways an agency can use to select the contractor in the CMGC method:

- One-Step, Request for Qualifications (RFQ), which is a qualifications based selection with no price component;
- One-Step, Request for Proposals (RFP), which is a best-value selection in which the contractor is chosen on a basis of both qualifications and price; or
- Two-Step, RFQ + RFP, in which the agency first releases an RFQ, and qualified bidders are then asked to submit a proposal to the RFP.

The CMGC method has many advantages and disadvantages. The Utah Department of Transportation (DOT) is one of the most experienced DOTs with the CMGC method. The Utah DOT Annual report states "the benefits of CMGC lead to enhanced designs, applied innovations, optimized schedules, and greater protection of the owner's investment" (Alder 2010). Chapter 3 will further explain the benefits and challenges of using the CMGC delivery method.

Design Build (DB)

As can be seen from Figure 3, the DB project delivery method is quite different from the DBB and CMGC methods. Under the DB method, the owner retains the services of a design-builder under a single contract. The design-builder is a "single, legal entity"

(Gransberg and Shane 2010) that both designs and builds the project. According to the FHWA, the DB method allows "certain aspects of design and construction to take place at the same time. This can provide significant time savings" (FHWA 2010a) when compared to the DBB method.

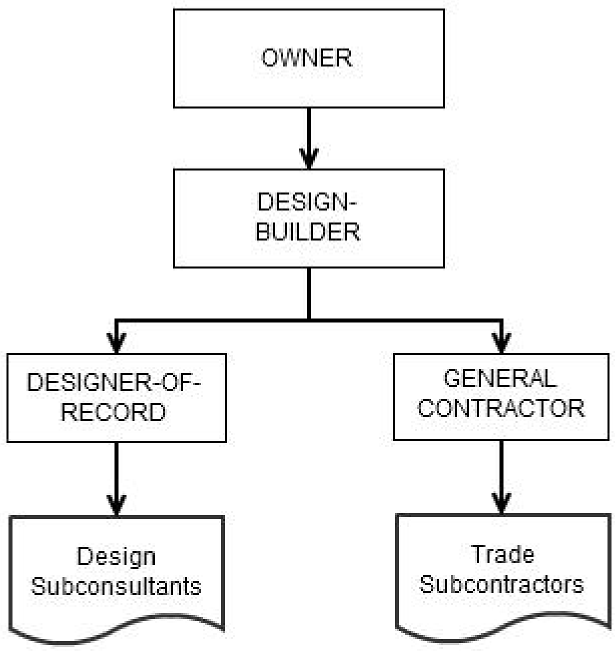

Figure 3: Design Build Contracts

The DB method is beneficial in that the overall project duration is shortened because the designer and builder are working together under the same contract, so the design does not need to be complete before construction can begin. However, from the owner's perspective, one of the biggest drawbacks of the DB method is that the owner gives up a certain amount of control over the project (Alder 2007). This is quite different from the DBB and CMGC methods where the owner has more control over the design details.

Preconstruction Phase

The preconstruction phase of a project is the planning and design phase. As stated earlier, in the CMGC method, the contractor becomes involved in this stage of the process. There are many good reasons for the contractor to be involved in this phase of the project, some of which include access to real-time pricing information and enhancing the constructability of the design. Preconstruction services and other necessary modifications to the traditional method process will be discussed in this section.

Preconstruction Services

One major benefit of using the CMGC method is that the contractor is involved in the project during the design phase. Chapter 3 will provide an extensive look at the benefits and challenges of the CMGC process. Preconstruction services are the services provided by the contractor during the design phase of a project. Gransberg and Shane noted that

> Preconstruction services can include almost anything the agency desires from its [CMGC contractor]. The range of possibilities runs the gamut from the typical estimating and scheduling assistance to the innovative, like managing public relations to the nearly unthinkable, such as preparing and submitting environmental permits to the unheard of, for instance developing a plan to relocate vagrants from under a bridge (Gransberg and Shane 2010).

Gransberg and Shane (2010) concluded that there are four main types of preconstruction services: design related, cost related, schedule related, and administrative related. Table 1 shows a list of possible preconstruction services organized by the four main types. Although this list shows many of the most commonly requested preconstruction services, it is not all inclusive.

As can be seen from Table 1, there are numerous preconstruction services that an agency can request of the contractor. Kuhn (2007) addressed the ever changing role of the contractor declaring that “expectations now include ‘filling in the blanks;’ defining scopes of work; assessing alternative materials, systems or methods; and managing the intent of the design team and desires of the owner” (Kuhn 2007). Gransberg and Shane (2010) found that preconstruction service fee for highway projects on average is 0.80% of the construction cost, and found that the cost was a “reasonable investment” for the owner.

Table 1: Preconstruction Services (adapted from Gransberg and Shane 2010)

• **Design Related:**	• **Schedule Related:**
o Validate agency/consultant design	o Validate agency/consultant schedules
o Assist/input to agency/consultant design	o Prepare project schedules
o Design reviews	o Develop sequence of design work
o Design charrettes	o Construction phasing
o Constructability reviews	o Schedule risk analysis/control
o Operability reviews	• **Administrative Related:**
o Regulatory reviews	o Coordinate contract documents
o Market surveys for design decisions	o Coordinate with 3rd party stakeholders
o Verify/take-off quantities	o Public information/public relations
o Assistance shaping scope of work	o Attend public meetings
o Feasibility studies	o Biddability reviews
o Encourage innovation	o Subcontractor bid packaging
• **Cost Related:**	o Prequalifying subcontractors
o Validate agency/consultant estimates	o Assist in right-of-way acquisition
o Prepare project estimates	o Assist in permitting actions
o Cost engineering reviews	o Study labor availability/conditions
o Early award of critical bid packages	o Prepare sustainability certification application
o Life cycle cost analysis	o Follow environmental commitments
o Value analysis/engineering	o Follow terms of Federal Grant
o Material cost forecasting	o Coordinate site visits for subcontractors
o Cost risk analysis	o Teamwork/Partnering meetings/sessions
o Cash flow projections/Cost control	
o Shape the project scope to meet the budget	

The following are definitions of some of the more common preconstruction services requested in CMGC projects (a full glossary of preconstruction services terms can be found in Appendix A):

- <u>Constructability review</u>: The American Association of State Highway and Transportation Officials Subcommittee on Construction (2000) defines a constructability review as "a process that utilizes construction personnel with extensive construction knowledge **early in the design stages** of projects to ensure that projects are buildable, while also being cost-effective, biddable, and maintainable."
- <u>Design review</u>: Gransberg and Shane (2010) state that a design review is preformed to "identify errors, omissions, ambiguities, and with an eye to improve the constructability and economy of the design submittal."

- Value analysis/engineering: According to the FHWA (FHWA 2012a), value engineering is defined as a systematic process of review and analysis of a project, during the concept and design phases, by a multidiscipline team of persons not involved in the project, that is conducted to provide recommendations for: (1) providing the needed functions safely, reliably, efficiently, and at the lowest overall cost; (2) improving the value and quality of the project; and (3) reducing the time to complete the project.
- Coordinate with 3rd party stakeholders: Many states require that the CMGC contractor coordinates with third-party stakeholders which can include anything from coordinating with various utilities to setting up informational meetings for the public to attend.

Chapter 4 will further discuss preconstruction services and choosing preconstruction services that will be of value to the CMGC project.

Modifications to the Traditional Project Delivery Process

Although the structure of the contracts between the DBB method and the CMGC method are similar, the fact that the contractor is involved during the design phase makes the two methods quite different. This section will discuss some of the major changes that an agency will face.

Design Contract Modifications and Collaboration

Because the contractor is involved in the design phase under a separate contract as the designer, the agency needs to take careful measure to ensure collaboration between the two parties. A paper by Shane and Gransberg (2010), emphasizes that the "major advantage was … in the collaboration between the designer and the builder during the preconstruction phase." However, some agencies note that getting the designer and contractor to want to work together as a difficulty when first beginning to use the CMGC method (Acimovic 2011, Alvarado, 2011).

This seems to be a common issue for agencies using the CMGC method. All state agencies are familiar with the traditional delivery method. With DBB projects, there is no contractual agreement between the designer and the builder. Since the builder enters the project earlier than in DBB projects, there is also now a need for the builder to work with the designer during the design phase. Because of this need, the owner must modify both the designer's and builder's contracts to include clauses stating that relations must exist between the two parties.

Shane and Gransberg (2010) noted that "open collaboration does not automatically occur because the agency has selected [CMGC] project delivery. Collaboration must be 'engineered' into the preconstruction service process through carefully written contracts for both the designer and the builder." Contract clauses need to be included specifically stating that collaboration must occur. If one of the parties is not actively participating in adequate collaboration, this would be considered a breach of contract, and the owner could effectively deal with the situation. Collaboration is a highly important part of using CMGC. "The importance of having staff which are not only experienced and capable, but are also willing to work hard at making a collaborative type project work is recognized by all parties [i.e. owners, designers, and contractors]" (Scheepbouwer 2010).

Gransberg and Shane (2010) found that the common design contract modifications include: coordination of design packages with construction bid packages, joint coordination with third parties during design, facilitate CMGC design review, joint value engineering with the contractor, and design milestones specified to match preconstruction services.

Another difficulty when implementing CMGC is making sure that all members of the team know what the CMGC procedures entail and how to use the new process properly (Acimovic 2011, Alder 2011, Alvarado 2011, Balis 2011, Dodson 2011, Panel 2011, Utah 2011). As can be seen in Chapter 3 of this document, this is one of the challenges that agencies face when implementing the CMGC method and will be discussed in detail in that chapter.

Best Value Selection Process

When an owner decides to use CMGC, they *must* make sure that the contractor selection process is fair and transparent. This is because when using CMGC, the winning contractor is usually chosen on a basis of best-value selection. Palaneeswaran and Kumaraswamy state:

> the 'best value' procurement is one that is structured to consider price and other relevant factors in making the bid selection to provide the greatest 'value for money' to the client. The best methods are the ones that allow the entire team to be selected based upon capabilities, experience, and qualifications, not merely on low price. Determining the successful bidder for a contract requires a detailed assessment of available information (Palaneeswaran and Kumaraswamy 2000).

Not only does the process need to be fair and transparent, but the owner also need to make sure that the process is known to the competitors, or the unsuccessful contractors will surely protest the award. Gransberg and Shane state:

> the owner publishes transparent prequalification criteria along with its procedures for using the input from contractor's proposals in determining the outputs of the evaluations. This puts all the contractors on an even footing and makes the defense against a possible protest stronger. Second, once published, the owner *follows its evaluation procedures to the letter*, collecting documentation along the way to prove that the decisions made for the project flow directly from the published evaluation plan and its attendant criteria. Finally, the [CMGC] selection program is logical and the decisions that flow out of it are based on *defensible logic* (Gransberg and Shane 2010, italics added).

Gransberg and Shane bring up two important factors in the decision-making process. First the owner must make sure that the grading criteria are known to the bidding contractors, then the owner must follow that grading criteria therefore making the process defensible. Unsuccessful bidders can then determine what factors in the process made them unsuccessful.

Independent Cost Estimate

Since the contractor is brought onto the project during the design phase in CMGC projects, the agency must choose the contractor on something besides price alone. Once the contractor is working on the project, there are no other "bidders" against the CMGC contractor. Agencies need to make sure they are getting a fair price for the project with the public's money. Some agencies choose to validate the CMGC contractor's prices by comparing them to past similar projects, and some simply do not have a method in place

(Shane and Gransberg 2012). Other agencies choose to use an Independent Cost Estimate (ICE) consultant as a verification of the CMGC contractor's prices.

The Utah DOT is one agency that uses the ICE consultant to validate prices. Alder gives an excellent overview of the Utah DOT's use of the ICE to validate prices in the 2011 Annual Report:

> To determine if the project pricing is realistic, UDOT [Utah DOT] secured the services of a third party estimating company that provides production rate based bids for comparison. This company works independently of both UDOT and the contractor. Neither UDOT nor the contractor can see the ICE results until bid opening. According to UDOT policy, any bids that are higher than 10% of the ICE may not be awarded. After each bid opening a meeting is held with UDOT, the ICE, and the contractor to review line items that differ by more than 10%. During this meeting it is determined if both estimators considered the same assumptions, risks, and Measurement and Payment description. If errors are determined in the bids, both the contractor and the ICE are allowed to correct their bid and resubmit. To reduce bid item conflicts at bid opening, UDOT initiated the use of Measurement and Payment meetings and Pricing meetings prior to bid submittal. The goal is to identify conflicting assumptions of what to include in each line item. (Alder 2012)

Some agencies take full advantage of the knowledge that the ICE consultant brings to the project, and the ICE consultant becomes one of the team members. Others view the ICE consultant simply as a price verification and do not allow the ICE consultant to actively participate in the process other than providing a "bid". (Shane and Gransberg 2012). Chapter 5 will discuss in detail the value of the ICE consultant.

Motivation

As previously stated, the CMGC delivery method is a new delivery method for highway agencies. In 2010, a comprehensive study on the CMGC project delivery method was conducted and resulted in the National Cooperative Highway Research Program (NCHRP) Synthesis 402 (Gransberg and Shane 2010). Additionally, the FHWA is encouraging the use of CMGC by highway agencies through the *Every Day Counts* (*EDC*) initiative, along with several other new methods, in an effort to enhance the country's infrastructure. The drive to incorporate the CMGC method into highway agencies is high, evidenced by the fact that the CMGC concept was part of the first *EDC* initiative and was carried into the second *EDC* initiative. Furthermore, the interest in the CMGC method has grown rapidly which is evidenced by the increased attendance at FHWA-sponsored CMGC Peer Exchanges by state highway agencies. The FHWA has also sponsored several CMGC Summits in an effort to expand the use of CMGC throughout state agencies.

Two of the three journal articles that comprise this thesis give an in-depth explanation of the motivation for the specific articles, which are a direct result of the researchers attending the CMGC Peer Exchanges. Because many states are just now obtaining the legal authority to use the CMGC method in their respective states and because of the culture shift required when using the CMGC method, guidance is needed. This research is part of a bigger research project in which the final deliverable is to develop a guidebook for the use of CMGC by highway agencies.

Problem Statement

Guidance is needed by the public transportation agencies that are beginning to use the CMGC method. Hence, this thesis explores three research questions. The first focuses on making a case for the use of the CMGC delivery method. The research question revolves around the major difference between the CMGC method and the DBB method, which is contractor involvement in the design phase, and how an agency can properly utilize the expertise of the contractor during this phase by choosing the most beneficial preconstruction services. Finally, the last research question explores the use of an ICE consultant to validate the CMGC contractor's prices. The following are questions that will be answered in this thesis:

- *Why should an agency use the CMGC method?*
- *How can the agency decide which preconstruction services to require of the contractor? and*
- *How can the agency ensure that they are receiving a fair price for the project?*

Content Organization

This thesis contains three journal articles that comprise Chapters 3, 4, and 5. Although each of these chapters contains a stand-alone document, they all focus on the preconstruction phase of the CMGC delivery method. The three chapters begin with a broad overview of the entire CMGC method and the benefits and challenges associated with delivering a CMGC project (Chapter 3), then the focus is narrowed to the preconstruction phase of the CMGC method (Chapter 4), and finally the focus is narrowed further to discuss the ICE consultant as part of the preconstruction phase (Chapter 5).

Chapter 3 was submitted to the Transportation Research Board and was accepted for publication and presentation at the 2012 annual meeting. The chapter provides an overview of the CMGC method and an analysis of the benefits and challenges associated with the implementation of the CMGC method. This analysis provides agencies an introduction to the CMGC method and explains how the agency can benefit from implementing the CMGC method into their program. This chapter also addresses possible challenges that an agency might face during the implementation.

Chapter 4 will be submitted for publication in the American Society of Civil Engineers *Journal of Management in Engineering* and provides a closer look at the preconstruction phase of the CMGC method. Once an agency decides to incorporate the CMGC method into their program, they need to understand how to gain the most benefit from the method. One way to gain the most benefit is to choose valuable preconstruction services. This chapter will provide an agency with a framework for choosing which preconstruction services to require of the CMGC contractor.

Chapter 5 was submitted to the Transportation Research Board and was accepted for publication and presentation at the 2013 annual meeting. The chapter provides an analysis of the value added to the CMGC method by the ICE consultant. Although it is not a necessity, the ICE is a unique element that can be used by an agency to validate the CMGC contractor's estimate. This chapter discusses the value that the ICE consultant brings to the project.

Chapter 2—Overall Approach to Research Methodology and Validation

The rigor used by researchers to collect data is crucial to the authority of the researcher's findings. This research used qualitative research methods only. Because the CMGC method is new to the highway industry, there are few agencies that have used the CMGC method and few projects delivered using the CMGC method. Thus, little quantitative data is available on CMGC projects. Furthermore, the researchers needed an in-depth look at the CMGC process; therefore, qualitative research methods were essential. The three main research instruments used in this research included

- literature review,
- content analysis, and
- case study research.

First a literature review was performed to determine the state-of-the-practice for transportation agencies using the CMGC project delivery method. The overall literature review performed for this research can be seen in Chapter 1. This literature review was performed to provide a background of the CMGC delivery method and to benchmark the state-of-the-practice of the delivery method. In addition to the background literature review, literature reviews for each of the three journal articles was performed to provide more specific literature to the topics discussed in each of the papers. Thus, a literature review section can be found in Chapters 3, 4, and 5.

This research relied heavily on content analysis research. Content analyses were performed on solicitation documents, presentations, and previous case study research. A content analysis is a research method defined as the "systematic assignment of communication content to categories according to rules and the analysis of relationships involving those categories" (Riffe et al. 2005). The data are analyzed to find patterns and characteristics, which when applied correctly will prove to be valid (Riffe et al. 2005). The content analysis provided a means to determine the trends of several categories within the CMGC process. Upon the completion of the literature review for each paper, the content analyses were performed. In Chapter 3, a content analysis of the presentations given at the 2011 CMGC Peer Exchange held in Utah was performed. This was done to update the analyses performed in the writing of the NCHRP Synthesis 402. Since no major research had been conducted on the CMGC delivery method since the writing of the synthesis, the best way to update in the information was to analyze the presentations given by agencies with CMGC project experience. This provided the basis for the research for the next two papers.

Case study research was also used for this research. Case study research is “a research strategy which focuses on understanding the dynamics present within single settings” (Eisenhardt 1989). The case study methodology followed Eisenhardt’s (1989) theory. Structured interviews were created and followed to the best of the researcher’s abilities. Furthermore, additional information added by the interviewees was added to determine differences between agencies and any gaps in the study. The structured interview questionnaire that was used for the CMGC case study projects discussed in Chapter 4 is shown in Appendix B. The structured interview questionnaire that was used for the ICE consultants that was used in Chapter 5 can be found in Appendix E.

Chapter 4 used all three of the research instruments. First a literature review was performed to determine which preconstruction services are used in the design phase, and it also provided the categories in which the preconstruction services could be divided into. Next a content analysis of 50 solicitation documents for CMGC projects was performed. The specific factors found in the literature were used during the content analysis of the solicitation documents. Finally, a content analysis of 27 case studies was performed looking for the same factors that were found in the literature and in the content analysis of the solicitation documents. The results were cross-referenced to determine which factors were most likely to be used and which were found to be most valuable from the agency’s perspective. Using the two different content analyses provided a means to compare the results from two different sources to find the trends in which preconstruction services were most often used. This tool allowed for management of the data.

Chapter 5 used all three research instruments as well. First a literature review was performed to determine the use of the ICE consultant in CMGC projects. This showed that the use of an ICE consultant on CMGC projects is not common. Next, a content analysis of the presentations given at the 2012 CMGC Peer Exchange in Massachusetts was performed. This allowed the researchers to determine which characteristics to look for in the research.

From the literature review and the content analysis of the presentations, a case study interview was created. Four ICE consultants were interviewed as part of the case study research.

Figure 4 shows the order in which the research instruments were used for the research in this thesis. As can be seen from the figure, first a literature review was used. Then either a case study or a content analysis, or both, was performed. Finally from the results of the literature review, content analysis, or case study research, conclusions were drawn.

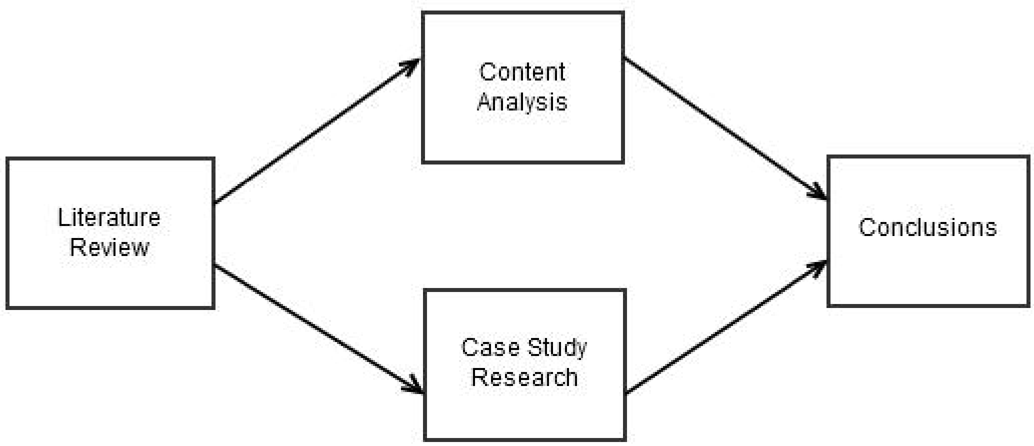

Figure 4: Research Methodology Flow Chart

The use of the three different research instruments provided the researchers with data from three separate sources which could then be cross-referenced to each other to determine where the sources provided the same data, and conclusions could be drawn. As more sources are used to find the data, the conclusions become more valid. Using three sources of information provides three different ways for the data to be compared and analyzed.

Chapter 3—Benefits and Challenges of Implementing Construction Manager/General Contractor Project Delivery: The View From the Field

Schierholz, J. Gransberg, D. D., and McMinimee, J. (2011). "Benefits and Challenges of Implementing Construction Manager/General Contractor Project Delivery: The View from the Field." *2012 Transportation Research Board* Paper #12-1206, National Academies, January 2012.

This chapter provides a broad look at the CMGC delivery method, analyzing the benefits and challenges associated with the delivery method. This journal article updated the previous literature on the benefits and challenges associated with CMGC. Furthermore, this article sets the base for the research that follows in the next two chapters. This article can be used by the upper management of agencies to help them decide if they should try to implement CMGC into their programs.

Abstract

The CMGC project delivery method is an emerging method in the transportation industry. To promote a better understanding of the benefits and challenges of implementing this promising project delivery method the FHWA sponsored a CMGC Peer Exchange in June 2011 in Utah as part of the *EDC* program. This paper presents the output from that conference based on a content analysis of the presentations from the conference, a panel discussion, and an interview with the Utah Department of Transportation. These results were combined with the results of the NCHRP Synthesis 402 to benchmark the state-of-the-practice in terms of recognized benefits and challenges of implementing CMGC. The paper concludes that the state-of-the-practice for CMGC is advancing and expanding since the NCHRP Synthesis 402 was completed in 2009. The top five benefits found in the synthesis remained in the top five but the CMGC contractor's ability to accelerate the schedule has become the most important benefit sought by departments of transportation (DOT). It also concludes that the major challenge to implementation is the need for training for DOT personnel as well as the consulting firms and construction companies that will be involved before attempting to implement CMGC project delivery.

Introduction

The CMGC project delivery method is "an integrated team approach to the planning, design, and construction of a highway project, to control schedule and budget, and to ensure quality for the project owner" (Gransberg and Shane 2010). The method has been used regularly for many years in building construction, but now, as a result of the FHWA's *EDC* program (Mendez 2010) it is beginning to gain acceptance as an effective means to accelerate the delivery of desperately needed infrastructure renewal projects. There are three primary team members on a CMGC project: the owner, the designer, and the CMGC contractor. The CMGC contract consists of two parts: preconstruction services and construction (Anderson and Damnjanovic 2008). The contractor is hired early in the design process and works closely with the designer on the preconstruction services contract and once a guaranteed maximum price (GMP) is established the CM becomes the GC and completes the construction. Additionally, in CMGC highway projects, the CMGC contractor is expected to self-perform some fixed percentage of that actual construction work (Mendez 2010), unlike CM-at-Risk in the building industry where the CM often self-performs no work.

In June 2011, the FHWA hosted a CMGC Peer Exchange conference in Salt Lake City, Utah, as part of its EDC program. Agencies interested in implementing CMGC were able to hear presentations about the CMGC process from experienced agencies. Speakers at the conference included three FHWA members, six state Department of Transportation (DOT) members with CMGC experience, the Transportation Director of the City of Phoenix, the vice president of Sundt Construction, and a consulting engineer with many years of CMGC experience. Presentations ranged from overviews of using the CMGC method at the federal and state levels to individual case studies conducted by various states. There was also a panel discussion with four state DOTs, one FHWA representative, and the Sundt Construction vice president. Furthermore, the research team conducted an interview with the Utah DOT while in Salt Lake City. A content analysis of the presentations, panel discussion, and interview was performed and several trends in the benefits and challenges associated with CMGC were found.

Motivation

Many states interested in implementing CMGC are being met with some resistance by either state authority (laws restricting the use of CMGC) or local authority (agency members hesitant to change). With conferences such as the CMGC Peer Exchange, members can bring back knowledge about the CMGC delivery method and discuss the benefits and challenges of this project delivery method to open a discussion to implement CMGC. The NCHRP Synthesis 402 highlighted the benefits and challenges of CMGC (Gransberg and Shane 2010). However, as states continue to implement CMGC on a wider variety of projects, more benefits are realized and more challenges are observed and overcome. Therefore the objective of this paper is to capture the collective lessons learned on the CMGC method presented at the conference and in the literature, synthesize them, and furnish a source for interested DOTs to find a critical evaluation of the benefits and challenges of implementing CMGC project delivery.

Literature Review

In 2010, the NCHRP Synthesis 402 was completed. The following advantages and disadvantages of CMGC were the top in each category according to frequency taken directly from the NCHRP Synthesis 402:

Advantages:

1. "The ability of the constructor to make substantive/beneficial input to the design.
2. The enhanced ability to accelerate the project's delivery schedule.
3. Enhanced cost certainty at an earlier point in design than DBB [Design-Bid-Build].
4. The ability to bid early work packages as a means to mitigate the risk of construction price volatility and accelerate the schedule.
5. Owner control over the details of the design." (Gransberg and Shane 2010)

Disadvantages:

1. "Reconciling the conflict between the primary motivations of the [CMGC contractor] and the designer (i.e., cost control versus conservative design to reduce design liability).
2. That the owner must still administer/coordinate both a design and a construction contract.

3. The final actual cost is not known until the GMP [Guaranteed Maximum Price] is established.
4. Agency personnel are trained to properly implement [CMGC] project delivery." (Gransberg and Shane 2010)

The synthesis concluded that the key to realizing the method's benefits for the DOT was the designer's willingness to participate actively and willingly in the CMGC preconstruction process and the preconstruction services received in a CMGC project are a "distinct benefit to the project's cost, schedule, and ultimate quality" (Gransberg and Shane 2010).

The underlying purpose of implementing Construction Manager (CM)-at-Risk in the commercial building sector is to furnish professional management to all phases of the project life to an owner whose organization may not have those capabilities internally, such as a church or small public entity (Strang 2002). However, the vertical model for CM-at-Risk project delivery is different than the ones in use for highway CMGC projects. The building sector models contemplate a contract where the CM-at-Risk is not required to self-perform any of the construction:

"The construction manager[-at-risk] is an agent of the Owner in managing the design process, but takes the role of a vendor when a total cost guarantee is given" (Strang 2002). Not only do all DOTs have the internal capabilities to professionally manage their design and construction, but many DOTs are also statutorily prohibited from awarding construction contracts to general contractors (GCs) that do not self-perform. In fact, many states, including Iowa, Indiana, Michigan, and Oklahoma, have a statutory minimum percentage of self-performed work (Shane and Gransberg 2010). States who use Federal Gas Tax monies for road projects must require contractors to self-perform 30% of the work or ask for a waiver.

A report on the City of Seattle's CMGC program offers three "significant benefits" of CMGC to self-performance:

- "The [CMGC] can exert better control of the project schedule if they are self-performing parts of the work that are essential to the critical path for the project, especially fundamental structural elements, such as concrete or framing, on which other subcontractors' work depends

- Subcontractors may prefer that the [CMGC] have a stake in the performance of the work
- The ability to self-perform can be part of what makes the job attractive to top-notch [CMGC] firms, since they customarily perform the type of work they bid for and have crews on hand to fulfill those responsibilities" (Denzel et al. 2004).

Since the CMGC contractor is usually selected early in the design process, it will collaborate with the owner and designer during all phases of the project, including but not limited to planning, design, third party coordination, constructability reviews, cost engineering reviews, value engineering, material selection, and contract package development (Gransberg and Shane 2010). The CMGC contractor and the designer must commit to a high degree of collaboration. This is especially vital when the agency is using CMGC to implement new construction technologies as the Utah DOT did when it introduced accelerated bridge construction techniques using the Self Propelled Modular Transporter technology (Alder 2007). In the agreement, the owner authorizes the construction manager to make input during project design. The owner will either complete the design with its own design personnel or out-source the design work to a consultant. UDOT does it both ways, depending on project requirements. UDOT reported that the major issue with using in-house designers is ensuring that the DOT designers commit to meeting a design schedule in the same fashion as design consultants (Gransberg and Shane 2010).

Synthesis 402 identified only seven DOTs with CMGC experience (Alaska, Arizona, Florida, Michigan, Oregon, Rhode Island and Utah) and only Arizona, Florida and Utah had completed more than two projects. Thus, the pool of national CMGC experience is quite shallow, making the requirement to transfer the lessons learned in those few agencies critical to the successful implementation of CMGC contemplated by the FHWA EDC program. Hence, this paper will attempt to document the state-of-the-practice regarding CMGC's benefits and challenges through the use of content analysis (Weber 1985) in both the literature and in the presentations given at the Peer Exchange in Salt Lake City.

Results of the CMGC Peer Exchange Content Analysis

A content analysis was performed on the presentations conducted at the CMGC Peer Exchange in Utah to develop a collective consensus on the benefits and challenges of implementing CMGC project delivery. Transportation researchers have long used this form of analysis to develop “valid inferences from a message, written or visual, using a set of procedures” (Neuendorf 2002). The research instrument revolves around a set of standard categories into which key words appearing in a written document, in this case a presentation or journal paper, can be placed and the frequency of their appearance is computed to infer the content of the document (Weber 1985). This study conducted content analysis consisted of two levels. First, all instances of each keyword were counted in each presentation and the context was recorded. Secondly, that context was used to determine, if possible, whether the author was discussing a benefit or a challenge. This allowed an inference to be made regarding the presenter’s experience on its CMGC projects. Summarizing the results for the entire population, permits trends can be identified and reported.

The results were combined with the results tallied in Synthesis 402’s analysis of fifteen documents. These are shown in Table 2 (Benefits) and Table 3 (Challenges), and the final count out of fifteen is listed in the NCHRP Synthesis 402 column. An additional fourteen columns were added to the tables representing the presentations, panel discussion, and Utah DOT interview. Looking at the two tables, one will note that there are more benefits than challenges noted. A total of 28 benefits were mentioned, an increase of eleven from the total seventeen benefits listed in the synthesis. The presentation identified fifteen total challenges versus the thirteen listed in the synthesis. Furthermore, the number of times that the top 25% of challenges were mentioned is significantly lower than the top 25% of benefits.

Table 2: Benefits of Using the CMGC Project Delivery Method

Benefits	Total (out of 29)	NCHRP Synthesis 402 (out of 15) (Gransberg and Shane 2010)	Utah DOT, #1 (Park 2011)	FHWA-HQ, #1 (Nadeu 2011)	FHWA-HQ, #2 (Balis 2011)	Consultant (McMinimee 2011)	Utah DOT, #2 (Alder 2011a)	Contractor (Rowley 2011)	Utah DOT, #3 (Newell 2011)	Oregon DOT (Dodson 2011)	Colorado DOT (Acimovic 2011)	FHWA-CFLHD (Hammontree 2011)	Arizona DOT (Alvarado 2011)	City of Phoenix (Bearup 2011)	Panel Discussion (Panel 2011)	Utah DOT Interview (Utah 2011)
Ability to fast-track	21	10	X		X	X	X		X	X	X	X	X	X		X
CM/GC Design Input	18	12	X							X		X	X	X		X
Early Knowledge of costs	16	10			X	X						X	X	X		X
Ability to bid early work packages	14	10							X		X	X		X		
Owner control of design	14	8				X	X			X	X		X			X
Flexibility during design/construction	12	4					X		X	X	X	X	X	X		X
Shared risk allocation	12	2	X		X	X		X	X	X	X	X	X			X
Focus on quality and value	10	4				X		X		X			X	X		X
GMP creates cost control incentive	9	6		X		X					X					
Spirit of Trust	9	4						X			X		X	X		X
Enhanced design quality	8			X	X	X		X	X	X				X		X
Teamwork/Partnering	8		X			X		X			X	X	X	X		X
Innovation	7		X	X		X		X	X		X			X		
Reduces design costs	6	5														X
Competitive bidding possible	6	4				X	X									
Third-party coordination facilitated	6	3							X			X				X
Select GC on qualifications	5	4												X		
Open books contingency accounting	5	4												X		
CM/GC is owners advocate during design	5	3						X			X					
Enhanced DOT Internal Efficiency	5				X		X					X	X	X		
Common Goals between team members	4				X			X	X		X					
Less radical change from DBB than DB	3	2				X										
Public Trust	3		X						X	X						
Quality of subcontractors	3												X	X		X
Enhanced construction quality	3												X	X		X
Cost model	2										X			X		
Leadership	2									X	X					
Social/Political Benefits	1		X													

Table 3: Challenges of Using the CMGC Project Delivery Method

Challenges	Total (out of 29)	NCHRP Synthesis 402 (out of 15) (Gransberg and Shane 2010)	Utah DOT, #1 (Park 2011)	FHWA-HQ, #1 (Nadeu 2011)	FHWA-HQ, #2 (Balis 2011)	Consultant (McMinimee 2011)	Utah DOT, #2 (Alder 2011a)	Contractor (Rowley 2011)	Utah DOT, #3 (Newell 2011)	Oregon DOT (Dodson 2011)	Colorado DOT (Acimovic 2011)	FHWA-CFLHD (Hammontree 2011)	Arizona DOT (Alvarado 2011)	City of Phoenix (Bearup 2011)	Panel Discussion (Panel 2011)	Utah DOT Interview (Utah 2011)
Training required for agency personnel	11	4			X		X			X	X		X		X	X
CM/GC and designer have different agendas	9	7									X		X			
Requires different procurement culture	9	3	X					X		X	X	X	X			
Actual cost not known until GMP is set	7	5									X					X
Still have two contracts to manage	6	5										X				
Lack of clear leadership during design	5	2						X					X			X
Designer not obligated to use CM/GC input	4	2									X		X			
Reduced competition among subs	4	1				X					X				X	
CM/GC doesn't control the design schedule	4	1						X			X		X			
Picks CM/GC early in process	3	3														
Contingencies difficult to allocate	3	2							X							
CM/GC can unintentionally assume design liability via review comments	2	2														
DOT Internal Inefficiencies - First project	2									X						X
CM/GC underestimates cost of preconstruction services	1	1														
Getting legislation passed	1														X	

Benefits

Table 2 shows the results of the content analysis regarding the benefits of implementing CMGC project delivery method. Of the 28 benefits, the top seven will be expanded on:

1. The ability to fast-track
2. CMGC contractor design input
3. Early knowledge of costs
4. Ability to bid early work packages
5. Owner control of design
6. Flexibility during design/construction
7. Shared risk allocation

Although the top five benefits listed in the synthesis remained in the top five overall, the order slightly changed. Furthermore, a few more benefits were added to the list of being substantially beneficial. The most commonly mentioned benefit was the ability to fast-track the project's schedule. This not only refers to being able to take advantage of concurrent design and construction, but also aggressive or strict schedules. Based on the analysis most presenters and authors cite that implementing CMGC results in an overall reduction in total project time. Along with being a benefit to the agencies, this is also a benefit to the general public since fast-moving projects reduce the user costs of congestion and enhance safety by minimizing the time work zones are in operation (Dowall 2003).

The next most mentioned benefit was the CMGC contractor design input followed by early knowledge of costs. Being able to have the CMGC contractor's input during the design phase allows the contractor to apply construction knowledge and experience early in the project which provides enhanced constructability on the project and potential cost and time saving. Getting the CMGC contractor involved early in the process also allows for early knowledge of costs through both real-time pricing and the ability to lock in certain material prices by bidding out early construction packages (Gransberg and Shane 2010). This is beneficial in many aspects such as maintaining the budget. Furthermore, with early knowledge of costs, the owner can make sure the scope is maintained or potentially even increase the scope of the project.

The next highest benefit was the ability to bid early work packages. This gives the contractor extra time before the construction begins. This allows the contractor to spend extra time on the schedule and allows time for the contractor to figure out complex construction requirements before the activities become critical. Furthermore, materials can be ordered in advance to lock in material prices and avoid potential construction delays waiting for materials to arrive.

Unlike design-build project delivery, the owner retains a high degree of control over the design while receiving design input from both the designer and the contractor. In this integrated environment, the owner's probability of getting a design with which it is satisfied is enhanced. The integrated environment creates another benefit and that is the flexibility CMGC offers throughout both design and construction. This is especially important when there is a need to consider third party or public input into the design. Also, the level of flexibility allows for changes in the scope of the project to occur during the design phase. With the contractor already on board, changes to the design can be made in the context of the contactor's knowledge of constructability and potentially reducing their ultimate impact on the CMGC project's schedule and budget. Savings can then be used to expand the scope if desired. The final major benefit revolves around the idea of shared risk allocation. Several presenters indicated that using the CMGC method allowed them to negotiate risk with the contractor and in doing so, reduce the amount of contingency that was contained in the GMP (McMinimee 2011, Alder 2011, Bearup 2011). One interesting trend to note is that although this idea was cited only twice by the authors reviewed in the synthesis, it was mentioned ten times during the presentations. While it only ranked as number seven overall, it was the second most mentioned benefit during the presentations.

Challenges

Table 3 shows the challenges of using CMGC project delivery method. Of the fifteen challenges, the top four will be expanded on:

1. Training required for agency personnel
2. CMGC contractor and designer have different agendas
3. Requires different procurement culture
4. Actual cost is not known until GMP is set

The most commonly noted challenge was the need to train agency personnel in this new project delivery method. However, this is a transient issue in that once the training is complete, the issue dissipates. Conferences, such as the CMGC Peer Exchange in Utah, are an excellent vehicle to transfer the knowledge of experienced agencies to those in need of training. These workshops provide great opportunities for inexperienced agencies to interact with experienced agencies and learn from the collective past experiences.

The next two top challenges are that the CMGC contractor and designer have different agendas and that the CMGC delivery method requires a different procurement culture. These challenges can also be addressed by simply educating all parties involved in the process. Strebel (1996) stated, “For many…change is neither sought after nor welcomed. It is disruptive and intrusive. It upsets the balance.” Additionally, Kotter and Schlesinger (2008) stated that people “resist change because they fear they will not be able to develop the new skills and behavior that will be required of them.” They went on to say “it is because of people’s limited tolerance for change that individuals will sometimes resist a change even when they realize it is a good one” (Kotter and Schlesinger (2008).

However, there are ways to mitigate this fear of the unknown. Kotter and Schlesinger (2008) noted “one of the most common ways to overcome resistance to change is to educate people about it beforehand. Communication of ideas helps people see the need for and the logic of a change” and “if the initiators involve the potential resisters in some aspect of the design and implementation of the change, they can often forestall resistance.”

Outreach to the consulting engineering and construction industries can identify the conflicts and furnish the foundation to be able to address them through standard contract clauses and training. Owners need to become strong leaders and actively engage the issues that changing the procurement culture involves. One method discussed in the conference was to hand-pick the agency personnel on early CMGC projects and select those individuals with a reputation for willingness to try new approaches and a propensity to innovate. Furthermore, as each party is educated about the changes in the CMGC procurement culture, they should be able to better prepare themselves to react to the change after the first contract is awarded.

The final major challenge is that the actual cost is not known until the GMP is set. Five of the seven citations were in the literature and only two presenters brought this up in their presentation. While this is certainly true, to understand it requires the context in which the keyword was used. In all cases, the CMGC delivery method was being compared with design-build project delivery. Design-build requires the contractor to fix a lump sum price before the design is complete and in doing so, forces the design-builder to include contingencies to cover the uncertainties present at the time the price proposal is submitted (Gransberg et al. 2011). Therefore, since a GMP is not established until the design has advanced to a point where contingencies can be minimized, the contract amount for a DB contract will always occur earlier than a CMGC contract, but experience has shown that the owner must pay a premium (in terms of higher contingencies that are not declared like they would be in the open books CMGC system) for the privilege of that early knowledge.

Conclusions

Given the above described analysis, the study was able to arrive at a number of conclusions. First, the state-of-the-practice in CMGC is advancing and expanding since Synthesis 402 was completed. This is evidenced by the fact that new benefits of using CMGC have been realized by DOTs that were not recognized in the synthesis. Among these are the ability to negotiate shared risk allocation, enhanced design quality, and opportunity for meaningful teamwork and partnering. Each of the three were mentioned eight more times in the Peer Exchange presentations than in the synthesis, and the ability to develop innovation was cited of seven more times in the presentations than in the synthesis. This leads to the conclusion that as agencies gain CMGC experience, they become more aware of its impact on a project's cost, time, and quality. This conclusion reinforces the need for this paper that outlines the benefits as perceived by DOTs in the field on actual CMGC projects.

In a similar vein, the top five benefits in the synthesis remained in the top five overall but "ability to fast-track" replaced "CMGC contractor design input" as the most often cited benefit. Given the current urgency being imparted on the rapid renewal of deteriorating bridges and roads and the emphasis given in the EDC program, it is not surprising that schedule benefits are taking the place of design benefits. This infers the conclusion that schedule risk is now the DOT's top priority. The conclusion is validated by the fact that "shared risk allocation" moved from the bottom of the list in the synthesis to the top 25% in the overall list.

The final conclusion deals with the need for training for DOT personnel before attempting to implement the CMGC project delivery. Additionally, designers and contractors need to be educated about CMGC along with the agency personnel. This requirement argues for joint industry-agency training programs where all parties to the CMGC contract can develop a common understanding of the project delivery method and benefit from the experiences of those agencies, consultants, and contractors who successfully pioneered the method.

To properly develop such a training curriculum, research is recommended to identify the issues that may form barriers to implementation in the consulting engineering and construction contracting industries. The research would capture the ways in which each barrier was surmounted and recommend a toolbox full of possible solutions based on lessons learned. The NCHRP 10-85 project is currently ongoing to develop guidelines for implementing the CMGC method. However, its scope does not extend into the training realm. As a result, a new effort will need to be made to prepare the foundational package to transfer the technology via continuing education for all the stakeholders in the CMGC process.

Acknowledgements

The authors would like to acknowledge the members of the FHWA and the Utah DOT who made it possible for the research team to attend this important meeting. A special thanks goes to Randy Park, PE and Phillip Ellsworth of the Utah DOT for making the arrangements to interview the CMGC project teams.

Chapter 4—Framework for Choosing Preconstruction Services that will add Value to a Construction Manager/General Contractor Project

Schierholz, J. and D.D. Gransberg, "Framework for Choosing Preconstruction Services that Add Value to a CMGC Project," *Journal of Management in Engineering* ASCE, Submitted November 2012

This chapter narrows the focus on the CMGC process. In this chapter, the preconstruction phase is analyzed. Because the concept of involving the contractor during the design phase under a separate contract than the designer, agencies need to know how to get the most benefit from the early contractor involvement. This article provides a way for agencies to determine which preconstruction services to require of the contractor during the design phase based on the specific project.

Abstract

As research on this topic has progressed, the research team has become aware that many state DOTs new to the process are unsure of not only how to choose which projects the CMGC project delivery method should be used, but also how to progress with the process once that decision has been made. This paper will analyze case studies performed on 27 different CMGC projects along with a content analysis of CMGC project solicitation documents. Although the project factors are poor indicators of what preconstruction services should be used on a project, the reasons for selecting CMGC as the delivery method can be used to determine the preconstruction services needed. Furthermore, an analysis of the type of preconstruction services requested of the CMGC contractors was performed. It was found that for both highway and non-highway projects, design-related and cost-related aspects of the CMGC process were found to be most valued by the agencies.

Introduction

The CMGC project delivery method is a project delivery method which uses two contracts: one for preconstruction services and one for construction services. As stated in the NCHRP Synthesis 402 "[CMGC] project delivery's major benefit to the agency is derived from contractor input to the preconstruction design process" (Gransberg and Shane 2010). Furthermore, although the owner will be spending more money for the preconstruction services, the overall cost will be reasonable and can potentially decrease the design costs (Gransberg and Shane 2010, Utah 2011).

Through attendance at CMGC Peer Exchanges and meetings with some state DOTs in various stages of using the CMGC project delivery method, the authors have discovered that agencies that are new to the CMGC process have several questions and concerns about choosing the right project to utilize the CMGC delivery method. Furthermore, once they choose to use CMGC as the delivery method for a given project, they want to know how to maximize the benefits of the presence of the contractor in the design phase by requesting the most valuable preconstruction services.

This paper is written on the basis of results obtained from 27 case studies performed on CMGC projects. Although all the case study projects are transportation related, eighteen of the case studies are of agencies whose primary projects are highway related projects, while the remaining nine are non-highway related agencies. Although the CMGC project delivery method is new in the highway industry, other transportation agencies have been using it for several years and are proficient at the process. Therefore, this analysis of the two sectors will furnish a means to show what is used in the highway industry and what has worked in similar industries.

Although these case studies are all similar in nature, some case studies were used to gather some information while others were used to gather other bits of information. Furthermore, the case studies were about projects that were at different stages of development, so some agencies could not properly answer all the case study questions. For these reasons, not every case study contains the exact same data. Consequently, some of the categories analyzed in this paper will have less than 27 total responses. This will be noted when it occurs.

Literature Review

In 2010, a comprehensive review of the CMGC project delivery method for highways was performed, resulting in the development of the NCHRP Synthesis 402. The authors used case studies, literature, and a content analysis of CMGC project solicitation documents to find the preconstruction services most frequently used in CMGC projects. Gransberg and Shane (2010) concluded that the preconstruction services will fall into four categories:

design, cost, schedule, and administrative. Table 1 (see Chapter 1) shows the menu of preconstruction services and the categories to which they relate.

West (2012) found that "the ability to accelerate a project schedule is the most commonly cited benefit in literature and case studies because it reduces schedule risk." This conclusion came from an analysis of 35 literature sources and 44 case studies which all used some form of alternative contracting methods. Alternative contracting methods include methods such as CMGC, DB, Early Contractor Involvement (ECI), Public Private Partnerships (PPP), and Alliancing/Partnering. Because "the ability to accelerate a project schedule" was so commonly cited, it can be concluded that it was seen as a valuable piece of the process with respect to all alternative contracting methods analyzed. For further information on specific benefits of CMGC projects, see Chapter 3.

The average fee for preconstruction services for highway projects is 0.80% of the construction cost (Gransberg and Shane 2010). Although this is just a fraction of the total cost of the project, the owner will still want to make sure that they are spending money in the most valuable way possible. For further reference on preconstruction services, see Chapter 1.

Case Study Analysis

Case study participants were asked a number of questions regarding the process they used when implementing the CMGC delivery method on the project. They were asked to select the project factors considered when choosing to use the CMGC delivery method, the reasons that went into deciding to use CMGC as the delivery method, and the preconstruction services requested of the contractor on the project. Finally, they were asked to numerically rate the preconstruction services as they related to the CMGC project delivery method. Each of these categories will be explained in detail and has a table associated with it. The numbers indicate how many positive responses were gathered from each source (i.e. highway project case studies and non-highway project case studies). Furthermore a discussion of the responses found in the content analysis of 50 solicitation documents will be associated with each table. The tables are organized according to the ranking determined from the highway project case studies.

Project Factors

In all of the case study interviews, the interviewees were asked to identify which project factors contributed to their decision to use CMGC as the delivery method on a given project. The process of determining the project delivery method is important on any project. The CMGC delivery method is simply one of the options that an agency possesses to deliver a project. The goal is choosing the right delivery method for the given project. One way to do this is to identify which project factors best correlate with a certain delivery method. Table 4 shows the top seven project factors that are strongly considered when choosing to use the CMGC delivery method for highway projects. The order of importance for highway projects is then compared to the results of non-highway projects.

Table 4: Project Factors Considered in the Decision to use CMGC as the Delivery Method

Project Factor	Highway (# Out of 12 projects)	Non-Highway (# Out of 15 projects)
Schedule issues	12	11
Project budget control issues	12	7
Project technical complexity	11	11
Project third party interface issues (utilities, business access, railroads, etc.)	11	6
Project environmental issues	10	3
Project traffic control issues	9	2
Project Monetary size	7	8

As can be seen from Table 4, agencies strongly considered “schedule issues” and “project budget control issues” on highway projects. The “schedule issues” factor was also the number one answer from the non-highway case studies. Scheduling issues are an important factor when an agency is deciding whether or not to use CMGC. Many projects need to either be completed in during a certain time of year or have a date by which they must be complete. When an agency is using CMGC, the contractor is involved early in the design process and works with the agency and designer to ensure that the tight schedule will be met.

Although “project budget control issues” was not ranked as highly in the non-highway case studies, it was one of the highest ranking project factors for highway projects.

Many projects have a strict budget that needs to be kept, and involving the contractor early can help to manage that budget.

Another highly-ranked project factor was the "technical complexity of the project" factor. Again, the early involvement of the contractor can help to alleviate some of the issues that arise when the project is technically complex. This is especially true if the complexities relate to the construction of the project. As can be seen from the table, this project factor was ranked as one of the top factors considered in non-highway projects.

The contractor can also help during the preconstruction phase if the project requires a large amount of communications with third parties. It is important for the contractor to be involved before the design is complete when dealing with many third party entities. Then the contractor can communicate with the third parties and then communicate the concerns or adjustments needed to the designer.

In the content analysis of 50 solicitation documents, the project type (i.e. bridge, road, etc.) was the highest ranked factor for using CMGC on a project. The next two highest ranking factors both dealt with the experience and availability of the agency staff. The next highest ranking factor in the solicitation documents was interface issues with third parties on the project. The rate of positive responses found in the content analysis of solicitation documents is rather low. This is due to the fact that the project delivery method is chosen prior to the issuance of the solicitation document.

From Table 4, the top two project factors considered when deciding to use CMGC as the delivery method for a highway project are schedule-related and cost-related factors. The next two factors are design-related and administrative-related project factors. Three of the seven project factors most commonly considered are administrative-related project factors, and two of the seven are cost-related. When an agency is deciding which project delivery method to use on a highway project, many of the factors that they analyze are administrative-related factors.

Reasons Selected

Next, the interviewees were asked to identify the reasons why they chose to use CMGC to deliver the project. It is important for an agency to identify why they chose to use a specific delivery method for a given project. If the project is or is not successful due to the delivery method, the agency can go back to the reasons they used to choose the delivery method and determine why the outcome may have occurred. Table 5 shows the eleven most frequently selected reasons for choosing to use CMGC as the delivery method for the project.

Table 5: Reasons for choosing to use CMGC as the Delivery Method

Reason	**Highway** (# Out of 12 projects)	**Non-Highway** (# Out of 15 projects)
Get early construction contractor involvement	12	14
Encourage constructability	12	7
Reduce/compress/accelerate project delivery period	11	9
Flexibility needs during construction phase	9	12
Encourage innovation	9	11
Redistribute risk	9	11
Complex project requirements	8	12
Third party issues (permits, utilities, etc.)	8	5
Facilitate Value Engineering	6	13
Establish project budget at an early stage of design development	5	10
Constrained budget	5	6

The table shows the most frequent reason for choosing CMGC is that the agency will get early construction contractor involvement. It was cited by nearly all the case study participants and, furthermore, was ranked as the sixth highest reason in the content analysis of solicitation documents. This is also one of the benefits of using the CMGC delivery method. This reason is directly related to the first two major project factors considered in the CMGC delivery method decision. The early contractor involvement leads to better a project schedule and budget control.

Constructability is another reason agencies choose to use the CMGC delivery method. This was also found to be ranked as the second highest in the content analysis. There is no better person to explain how constructible the design set is than the person who will be constructing the project. This action also saves time later in the process, as there will be less change orders, etc.

The next reason used to select CMGC to deliver a project on highway projects is to reduce the project delivery period. This is directly related to the project factor of schedule issues. If the project is on a tight schedule, having the contractor on the project during the design phase can be beneficial because the contractor can tell the designer which work packages to complete first. In this manner, materials can be ordered and construction can begin as early as possible.

The “flexibility during the construction phase,” “encourage innovation,” and “redistribute risk” reasons were each cited nine times in the highway case studies. These reasons were also highly ranked in the non-highway case study projects and in the content analysis. Since such a strong relationship is created between the team members (i.e. owner, designer, and contractor) during the preconstruction phase, changes during the construction phase can be easily worked out between the three parties involved. “Flexibility needs during construction” was viewed as one of the most important factors when choosing CMGC for non-highway projects but was ranked very low in the content analysis.

“Innovation on the project” is also an important reason to choose CMGC as the delivery method for a project. The Tuttle Creek Dam Rehabilitation project (see Appendix C.8) was a six-and-a-half year project in which the United States Army Corps of Engineers needed to make repairs on the dam. It was one of the largest repairs on an active dam that has ever been performed. In this project, the contractor worked with the designer to invent a new technology to be used on the project. This saved not only time, but also money. Furthermore, the CMGC method was appropriate for this project because it was challenging to develop contract documents due to the innovative technology. “Encouraging innovation” was ranked highly among the non-highway case studies and was one of the top categories in the content analysis.

Finally, it is important in a project that the right entities hold the proper risk. Through the team environment, it is easy for the owner, designer, and contractor to sit down and decide which risk belongs to which party. Being able to distribute this risk properly, and sometimes eliminate the risks, inherently brings the cost of the project down. This reason was ranked highly among the non-highway case studies and was one of the top categories in the content analysis.

From Table 5, the top two reasons for selecting CMGC as the delivery method for highway projects are both design-related reasons. The next highly-ranked reason is schedule-related. Of the next three reasons for selecting CMGC as the delivery method for highway projects, two of them are design-related factors, and one is cost-related. Five out of the top ten reasons for highway projects are design-related. Cost-related reasons account for three of the top ten. Schedule-related and administrative-related reasons each account for one reason that agencies choose to use CMGC as the delivery method for highway projects.

Preconstruction services most frequently asked for

Finally the interviewees were asked to select which preconstruction services were required of the contractor on the project. Table 6 shows a list of the most frequently requested preconstruction services in the case studies. This information was gathered in only twenty of the twenty-seven case studies; therefore, the number of non-highway projects is only out of eight case studies.

Table 6: Preconstruction Services Requested when using the CMGC Delivery Method

Preconstruction Phase	**Highway** (# Out of 12 projects)	**Non-Highway** (# Out of 8 projects)	**Content Analysis** (# Out of 50 documents)
Constructability review	12	8	41
Prepare project schedules	12	7	24
Prepare project estimates	11	7	32
Assist/input to agency/consultant design	10	7	14
Coordinate with 3rd party stakeholders	10	6	14
Cost engineering reviews	10	6	2
Validate agency/consultant design	9	4	1

As can be seen from the table, a constructability review is the most commonly requested preconstruction service for highway projects, non-highway projects, and out of the content analysis. This is consistent as also being one of the highest ranked reasons for choosing CMGC for highway projects and was also highly ranked in the content analysis.

The next highest ranking preconstruction service for highway projects is to prepare project schedules. This preconstruction service is directly related to the project factor, “schedule issues,” which was ranked as one of the top project factors considered when choosing to use CMGC for highway projects. With the contractor there to prepare project schedules throughout the design phase, the agency can determine if the construction will meet the tight schedule.

"Preparing project estimates" was used as a preconstruction service in eleven of the twelve highway case studies. This was highly ranked in the content analysis and was a second-level ranking on non-highway projects as it was on highway projects. This preconstruction service is important because the contractor can provide the owner and designer with real-time pricing information. Therefore, design decisions can be made according to price if needed.

Table 6 shows that of the top two preconstruction services requested of contractors in the highway projects, one is design-related and the other is schedule-related. The third most request preconstruction service is cost-related. Of the next three preconstruction services, there is one each of design-related, administrative-related, and cost related services. For preconstruction services requested of the contractor in highway projects, three of the top seven are design-related; two, cost-related; one, schedule-related; and one, administrative-related.

Value added to the process according to interviewee

Finally, the case study participants were asked to rate certain aspects of the CMGC project delivery method as to how much value was added to the process. They were asked to rate each aspect from 0 to 5; with 0 being no added value and 5 being of the highest value. It is important to determine the amount of value added by these individual aspects to the project. Any time an agency adds something to the project, the cost of the project will increase. Therefore, the agencies need to ensure that the services they are asking for in CMGC projects are actually valuable to the process. Table 7 shows the results of the case studies. Again the results are color coded to show how the results from the highway case study projects related to the non-highway case study project. The rating column shows the average rating of all the case studies in the given category. The gray columns show how many responses were used to determine the average rating. Not all the case studies included the same aspects, so some numbers are lower than others. Furthermore, some agencies did not have an opinion on some of the aspects, so no response was recorded or used in calculated the average rating.

Table 7: Aspect of the CMGC Delivery Method that Adds Value to the Process

Service that adds value	**Highway**		**Non-Highway**	
	Rating (5-high; 0-low)	Number of responses (out of 10)	Rating (5-high; 0-low)	Number of responses (out of 9)
Constructability reviews	5.00	10	3.89	9
Early contractor involvement	4.90	10	4.00	9
Cost engineering reviews	4.78	9	3.78	9
Schedule validation	4.70	10	4.00	4*
Scope definition/clarification	4.63	8	4.00	4*
Value analysis/value engineering	4.56	9	4.33	9
Coordination with 3rd party stakeholders	4.50	10	3.75	4*
Early awards for critical bid packages (i.e. asphalt materials, steel, etc.)	4.50	8	3.75	4*
Design reviews	4.50	10	3.89	9

As can be seen from the table, the most valuable part of the CMGC process was the constructability reviews. This scored a 5, the highest ranking, among all 10 highway case study projects that responded to this question. Constructability reviews are seen as extremely valuable on highway projects. This result was expected because it was ranked in the highest category in the reasons for choosing the CMGC project delivery method and was one of the most requested preconstruction services. Although the non-highway case study participants did not rate constructability reviews as highly as the highway projects, it was still rated as above average.

The second-highest valued aspect for highway projects was the "early contractor involvement" aspect. It was rated at 4.90 for highway projects and 4.00 for non-highway projects. This aspect is ranked highly in both categories because having the contractor included during the design phase is the whole point of the CMGC project delivery method. The next item on the list is "cost engineering reviews." Again, this aspect was rated very highly in the highway case study projects. Although it was not ranked as highly in the non-highway case study projects, it was still rated as being above average. Furthermore, this aspect is linked to factors in the other categories as well. "Project budget issues" was one of the highest ranked project factor considered when choosing to use CMGC on a project. A constrained budget was in the fourth level ranking in the reasons for choosing CMGC. It was also a third-level ranking in the preconstruction services category.

"Schedule validation" is also ranked highly in both the highway and non-highway case study projects. This is directly related to one of the highest ranked preconstruction services of "preparing project schedules." The contractor will not only validate that the project will be able to finished on time, but will also prepare more detailed construction schedules.

From Table 7, the highest valued aspects of the CMGC process are design-related for highway projects. The next most valued aspect is cost-related, followed by a schedule-related aspect of the CMGC process. In fact, four of the top nine most valued aspects of the CMGC process are design-related for highway projects. Three of the nine are cost related-aspects; one, schedule-related; and one, administrative-related. For highway projects, the most valued aspects are design-related, and the second most valued aspects are cost related.

As can be seen from Table 7, the aspects most valued by the highway project case studies do not match well with the aspects most valued in the non-highway projects. Table 8 shows the rankings of the aspects for the non-highway projects.

Table 8: Aspect of the CMGC Delivery Method that Adds Value to the Process; Non-Highway Projects

Aspect	**Non-Highway Projects**
Conceptual estimating	4.56
Value analysis/value engineering	4.33
Schedule validation	4.00
Early contractor involvement	4.00
Scope definition/clarification	4.00
Constructability reviews	3.89
Design reviews	3.89
Budget validation	3.80
Cost engineering reviews	3.78

From Table 8, the two highest valued aspects of the CMGC process are both cost-related for the non-highway case study projects. In fact, four of the nine most valued aspects of the CMGC process are cost-related aspects. Additionally four more are design-related aspects. The final aspect is schedule-related. For non-highway projects, cost-related aspects and design-related aspects comprise most of the valued aspects of the CMGC process.

Conclusions

Two main conclusions are drawn from the analysis of the twenty-seven case studies.

- Project factors do not necessarily correlate with the preconstruction services in the contracts; however, the reasons for selecting CMGC as the delivery method for the project correlate to the preconstruction services requested. Furthermore, these preconstruction services are also highly valued by the agency in highway projects. The solicitation documents had the most information about which preconstruction services were requested of the contractors. This is because by the time the solicitation document is released, the project delivery method has already been determined. Therefore, the solicitation documents do not contain much information about the reasons why CMGC was chosen for a project.
- In highway projects, the most valued aspects of the CMGC process were design-related, followed by cost- and then schedule-related and administrative-related. In non-highway projects, however, the most valued aspects of the CMGC process were cost-related followed by schedule-related, and then design-related services. Overall, the CMGC process is valued for its design-related and cost-related aspects.

The first conclusion drawn from the analysis suggests that there is not a high correlation between the project factors and the preconstruction services requested on the projects. The project factors are used to determine how to deliver the project. The main delivery methods for highway projects are Design-Bid-Build, Design-Build, and CMGC. Since each method has its own advantages and disadvantages, agencies need to determine from the project factors which delivery method will work best for the project. Each of the four categories (i.e. design, cost, schedule, and administrative) need to be carefully evaluated when choosing which delivery method to use for a project. When the project factor is used to determine the project delivery method, it does not mean those factors directly impact what services are requested of the contractor.

The reasons for selecting CMGC as the delivery method should lead the agency to the preconstruction services that they request in the solicitation documents. For highway projects, the top two reasons that an agency chooses CMGC are both design-related reasons. The third reason is schedule related. Furthermore, of the top two preconstructions services that they require of the contractor, one is a design-related service and the other is a schedule-related service. However, of the most valued aspects of the CMGC process, both of the top two are design-related aspects. The schedule-related aspect is also highly ranked. For the highway project case studies, the out of the top reasons for selecting CMGC to deliver the project, half of them were design-related. For the preconstruction services, nearly half of the services were design-related. Finally, of the most valued aspects of the CMGC process, nearly half of them were design-related. Therefore, it can be concluded that for highway projects, CMGC is useful for design-related purposes. It can also be concluded that for highway projects, CMGC is useful for cost-related purposes. Although design-related factors were highest in each of the categories analyzed, the cost-related factors came in as a close second.

The non-highway case study projects show different results. From Table 8, the non-highway projects value the cost-related aspects of the CMGC process as much as they value the design-related aspects. As stated earlier, the CMGC delivery method has been used for a long time in delivering non-highway projects and is fairly new in the highway industry. The results of this analysis suggest that the type of project does not seem to affect that using CMGC to deliver the project is valuable to both the design-related aspects and the cost-related aspects.

Chapter 5—Critical Analysis of the Value Added by the Independent Cost Estimate Consultant to the Construction Manager/General Contractor Project Delivery Method

Schierholz, J. and Gransberg, D. D., (2013). "Critical Analysis of the Value Added by the Independent Cost Estimate Consultant to the Construction Manager/General Contractor Project Delivery Method." 2013 *Transportation Research Record*, Accepted for publication in the Proceedings of the 2013 Transportation Research Board Annual Meeting, January 2013.

This chapter looks at a specific aspect of the CMGC process, the ICE consultant. The use of an ICE consultant is not a necessity for a successful CMGC project. Currently, few agencies that use CMGC also use the ICE consultant. This chapter shows that hiring an ICE consultant to be involved during the design phase can be beneficial to the agency because the consultant brings not only estimating expertise, but also construction expertise, to the project team.

Abstract

The CMGC project delivery method is an emerging project delivery method in the transportation industry. As part of its *EDC* program, the FHWA is promoting the use of CMGC through Peer Exchanges. One recurring theme of the Peer Exchange was the fact that value was added to a construction project during the preconstruction phase by the early involvement of the contractor and the ICE consultant. A content analysis of the presentations given at the most recent Peer Exchange in Boston, Massachusetts, along with four case studies from ICE consultants were reviewed along with literature on the topic to determine the extent of the value added to the CMGC process by involving the ICE consultant.

Introduction

The CMGC project delivery method is a relatively new method which uses two contracts: one for preconstruction services and one for construction services. Although this project delivery method is still in its developmental stages, some advantages to using it have already surfaced. As stated in the NCHRP Synthesis 402:

> [CMGC] project delivery's major benefit to the agency is derived from contractor input to the preconstruction design process. The cost of preconstruction is a reasonable investment that accrues tangible returns. The average fee for preconstruction services on highway projects was found to be 0.80% of estimated construction costs (Gransberg and Shane 2010).

This indicates that, although the owner will be spending more money for the preconstruction services, the overall cost will be reasonable and can potentially decrease the design costs (Gransberg and Shane 2010, Utah 2011).

The CMGC project delivery method is gaining popularity in many states. In the CMGC project delivery method, there are three primary team members: the owner, the designer, and the CMGC contractor. However, many DOTs that are new to the process have many questions about the process, especially how to validate the prices given to them by the CMGC contractor during the preconstruction phase. To ensure that the public is getting the best value for its dollar, some DOTs use an ICE to validate the CMGC contractor's prices. The ICE consultant acts as the fourth member of the team.

In May 2012 the FHWA hosted a CMGC Peer Exchange conference in Boston, Massachusetts as part of its *Everyday Counts Program* (EDC). Presentations included the perspectives from contractors, designers, ICE consultants, and various DOTs at various stages of the CMGC process. A content analysis of these presentations was performed. Additionally, four different ICE consultants were interviewed for Case Studies on projects they have worked on. Finally, in an effort to determine the current state of practice, a literature review was performed.

Motivation

The authors of this paper worked with one state DOT as they gained the authority to use CMGC in their state. One of the biggest concerns of the DOT and the contractors was the issue of cost validation. This concern arises due to the fact that the design is not complete when the CMGC contractor is chosen; therefore, during the preconstruction phase, the CMGC contractor is "bidding" against itself. The DOT wants to ensure that the public is getting the best value for its dollar, so some DOTs use an ICE consultant to validate the CMGC contractor's prices.

Literature Review

In a paper by West, Gransberg, and McMinimee (2012), the authors noted that one of the effective tools in the CMGC project delivery method is the Blind Bid Comparison process. This process compares three estimates: the CMGC contractor's estimate, the Engineer's estimate, and the ICE. The owner can then compare the estimates. Generally, if the CMGC contractor's estimate falls within 10% of the ICE, the CMGC contractor will be awarded the construction contract. If not, factors that may affect the price of the project are discussed (West et al. 2012). In this method, the CMGC contractor is not allowed to see the ICE consultant's numbers. However, some states do allow all parties involved to view all numbers by the other parties (Shane and Gransberg 2012).

The ICE consultant may be heavily involved in the preconstruction process. One ICE consultant states that the ICE is "a competent and realistic estimate" (Lindley 2012a). The ICE consultant will discuss factors that may affect the price of the project such as risk, assumptions, means and methods, etc. with the CMGC contractor to make sure every person of the team is on the same page. The Utah DOT requires that the CMGC contractor must be within 10% of the ICE. Of course, each agency that utilizes the CMGC project delivery method has its own system in place as to how much of a difference will tolerated between the ICE and the CMGC contractor's estimate. Furthermore, each agency has its own method for choosing the ICE consultant and the timing of that selection (Shane and Gransberg 2012, Wilson 2012, Lindley 2012b, Stanton 2012, McDole 2012).

In a report by Gransberg et al. (2012), a case study analysis of ten case studies was performed. It was found that four of the ten case studies used the ICE to validate prices. Furthermore, four out of ten also used the blind bid comparison method. Although this is an effective tool in the CMGC project delivery method, it is not necessary for success. However, "the fact that UDOT [Utah DOT] the most experienced DOT uses both the blind bid and the ICE confirms their value" (Gransberg et al. 2012). Alder (2012) explains the Utah DOT's use of the blind bid comparison:

- "Designer, Contractor, and Independent Cost Estimator (ICE) prepare estimates.
- Bid items are compared confidentially.

- Bid items where one estimate is 10% above any other estimate are discussed.
- This may be repeated 3 times and then final bids are submitted.

> Once final bids are obtained the Department [Utah DOT] may chose [*sic*] to award the contractor with the construction contract, or sever CMGC and prepare the project for DBB" (Alder 2012).

The Utah DOT has created flow charts outlining their processes for the Blind Bid Opening and the Cost Analysis and Contract Award. These flow charts can be seen below. Figure 5 is the Blind Bid Opening flow chart, and Figure 6 is the Cost Analysis and Contract Award Process.

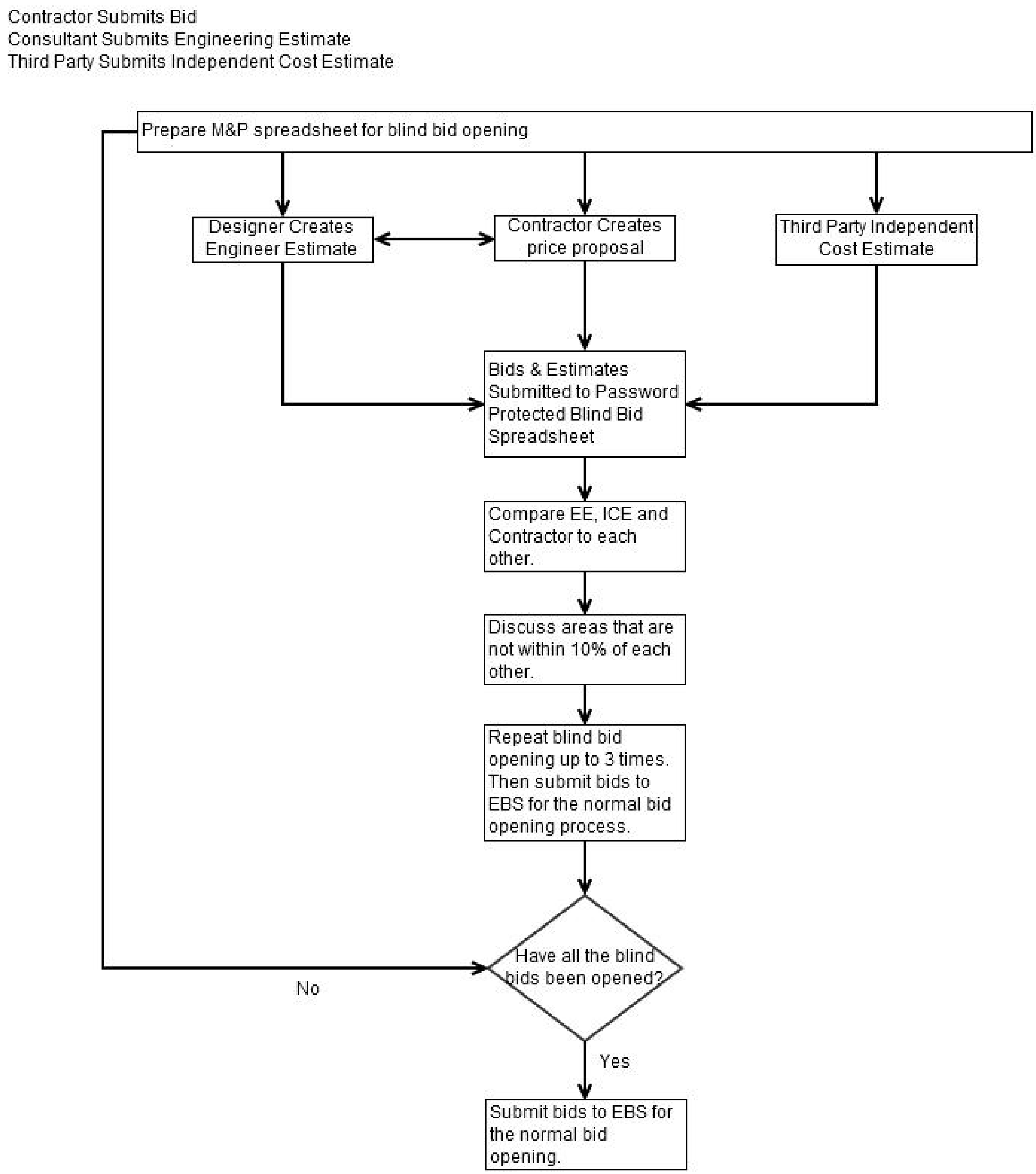

Figure 5: Utah DOT Blind Bid Opening Flow Chart (Adapted from Alder 2011)

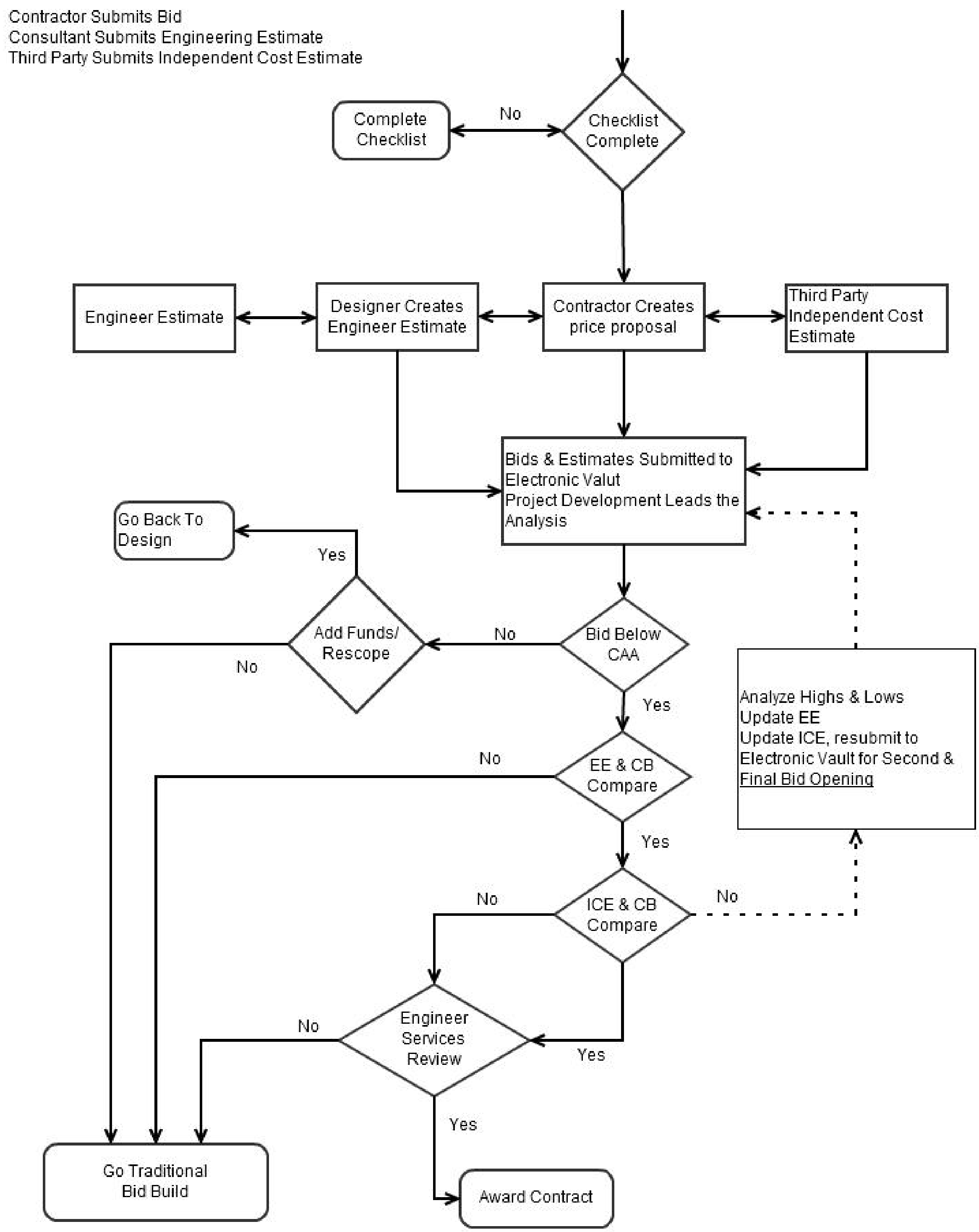

Figure 6: Utah DOT Cost Analysis and Contract Award (Adapted from Alder 2012)

As can be seen from Figure 5, the Blind Bid Opening flow chart, the designer, contractor, and ICE consultant each prepare a separate estimate. These numbers are entered into a spreadsheet, without any party able to see any other party's numbers. All the numbers for the estimates are compared to one another. At this point, the team sits down and discusses any variations in the numbers (i.e. numbers that are not within 10% of each other). The team can discuss any assumptions, risks, etc. associated with a specific number. When the discussions are over, each member refines their individual estimate. After sufficient time, the process is repeated. This is done up to three times before the final bids are submitted. At this point, it proceeds like a normal bid opening.

Figure 6 is the Cost Analysis and Contract Award flow chart. This chart goes more in depth as to how the bids are compared. As can be seen, the bids are submitted to the electronic vault. If the bids are higher than the Commission Approved Amount (CAA) then either funds need to be added to the budget or the project needs to be rescoped. The use of the CMGC project delivery method allows for this step to occur. Since the project is still in the preconstruction phase, it is easier to shape the scope to fit the budget. Since the estimates are being developed at this time, it is easy for the agency to see if they are going over budget and need to reevaluate the scope before the budget is completely blown away. If the bid is below the CAA then the Contractor's Bid (CB) is compared to the Engineer's Estimate (EE) and then to the ICE. After the comparison to the ICE, the ICE consultant has the opportunity to update and resubmit the bid one additional time. This is the point where the DOT determines if they will accept the Contractor's bid or not. If they do reach an agreement, the construction contract is awarded; if not, the project is converted to a DBB project.

However, this is just the method used by the Utah DOT. Gransberg et al. (2012) asserts that the CMGC contractor's estimate, EE and ICE are used in the beginning of the preconstruction phase to ensure that the project will fall within the agency's budget. If it does not, the agency needs to decide to reshape the scope or terminate the project. This process continues on throughout the entire preconstruction phase until approximately 90% design completion, which is when the GMP negotiations take place. Once the CMGC contractor submits an acceptable GMP, construction can begin (Gransberg et al. 2012). The ICE consultant is actively involved throughout this entire process helping to validate the

CMGC contractor's estimates and also to provide help adjusting the scope of the project if necessary to make it fit within the agency's budget constraints. Furthermore the ICE consultant may help with other tasks such as value engineering and developing cost models (Gransberg et al. 2012). It is important to note that the ICE consultant acts as a fourth member of the team. They are working to make sure that the DOT receives a fair price for the project, and they also may help in shaping the scope of the project. This all can be done through the early involvement of the contractor and the ICE consultant and the teamwork environment provided by the CMGC project delivery method.

Results of Independent Cost Estimate Case Studies

Four ICE consultants completed case studies in order to provide the authors with an in depth look at the process from the ICE consultant's point of view. Consultants that perform ICEs generally have many years of construction estimating experience (Gransberg 2012). One consultant noted that the members of his company had over 200 years of estimating experience (Lindley 2012b). As part of the case study, the consultants were asked to state which preconstruction services they performed on the project. Table 9 shows the list of all the preconstruction services performed by the ICE consultant in the four case studies. As can be seen from the table, the ICE consultant performs many preconstruction services. The most common preconstruction services performed by the ICE consultant, cited by all four case studies, include:

- Design reviews
- Verify/take-off quantities
- Prepare project estimates
- Material cost forecasting
- Validate agency/consultant schedules
- Construction phasing
- Discussions with the CMGC contractor, and
- Attend meetings between designer, owner, and the CMGC contractor.

These services are similar to the services performed by the CMGC contractor during the preconstruction phase. Involving the contractor early on in the process adds value to the project (West 2012). Therefore, if the ICE consultant is performing some of the same duties as the contractor, and validating what the contractor is doing, then it can be inferred that by including the ICE consultant on the project, value is being added to the project.

Table 9: List of Preconstruction Services offered by the Independent Cost Estimate Consultant according to Case Studies

Preconstruction Service performed by ICE	Wilson (2012)	Lindley (2012b)	Stanton (2012)	McDole (2012)	Total
Design Related					
Design reviews	x	x	x	x	4
Verify/take-off quantities	x	x	x	x	4
Validate agency/consultant design	x	x	x		3
Assist/input to agency/consultant design	x	x	x		3
Constructability reviews	x	x	x		3
Assistance shaping scope of work	x	x	x		3
Encourage innovation	x	x	x		3
Regulatory reviews	x	x			2
Feasibility studies	x	x			2
Design Charrettes		x			1
Operability reviews		x			1
Market surveys for design decisions		x			1
Cost Related					
Prepare project estimates	x	x	x	x	4
Material cost forecasting	x	x	x	x	4
Validate agency/consultant estimates	x	x	x		3
Cost engineering reviews	x	x		x	3
Value analysis/engineering	x	x	x		3
Cost risk analysis	x	x	x		3
Shape the project scope to meet the budget	x	x	x		3
Life cycle cost analysis	x	x			2
Cash flow projections/Cost control		x	x		2
Schedule Related					
Validate agency/consultant schedules	x	x	x	x	4
Construction phasing	x	x	x	x	4
Prepare project schedules	x	x	x		3
Schedule risk analysis/control	x	x	x		3
Develop sequence of design work		x			1
Administrative Related					
Discussions with the CMGC contractor	x	x	x	x	4
Attend meetings between designer, owner, and the CMGC contractor	x	x	x	x	4
Teamwork/Partnering meetings/sessions	x	x	x		3
Biddability reviews			x		1
Study labor availability/conditions			x		1

Throughout the case study analysis, it became obvious that there are no set rules when it comes to the ICE consultant. Some agencies retain the ICE consultant services prior to engaging the CMGC contractor services; others wait until after they have hired a CMGC contractor. In most cases, the ICE consultant assisted with the development of a cost model, but not in every project. As can be seen from Table 9, the ICE consultants are asked to perform a variety of different tasks depending on the agency and the project. Furthermore, the manner in which the ICE consultants are chosen by the DOTs varies as well. Some consultants responded to solicitation documents, while others were chosen from a prequalified pool of contenders.

Through the case studies, it was found that the range of fees for the ICE consultant's efforts was between 0.15% and 2.5%; however, the 2.5 % was an unusual amount and it generally ran under 1% for that particular ICE consultant. From the case study analysis, it is fair to say that the cost of obtaining the ICE consultant's services generally runs at a little less than 1% of the total construction cost.

All of the ICE consultants interviewed for these case studies offered the same advice: hire the ICE consultant early in the process to gain the most benefit. This seems reasonable since the agency would want the ICE consultant to have as much time as the contractor to develop the estimates and perform other duties specified by the DOT.

Results of the CMGC Peer Exchange Content Analysis

One of the presenters at the CMGC Peer Exchange in Boston, Gary Lindley, stated:

> One of the major contributions that our company brings to the 'Team' is that we have a huge amount of real world construction experience…Our varied experience in many states and with all types of construction, plus upper construction management experience, gives us the credibility to work with owners and the contractor. We have experienced estimators in structures, concrete, earthwork, railways, asphalt, utilities, scheduling, [and] aggregate production (Lindley 2012a).

The ICE consultant truly acts as a valuable fourth member of the CMGC team. The ICE consultant brings construction experience and knowledge to the table, and can offer valuable suggestions for the team while remaining objective in their opinions. This is one theme that was evident throughout the presentations in Boston.

A content analysis of all the presentations at the CMGC Peer Exchange in Boston was performed. Table 10 shows all the ways in which the ICE consultant is used in the CMGC process, according to the presenters. As can be seen from the table, the most noted use of the ICE consultant is to conform risks and to negotiate risk pricing and assumptions. Similarly, the second item in the table is that the DOT uses the other two estimates in the CMGC process to open up discussions with the CMGC contractor about Guaranteed Maximum Price (GMP), and any differences there might be in the prices. Two of the presentations stated that having the ICE consultant involved in the process added value. This is because, like two of the presenters noted, involving the ICE consultant in the process is adding another expert opinion to the process.

Table 10: Content Analysis of Presentations

Remarks from Presentations	Gransberg (2012)	Haynes (2012)	Park (2012)	Lindley (2012a)	Rowley (2012)	Wadsworth (2012)	Total (out of 6)
Conform risks and negotiate risk pricing/assumptions	x	x		x		x	4
DOT uses ICE and EE to discuss differences in the GMP with the CMGC contractor	x	x				x	3
Cost validation			x			x	2
Fair market values			x	x			2
Added value			x	x			2
Another expert opinion			x	x			2
Innovation				x		x	2
Team effort				x	x		2
Systems and methods				x		x	2
Use normal bid process		x					1
CMGC contractor's estimate must be within 10% of ICE		x					1
Pricing iterations		x					1
Company experience				x			1
Project knowledge				x			1

As can be seen from the table, there are many valuable uses for the ICE consultant. Most notably, the ICE consultant helps with pricing the risk. One way of driving down the cost of a project is to remove as much risk as possible. The ICE consultant helps to do this. Furthermore, the ICE consultants have many years of construction experience, and they add valuable knowledge to the team. The ICE consultant ensures that the DOT is getting a fair market price for the project. Randy Park, of the Utah DOT, stated in his presentation "Due to the value gained in making informed decisions, and the savings through innovations this additional cost [of hiring an ICE consultant] is outweighed by the overall value and long term cost-benefits to the Department" (Park 2012).

Conclusions

Involving the ICE consultant on a CMGC project is a good idea. The ICE consultant adds value to the project. This added value comes in many forms:

- Scope definition
- Developing cost models
- Value engineering
- Fair market value/cost validation
- Risk reduction
- Expert, third party opinions
- Extra set of eyes throughout the project whether it is for constructability reviews, schedule reviews, etc.

Although the cost of involving the ICE consultant varies from agency to agency, in general, it is less than 1% of the total construction cost. Therefore, the benefits of involving the ICE consultant greatly outweigh the cost. The ICE consultant acts as the fourth member of the project team as the team works toward the common goal of a successful project.

Acknowledgements

The authors of this paper would like to thank the FHWA for allowing the research team to attend the CMGC Peer Exchange in Boston, MA, and the ICE consultants who participated in the case studies for this paper.

Chapter 6—Consolidated Conclusions and Limitations

Conclusions

This section will provide an overview and analysis of the conclusions found in each of the three research papers. Chapter 3 gave the benefits and challenges of the CMGC process based on literature and a content analysis of the presentations at a peer exchange. There were three main conclusions in Chapter 3:

- First, the researchers found that the state-of-the-practice in the CMGC method is rapidly advancing. This was shown by the new benefits that had emerged since the publication of the NCHRP Synthesis 402. It was concluded that as agencies gain CMGC experience, they become more aware of its impact on a project's cost, time, and quality.
- The "ability to fast-track" a project was the most often cited benefit. This infers that schedule risk is at the top of an agency's priority list. This conclusion is validated by the fact that "shared risk allocation" was also cited in the top 25% of the list of benefits.
- Training for DOT personnel is needed before attempting to implement the CMGC delivery method. Furthermore, designers and contractors also need to be educated about the process before a CMGC project commences.

Chapter 3 updated some of the conclusions that were found in the NCHRP Synthesis 402 and set the base for the research that followed. Furthermore, it provided a look at the CMGC delivery method at a high level, noting the benefits and challenges associated with the entire process.

Chapter 4 provided an analysis of project factors, reasons for selecting CMGC, the preconstruction services requested of the contractor, and the value of the different aspects of the CMGC process according to the agencies. Two main conclusions were found in that chapter:

- Project factors do not necessarily correlate with the preconstruction services in the contracts; however, the reasons for selection CMGC as the delivery method for the project correlate to the preconstruction services requested. Furthermore, these preconstruction services are also highly valued by the agency in highway projects.

- In highway projects, the most valued aspects of the CMGC process were design-related, followed by cost- and then schedule-related. In non-highway projects, however, the most valued aspects of the CMGC process were cost-related followed by schedule-related, and then design-related services. Overall, the CMGC process is valued for its design-related and cost-related aspects.

Chapter 4 provided a closer look at the CMGC delivery method, by focusing on just the preconstruction phase of the process. This Chapter gives agencies that are new to the CMGC process a tool for determining which preconstruction services should be required of the contractor during the preconstruction phase.

Finally, Chapter 5 provides an analysis of the ICE consultant and the value brought to the team by the consultant. The paper had two main conclusions:

- The ICE consultant can add value to the project in many different forms including:
    - Scope definition
    - Developing cost models
    - Value engineering
    - Fair market value/cost validation
    - Risk reduction
    - Expert, third party opinions
    - Extra set of eyes throughout the project whether it is for constructability reviews, schedule reviews, etc.
- Although the cost of involving the ICE consultant varies from agency to agency, in general, it is less than 1% of the total construction cost. Therefore, the benefits of involving the ICE consultant greatly outweigh the cost. The ICE consultant acts as the fourth member of the project team as the team works toward the common goal of a successful project.

Chapter 5 has a narrow focus on the specific aspect of the CMGC process, the ICE consultant. The use of an ICE is not necessary in the CMGC process. However, the research conducted for the journal article suggests that using an ICE consultant during the preconstruction phase can be beneficial to the overall project when the expertise of the ICE consultant is properly utilized.

Limitations

For every research study, there are limitations. In Chapter 3, the limitations of the research were that the results of the NCHRP Synthesis 402 were only updated according to the presentations at the CMGC Peer Exchange in Salt Lake City in June 2011. Although the presenters came from various states, and various agencies, and had differing levels of experience with the CMGC delivery method, there was not a representative to present from every highway transportation agency that has ever used CMGC to deliver a project.

Furthermore, the content analysis consisted of the presentations given at the conference. Although the researchers had copies of each of the presentations, some of the presenters had more information on their slides than others. In some cases, the notes taken by the researchers during the presentations aided the analysis of the presentations. Therefore, some discussions by some presenters could have not been recorded, thus not included in the analysis of the presentations.

The limitations in Chapter 4 deal with the case studies themselves. In Chapter 4 there were 27 case studies that were analyzed to find trends in the CMGC method. Although these case studies were all focused on CMGC projects, some of them were performed for other research studies. Therefore, not every piece of information was collected in every case study. Furthermore, the raw data from each of the case studies was unavailable. In these instances, the summary results of the case studies were analyzed. Although the summary results should include all the necessary information, the author of one of the summaries may have left out some information that was unnecessary to the study that was being performed at the time.

The case studies were chosen be as representative as possible, and the researchers tried to choose experienced agencies, agencies new to the CMGC process, and agencies with varied geographical locations. The results cannot be generalized to interpret that they will hold true for every CMGC project ever. CMGC is the chosen delivery method for many different reasons, specific to agencies and the projects. Therefore, the conclusions of Chapter 5 are simply the results of those specific 27 case studies.

A content analysis of 50 solicitation documents was also performed for use in Chapter 4. While the researchers tried to keep the analysis as consistent as possible, a content analysis is subject to interpretation by the researcher. Therefore, some slight inconsistencies when compared to another researcher may exist.

Chapter 5 was based on the results of a content analysis of presentations at a CMGC peer exchange, four case studies, and a literature review. Therefore, the results of this research are limited to the interpretation of the presentations by the researcher, and the limited number of case studies. Few agencies use the ICE to validate prices during the CMGC process. Additionally, some of the agencies used the same ICE companies to perform the validation. This makes the research limited to the agencies that currently use the ICE to validate prices, and the ICE companies that they use in the process. Furthermore, some agencies that use an ICE consultant, do not fully utilize the expertise of the consultant. Also, only six of the presentations at the CMGC peer exchange had any mention of the ICE and ICE consultant. This was less than half of the total presentations given at the peer exchange. Therefore, the research is limited by the small number of case studies performed, and small number of presentations given over the topic.

Chapter 7—Contributions and Recommendations for Future Research

Contributions

In 2010, a comprehensive study on the CMGC project delivery method was conducted and resulted in the NCHRP Synthesis 402 (Gransberg and Shane 2010). Because of the FHWA's *EDC* program, the CMGC delivery method has been gaining popularity throughout the nation. The importance and timeliness of the CMGC delivery method is shown by the fact that the initiative was carried from the EDC1 program into the EDC2 program (FHWA 2012b). Public agencies are eager to use the delivery method in their respective states. Although the NCHRP Synthesis 402 research is only two years old, the push to use CMGC has caused many new aspects of the CMGC delivery method to become apparent. The research showed that as more agencies are gaining the authority to use the CMGC delivery method, the process is evolving. Furthermore, agencies are using it to realize previously unrecognized benefits.

Chapter 3 provided the base for this research because it essentially updated the information from the synthesis. This also helped to identify some of the gaps left by the research in the synthesis, and it identified new parts of the process that were emerging as states gained authority. For example, although there was information on the ICE and need for a cost validation, there was no research as to the value added to the CMGC process by the ICE consultant. This research took a slightly different look at the process and did not focus on the value of the estimate itself, but rather focused on the valued added to the CMGC process by involving a fourth member of the team. Since the ICE consultant often has significant personal construction contracting experience, they bring added knowledge to the team. Not only does the ICE consultant work as an advocate for the owner, but also as an advocate for the project.

Finally, Chapter 4 provides an analysis of certain aspects of the CMGC process, how they relate to one another, and how valuable they are to the owner. Although there has been research stating that preconstruction services are valuable to the owner, there was not a framework that identified how to choose the preconstruction services, and the ranking of the value of those services. Chapter 4 gives insight as to how to choose the preconstruction services by first identifying the reasons for choosing CMGC as the delivery method. Furthermore, previous research found that in alternative project delivery methods, one of the main benefits was schedule-related (West 2012). This was also found to be the number-one benefit cited by presentations at the peer exchange. However as the research progressed, it was determined that for CMGC projects, the most valuable aspects of the CMGC process are design-related and cost-related. This was true for both highway and non-highway projects.

Recommendations for Future Research

The CMGC delivery method is quickly gaining popularity. Because many state agencies are just now obtaining the authority to use it and are implementing it, the process is ever-changing. The research on this topic has just begun. Research on the CMGC delivery method could continue as follows:

- This research provides information on how to choose preconstruction services for a CMGC project. However, further research could be conducted quantifying the value added to the CMGC project by the services performed by the contractor during the preconstruction phase. If this research could be completed, the owners could put a value to each of the preconstruction services requested and use that as part of their decision-making tool to determine which preconstruction services to include as part of the CMGC contract.
- More research on the ICE and the ICE consultant needs to be performed. The research for this document was performed using a literature review, a content analysis of presentations, and four case studies. At this point, few agencies use the ICE and ICE consultant in the CMGC process. As more state agencies gain the authority to use CMGC, probably more agencies will decide to use the ICE to validate costs. As more data becomes available, more research should be performed to quantify the value of the using the ICE and ICE consultant.
- The benefits and challenges of using the CMGC process found in this research were found by adding the information obtained by performing a content analysis of presentations given at a CMGC peer exchange to the information in the literature (i.e. NCHRP Synthesis 402). This research could be further validated by adding case study research to the results of this research. After more state

agencies start to use the CMGC process, there could potentially be a wider variety of benefits and challenges identified.

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Overview of Appendices

The appendices are provided to give the reader additional information on the research in this study. Many of the case studies referenced in this study have not yet been published; therefore, summaries of each of the case studies will be shown. Furthermore, structured interview questionnaires and reference tables used in the research are included.

- Appendix A—Glossary of Preconstruction Services Terms
  - This appendix contains the definitions of all preconstruction services terms listed in Table 1: Preconstruction Services (adapted from Gransberg and Shane 2010) in Chapter 1.
- Appendix B—Structured Interview Questionnaire
  - This appendix contains the questionnaire that was used to obtain the CMGC project information from 19 of the 27 case studies, which can be seen in Chapter 4.
- Appendix C—Case Studies used in case study analysis
  - This appendix contains the summaries of each of the case studies. Since the case studies were completed for different research projects, the format of the summaries is not the same. The summaries have been left in the same format in which they will be or were published. Additionally, each case study has an appropriate citation at the beginning as to where it can be found. The data used can be seen in Chapter 4.
- Appendix D—Solicitation Document Content Analysis
  - This appendix will show the content analysis of the fifty solicitation documents. Although numerous items were recorded for the purposes of the content analysis, only the line items that were directly used in the research in this thesis will be shown. This data can be seen in Chapter 4.
- Appendix E—ICE Consultant Questionnaire

  This appendix contains the case study questionnaire that was used to obtain the information on the ICE consultant paper, in Chapter 5.

Appendix A—Glossary of Preconstruction Services Terms

Design-Related Preconstruction Services

- Validate agency/consultant design—constructor evaluates the design as it is originally intended and compares it to the scope of work with both the required budget and schedule to determine if the scope can be executed within those constraints. A validated design is one that can be constructed within the budget and schedule constraints of the project.
- Assist/input to agency/consultant design—the contractor will offer ideas/cost information to the designer to be evaluated during the design phase. Ultimately, the designer is still responsible for the design.
- Design reviews—done to identify errors, omissions, ambiguities, and with an eye to improving the constructability and economy of the design submittal.
- Design charrettes—the contractor would participate in structured brain-storming sessions with the designer and owner to generate ideas to solve design problems associated with the project.
- Constructability reviews—review of the capability of the industry to determine if the required level of tools, methods, techniques, and technology are available to permit a competent and qualified construction contractor to build the project feature in question to the level of quality required by the contract.
- Operability reviews—bringing in the agency’s operations and maintenance personnel and providing them with an opportunity to make suggestions that will improve the operations and maintenance of the completed projects.
- Regulatory reviews—a check to verify that the design complies with current codes and will not have difficulty obtaining the necessary permits.
- Market surveys for design decisions—furnish designers with alternative materials or equipment along with current pricing data and availability to assist them in making informed design decisions early in the process to reduce the need to change the design late in the process resulting from budget or schedule considerations.

- Verify/take-off quantities—the contractor verifies the quantities generated by the designer for the engineer's estimate.
- Assistance shaping scope of work—contractor generates priced alternatives from the designer and owner to ensure that the scope of work collates to the constraints dictated by the budget and/or schedule.
- Feasibility studies—contractor investigates the feasibility of possible solutions to resolve design issue on the project.

Cost-Related Preconstruction Services

- Validate agency/consultant estimates—constructor evaluates the estimate as it is originally intended and determines if the scope can be executed within the constraints of the budget.
- Prepare project estimates—constructor provides real-time cost information on the project at different points in the design process to ensure that the project is staying within budget.
- Cost engineering reviews—review that includes not only the aspects of pricing but also focuses on the aspect that "time equals money" in construction projects.
- Early award of critical bid packages—contractor determines which design packages should be completed first to ensure that pricing can be locked in on the packages.
- Life-cycle cost analysis—contractor provides input to design decision that impact the performance of the project over its lifespan.
- Value analysis—process that takes place during preconstruction where the CMGC contractor identifies aspects of the design that either do not add value or whose value may be enhanced by changing them in some form or fashion. The change does not necessarily reduce the cost; it may actually decrease the life-cycle costs.
- Value Engineering—systematic review by a qualified agency and/or contractor personnel of a project, product, or process so as to improve performance, quality, safety, and life-cycle costs.

- Material cost forecasting—the contractor utilizes its contacts within the industry to develop estimates of construction material escalation to assist the owner and designer make decisions regarding material selection and early construction packages.
- Cost risk analysis—furnishing the agency with information regarding those cost items that have the greatest probability of being exceeded.
- Cash flow projections/Cost control—the contractor conducts earned value analysis to provide the owner with information on how project financing must be made available to avoid delaying project progress. This also may include an estimate of construction carrying costs to aid the owner in determining projected cash flow decisions.

Schedule-Related Preconstruction Services

- Validate agency/consultant schedules—contractor evaluates if the current scope of work can be executed within the constraints of the schedule.
- Prepare project schedules—contractor prepares schedules throughout the design phase to ensure that dates will be met, and notify the owner when issues arise.
- Develop sequence of design work—the contractor sequences the design work to mirror the construction work, so that early work packages can be developed.
- Construction phasing—the contractor develops a construction phasing plan to facilitate construction progress and ensure maintenance of traffic.
- Schedule risk analysis/control—the contractor evaluates the risks inherent to design decisions with regard to the schedule and offers alternative materials, means and/or methods to mitigate those risks.

Administrative-Related Preconstruction Services

- Coordinate contract documents—the contractor evaluates each component to the construction contract against all other components and identifies conflicts than can be resolved before award of the construction phase contract.
- Coordinate with third-party stakeholders—the contractor communicates with third parties involved in the project including but not limited to utilities, railroads, and the general public.

- Public information-public relations—the contractor implements a program to identify public relations issues and solve them to ensure the project is not delayed by public protest.
- Attend public meetings—the contractor can organize and attend public meetings to answer questions from the public about the construction of the project.
- Biddability reviews—the contractor reviews the design documents to ensure that subcontractor work packages can be bid out and receive competitive pricing. This action reduces the risk to the subcontractors because they are given the specific design product they need for their bids; not just told to find their work inside the full set of construction documents.
- Subcontractor bid packaging—the contractor coordinates the design work packaging to directly correlate with subcontractor work packages so that early packages can be easily bid out and awarded.
- Prequalifying subcontractors—the contractor develops a list of qualified subcontractors that are allowed to bid on packages as they are advertised.
- Assist in right-of-way acquisition—the contractor assists the designer in identifying options for right-of-away acquisitions by providing means and methods input. The primary purpose is to minimize the amount of right-of-way actions that must be undertaken
- Assist in permitting actions—the contractor is empowered to meet with resource agencies and develop permit applications with assistance from the designer.
- Study labor availability/conditions—the contractor furnishes advice during design with regard to the availability of specialty trade subcontractors and the impact of that availability on project budget and schedule constraints.
- Prepare sustainability certification application—when certification for sustainability is desired, the contractor is empowered to prepare the necessary paperwork to submit for certification.

Appendix B—Structured Interview for Construction Manager/General Contractor Case Studies

This appendix contains the questionnaire that was used to obtain the CMGC project information from 19 of the 27 case studies. The results were used in Chapter 4 of this document.

Structured Interview Questionnaire - Agency

CONDITIONS: This interview can either be conducted in person or via telephone. The following protocol shall be followed during its administration:

1. The questionnaire shall be sent to the respondent at least 2 weeks prior to the interview via email.
2. Two days prior to the interview, a follow-up message with the questionnaire attached will be sent to confirm the date and time of the interview.
3. To maximize the quality and quantity of information collected, the primary respondent should be encouraged to invite other members of his/her organization to be present during the interview. Thus, a single transportation agency response can be formulated and recorded.
4. The interviewer will set the stage with a brief introduction that emphasizes the purpose of the research, the type of information expected to be collected, and the ground rules for the interview.
5. Once the interviewees indicate that they understand the process at hand, the interview will commence.
6. The interviewer will read each question verbatim and then ask if the interviewee understood the question before asking the interviewee to respond.
7. Each question contains a specific response that must be obtained before moving to the next question. Once that response is obtained, the interviewer can record as text additional cogent information that may have been discussed by the interviewees in working their way to the specific response.
8. Upon conclusion of the interview, the interviewer will ask the interviewees if they have additional information that they would like to contribute and record those answers as text.
9. The interviewer will assemble a clean copy of the final interview results and return them to the interviewee for verification.

STRUCTURED INTERVIEW:

I. General Information:

1. City and state in which the respondent agency is headquartered:
    a. Name of Agency: ;

2. What type of organization do you work for?
    ☐ State DOT ☐ Other public transportation agency ☐ Other; Please describe:

3. Annual construction budget:

4. Average annual number of projects:

5. Project monetary size range: $ to $

6. Average monetary size of a typical project $

7. Percentage of out-sourced design effort versus in-house design %

8. Does your agency use CM-at Risk/CMGC/GCCM/CMc/ECI contracting to augment its existing workforce during program funding spikes?
    a. ☐ Yes ☐ No Please explain if necessary:

9. Do other public agencies in your state have authority to use CM-at Risk/CMGC?
    ☐ Yes ☐ No Please explain if necessary:

General remarks about agency program that might affect use of CM-at Risk/CMGC:

Agency CM-at Risk/CMGC/ Project Delivery Experience

Project Delivery Experience	CM-at Risk/CMGC
1 Has your agency awarded a project under this project delivery method?	☐ *Yes* ☐ *No*
❑ A. If yes, how many projects?	A. ☐1-5 ☐6-10 ☐>10
❑ B. If yes, what percentage of your total construction budget?	B. ☐<10% ☐11-25% ☐26-50% ☐>50%
❑ C. How long have you used these methods?	C. ☐< 2 years ☐3-5 years ☐> 5 years
2 Is your agency restricted on the use of this project delivery methods?	☐ *Yes* ☐ *No*
❑ A. If yes, what is the restriction? Explain "other"	A. ☐ Legislative ☐ Regulation ☐ Policy ☐Other
❑ B. If yes, are you able to obtain a waiver for CM-at Risk/CMGC? Explain "other"	B. ☐ Yes ☐ No ☐ Other

Case Study Project Title:

General Composition: ☐ Road construction ☐ Road rehabilitation ☐ Bridge construction ☐ Bridge rehabilitation ☐ Other________________________________

Short Description of Scope: *list major features of work… 3-4 sentences, or get a copy of the RFP/RFQ. Include location of project.*

Contract GMP Value: $____ million ____________________
Contract Duration: ________ months ____________________
Preconstruction services fee: $ or % _______________________
Design fee: $ or % ____________________

II. Case Study Agency Project Delivery Method Decision-making Information

1. Who ultimately makes the project delivery method selection decision:
   ☐ Agency design personnel ☐ Agency construction personnel ☐ Agency upper management
   ☐ Entity outside the agency's organization; Explain:

.

2. What project factors are considered when making the project delivery method decision?

Project Factor	Considered in decision	Drives use of CM-at Risk/CMGC delivery method
Project monetary size	☐	☐
Project budget control issues	☐	☐
Project schedule issues	☐	☐
Project technical complexity	☐	☐
Project type (typical agency project vs non-typical agency project)	☐	☐
Project type (bridge vs road project)	☐	☐
Project technical content (i.e. ITS, seismic features, tolling equipment, etc.)	☐	☐
Project location (urban vs rural)	☐	☐
Project environmental issues	☐	☐
Project third party interface issues (utilities, business access, railroads, etc.)	☐	☐
Project traffic control issues	☐	☐
Project quality assurance requirements	☐	☐
Project life cycle issues (maintenance/operations)	☐	☐
Project sustainability issues	☐	☐
Incentives for obtaining federal or state funding	☐	☐
Project generates revenue (tolls, special taxes, etc.	☐	☐
Agency staff design review/construction inspection requirements	☐	☐
Agency staff experience with delivery method	☐	☐
Agency staff availability to oversee project development	☐	☐
Desire to include specific innovation	☐	☐
Other	☐	☐

3. Which of the following were reasons that your agency uses to select CMGC delivery methods? Check all that apply. Which of the below is the **single** most significant reason for selecting CMGC delivery method? (*Interviewer circle the check box*)

	CM-at Risk/CMGC
Reduce/compress/accelerate project delivery period	☐
Establish project budget at an early stage of design development	☐
Constrained budget	☐
Get early construction contractor involvement	☐
Encourage innovation	☐
Facilitate Value Engineering	☐
Encourage constructability	☐
Encourage price competition (bidding process)	☐
Compete different design solutions through the proposal process	☐
Redistribute risk	☐
Complex project requirements	☐
Flexibility needs during construction phase	☐
Third party issues (permits, utilities, etc.)	☐
Reduce life cycle costs	☐
Provide mechanism for follow-on operations and/or maintenance	☐
Innovative financing	☐
Encourage sustainability	☐
Project is a revenue generator	☐
Reduced agency staffing requirements	☐
Reduced agency review/inspection requirements	☐
Other (explain below)	☐

4. Please explain the process that you use to choose of the project delivery method for a typical project.

5. Is a formal risk analysis conducted on a typical project in any of the following areas?
   ☐ Project Scope ☐ Project Schedule ☐ Project Cost ☐ Contracting Risk ☐ Other
6. Do your project cost estimates involve an analysis of uncertainty (i.e. was a range cost estimate developed)?
   ☐ Yes ☐ No

7. Do you employ any formalized risk allocation techniques to draft the contract provisions?
   Examples are material escalator clauses or schedule allowances
   ☐ Yes ☐ No If yes, please describe:

Interviewer: Collect sample copies of the provisions referred to in this question. Review them with the interviewee.

III. Case Study Agency CM-at Risk/CMGC Procurement Process Information:

1. At what point in the project design development process is the project delivery method decision made?
   ☐ 0% ☐ 1%-30% ☐ 31%-50% ☐ 51%-80% ☐ >80% Actual percent :

2. What type of procurement process to you use to advertise a CMGC project?
   ☐ Request for Qualifications (RFQ) only [no proposed fees] ☐ Request for Proposals (RFP) [includes some or all fees] only

   ☐ RFQ + RFP ☐ Request for letters of interest ☐ Other please explain:

Interviewer: Collect sample copies of the documents referred to in this question. Review them with the interviewee.

3. Once CM-at Risk/CMGC project delivery has been selected, who does the design?
   ☐ In-house design personnel ☐ Consulting engineers ☐ Combination of both

4. Once CM-at Risk/CMGC project delivery has been selected, which entity is brought to the project first?
   ☐ the designer (including in-house design) ☐ the CMGC

5. If the answer to 4 is “the designer,” does the designer assist in the CMGC selection process?
   ☐ Yes ☐ No ☐ Other: please explain

6. If the answer to 5 is yes, which of the below tasks is the designer involved in?
   ☐ Evaluation of CMGC qualifications ☐ Checking/validating CMGC references

   ☐ CMGC interviews/presentations ☐ Developing short list

   ☐ Voting member of CMGC selection panel ☐ Evaluation of CMGC fees

   ☐ Non-voting member of CMGC selection panel ☐ Negotiation of CMGC fees

   ☐ Other: Please explain:
7. If the answer to 4 is "the CMGC," does the CMGC assist in the designer selection process?
   ☐ Yes ☐ No ☐ Other: please explain

8. If the answer to 7 is yes, which of the below tasks is the CMGC involved in?
   ☐ Evaluation of designer qualifications ☐ Checking/validating designer references

   ☐ Designer interviews/presentations ☐ Developing short list

   ☐ Voting member of designer selection panel ☐ Evaluation of design fees

   ☐ Non-voting member of designer selection panel ☐ Negotiation of design fees

   ☐ Other: Please explain:

9. In your CMGC selection process, do you develop a shortlist?
   ☐ Yes ☐ No

10. If the answer to 9 is yes, how many CMGCs are on your typical shortlist?
    ☐ 1 ☐ 2 ☐ 3 ☐ >3

11. If the answer to 9 is no, why don't you develop a shortlist?
    ☐ Legislation prohibits shortlist ☐ Agency policy prohibits shortlist ☐ Avoid possible protest

    ☐ Other: Please explain:

12. Which of the following pieces of information are required to be submitted in response to a typical RFQ/RFP/advertisement?

Question 12 Matrix

Do either the RFQ or the RFP require the following to be submitted as part of the CMGC's statement of qualifications or proposal?	Required submittal?		If YES: Is it evaluated to make the CMGC award decision?		If NO: Is it a required submittal after contract award?	
	Yes	No	Yes	No	Yes	No
Organizational structure/chart	☐	☐	☐	☐	☐	☐
Past CMGC project experience	☐	☐	☐	☐	☐	☐
Past related project experience (non-CMGC)	☐	☐	☐	☐	☐	☐
References from past projects	☐	☐	☐	☐	☐	☐
Qualifications of the CMGC's Project Manager	☐	☐	☐	☐	☐	☐
Qualifications of the CMGC's preconstruction services manager	☐	☐	☐	☐	☐	☐
Qualifications of the CMGC's general superintendent	☐	☐	☐	☐	☐	☐
Qualifications of the CMGC's estimator/scheduler	☐	☐	☐	☐	☐	☐
Qualifications of the Construction Quality Manager	☐	☐	☐	☐	☐	☐
Qualifications of other key personnel (*list below)*	☐	☐	☐	☐	☐	☐
Construction quality management plan	☐	☐	☐	☐	☐	☐
Construction traffic control plan	☐	☐	☐	☐	☐	☐
Other key project plans (*list below)*	☐	☐	☐	☐	☐	☐
Preliminary project schedule	☐	☐	☐	☐	☐	☐
Declaration of self-performed work	☐	☐	☐	☐	☐	☐
Subcontracting plan	☐	☐	☐	☐	☐	☐
DBE plan	☐	☐	☐	☐	☐	☐
Proposed preconstruction services fee	☐	☐	☐	☐	☐	☐
Proposed post-construction services fee (profit)	☐	☐	☐	☐	☐	☐
Proposed general conditions fee	☐	☐	☐	☐	☐	☐
Rates for self-performed work	☐	☐	☐	☐	☐	☐
Critical analysis of project construction budget	☐	☐	☐	☐	☐	☐
List of proposed subcontractors	☐	☐	☐	☐	☐	☐
Do either your RFQ or your RFP contain the following?						
Description of scope of work	☐	☐	☐	☐	☐	☐
Preliminary plans/specifications	☐	☐	☐	☐	☐	☐
Construction testing matrix	☐	☐	☐	☐	☐	☐
Quality management roles and responsibilities	☐	☐	☐	☐	☐	☐
Design criteria checklists	☐	☐	☐	☐	☐	☐
Other critical material (*list below)*	☐	☐	☐	☐	☐	☐

13. Do you interview CMGCs as part of the selection process?
☐ Yes, in person ☐ Yes, remotely (video teleconference or other means), ☐ No

14. If the answer to 13 is yes, what of the following are parts of your interview process? (check all that apply)
    ☐ Formal presentation of corporate qualifications/past projects

    ☐ Formal presentation of qualifications/past project experience for key CMGC personnel

    ☐ Formal presentation of project-specific issues (right-of-way availability, schedule compression, bid packaging, etc.)

    ☐ Formal presentation of preconstruction services components (constructability process, estimating process, scheduling process, etc.)

    ☐ Review and discussion of checklists/documents used by the CMGC in preconstruction services components (constructability process, estimating process, scheduling process, etc.)

    ☐ Informal review/discussion of any of the above. (*interviewer: circle the appropriate items above*)

    ☐ Other: please explain:
15. When selecting a CMGC, what method do you use to identify the winner?
    ☐ Direct point scoring in <u>unweighted</u> categories published in the RFQ/RFP/advertisement

    ☐ Direct point scoring in <u>weighted</u> categories published in the RFQ/RFP/advertisement

    ☐ Adjectival rating in <u>unweighted</u> categories published in the RFQ/RFP/advertisement

    ☐ Adjectival rating in <u>weighted</u> categories published in the RFQ/RFP/advertisement

    ☐ Cost-technical trade-off (proposed fees compared to qualifications/other factors & best value selected)

    ☐ Comparative evaluation (i.e. "CMGC A is more experienced than CMGCs B and C" etc. for each category)

    ☐ Unscored selection panel consensus (i.e. panel discusses evaluation results & makes selection on consensus view)
    ☐ Unscored selection panel vote (i.e. each panel member selects his/her choice & CMGC with most votes wins)
    ☐ Other: please explain:

16. Is price used as a selection criterion in your CMGC award method? ☐ Yes ☐ No

17. If price is used a selection criteria, what weight is assigned to construction related - price factors compared to all other factors?

    ☐ 0-25% ☐ 26-50% ☐ >50% Actual percentage:

18. If price is a selection factor, how are the construction related - price factors incorporated in the GMP?

    Please explain:

19. Have you ever had a protest of your CMGC selection process? ☐ Yes ☐ No

20. If the answer to 19 is yes, what was the basis of the protest and how was it resolved? Basis of protest: (*interviewer: collect details of protests including any documents that may be available*)

    ☐ Protest was sustained (in favor of the protestor) ☐ Protest was denied (in favor of the agency)

21. If you out-source the design, do you modify the design contract to include CMGC-specific clauses?
    ☐ Yes ☐ No

22. If the answer to 21 is yes, what types of CMGC-specific clauses are included? (check all that apply)
    ☐ Design packages to be reviewed by CMGC ☐ Design milestones to facilitate preconstruction services package

    ☐ Requirements to incorporate/respond to CMGC review comments ☐ Budget review points

    ☐ Requirement to notify CMGC of significant design changes ☐ Value engineering with CMGC

    ☐ Coordination of design packages with construction bid packages ☐ Material availability/selection decisions

    ☐ Construction means & methods decisions ☐ Coordination with 3rd party stakeholders

    ☐ Other: Please explain:

23. If you convert to DBB, is the CMGC allowed to bid for the construction contract?
    ☐ Yes ☐ No

24. Do you allow the CMGC to prequalify subcontractors?
    ☐ Yes, CMGC is free to pick and choose its own subs

    ☐ No, CMGC is required to accept bids from all subs and award to lowest bidder

    ☐ Other: please explain:

25. Do you allow the CMGC to self-perform any of the construction? ☐ Yes ☐ No

26. If the answer to 25 is no, why not?
    ☐ Legislation prohibits self-performance ☐ Agency policy prohibits self-performance

    ☐ Avoid possible protest due to potential conflict of interest ☐ Other: Please explain:

27. If the answer to 25 is yes, how do you determine what work the CMGC may self-perform?
    ☐ CMGC declares bid packages it wants to self-perform & there are no further constraints

    ☐ CMGC declares bid packages it wants to self-perform & must bid against industry to win them

    ☐ Other please explain:

28. If the answer to 25 is yes, are limits (%) on the amount of work the CMGC may self-perform?

    ☐ Yes limit is: % ☐ No

29. What preconstruction services are included in your CMGC contracts? (check all that apply)
    ☐ Validate agency/consultant estimates ☐ Validate agency/consultant schedules ☐ Validate agency/consultant design
    ☐ Prepare project estimates ☐ Prepare project schedules ☐ Assist/input to agency/consultant design
    ☐ Constructability review ☐ Cost engineering reviews ☐ Value analysis ☐ Market surveys
    ☐ Coordinate with 3rd party stakeholders ☐ Assist in right-of-way acquisition ☐ Assist in permitting actions
    ☐ Other please explain:

30. How do you establish the CMGC's fee for post-construction services (i.e. profit/general conditions/overhead on construction project)?
    ☐ Agency has fixed rate ☐ CMGC proposes fee as part of selection process (winner's fee is accepted as best value)

    ☐ CMGC proposes fee as part of selection process and final fee is negotiated after contract award

    ☐ Fee is negotiated with winner after contract award (no proposed fee prior to award)

    ☐ Other please explain:
31. Does your agency have a specific training or certification program for Project Managers engaging in CMGC projects?
    ☐ Yes ☐ No

32. Does your agency encourage or require a formal Partnering process on CMGC projects
    ☐ Yes ☐ No

IV. Case Study CM-at Risk/CMGC Payment Provisions

General Format/Structure of the Contract

1. What type of compensation method does your agency use for the CMGC contract?
Lump sum GMP
Lump sum, fixed price (no GMP)
Unit price GMP
Unit price (no GMP)
Cost plus fee with G-Max
Preconstruction services only with hard bid construction packages
Other, please explain:

2. What are the major components of the guaranteed maximum price (GMP)?

3. In what phase of project development does your agency determine the final budget for the project?
Planning
Scoping
Preliminary Design
Final Design

Preconstruction

4. How does your agency establish the fee for preconstruction services?
Agency has fixed rate
CMGC proposes fee as part of selection process (winner's fee is accepted as best value)
CMGC proposes fee as part of selection process and final fee is negotiated after contract award
Fee is negotiated with winner after contract award (no proposed fee prior to award)
Other, please explain:

5. Is the preconstruction fee incorporated into the GMP?
Yes No

Negotiations on the GMP

6. In the GMP development what cost components (see Question 2) are determined based on negotiations?

7. How do you determine the percent design completion when the GMP will be negotiated?
Based on the project characteristics and risk of the project
Agency has a predefined percent of progress in design (please explain)
Others, please explain

8. If the answer to 7 is "based on the project characteristics and risk of the project," how does risk affect the GMP development process?
Agency does the preliminary risk analysis and defines the point when the GMP is negotiated
Negotiation point in time is based on the CMGC risk analysis
Others, please explain

9. Is estimated construction cost included in the State Transportation Improvement Program (STIP) before the CMGC is selected?
Yes No

10. Is the budget for the project known by the CMGC before commencing the selection of the CMGC?
Yes No

11. Is the budget for the project known by the CMGC before negotiating the GMP?

12. After setting the GMP under what circumstances can the GMP be changed?

13. What process do you use to award construction contract if your agency and the CMGC are unable to agree on the GMP?
Convert to DBB and bid publicly
Other, please explain:

14. If you convert to DBB delivery, is the CMGC allowed to bid on the construction?
yes No

Cost Development and Cost Estimation

15. Does your agency use a progressive[1] GMP compensation approach under CMGC project delivery?
Yes No

16. If your agency has a list of standard bid items within your agency, is it mandatory for the contractor to use this list in developing the GMP?
Yes No

17. What level of the cost estimate detail is the CMGC typically required to provide?

[1] *Progressive GMP* is a variation on GMP assembly where the owner permits the prime contractor to set a series of incremental GMPs as design work packages are completed and then add them all together at the end to constitute the final GMP.

Fee

18. How is the fee for construction services defined?
Agency has fixed rate
CMGC proposes fee as part of selection process (winner's fee is accepted as best value)
CMGC proposes fee as part of selection process and final fee is negotiated after contact award
Fee is negotiated with winner after contract award (no proposed fee prior to award)

19. If the answer to 18 is "agency has fixed rate," how do you determine the CMGC's fee for construction services? Please explain.

20. When using CMGC does your agency define what will be covered by the fee?
Yes No

21. Would a list of the items covered by the fee be helpful when reviewing/negotiating the GPM?
Yes No

Procurement

22. Does your agency use CMGC in projects where early procurement is necessary (early procurement means buying materials or selecting subcontractors during design)?
Yes No

23. If the answer to 22 is yes for materials, what is the compensation approach for early procured materials?

24. Does your agency require the CMGC to propose a separate GMP for materials if the materials are procured during design?
Yes No

25. If the answer to 24 is yes, what is the reason for early procurement of materials?
To mitigate the risk of fluctuations in materials prices
To enable buying materials that have long delivery times
Others, please explain

Risk and Contingency

26. Is transferring risk to the contractor one of your motives of using CMGC with GMP?
Yes No

27. Which types of contingencies are used in CMGC contracts?
Single project contingency
Separate owners and CMGC's contingencies
Management reserve in addition to contingencies
Other, please explain.

28. What are major drivers of contingency in CMGC contracts?

29. How is the contingency value(s) estimated?

30. Does your agency decrease the contingency as project progresses?
Yes No

Shared Savings

31. Do you consider sharing the savings in CMGC contracts in situations where there is a cost underrun of the GMP?
Yes No

32. If the answer to 31 is yes, is there any limitation in the amount of the shared savings?
Yes, Please explain.
No

Subcontracting

33. Do you allow the CMGC to self-perform a portion of the construction work?
Yes No

34. If the answer to 33 is no, why not?
Legislation prohibits self-performance
Agency policy prohibits self-performance
Avoid possible protest due to potential conflict of interest
Other, please explain

V. Case Study Quality Assurance Program for CM-at Risk/CMGC Projects

1. Do you use a different QA program for CMGC projects than you do for DBB projects?
   ☐ Yes ☐ No If yes, what is the major difference?

2. Have you used CM-at Risk/CMGC to reduce the size of your construction inspection staff?
   a. ☐ Yes ☐ No Please explain if necessary:

3. Have you used CM-at Risk/CMGC to reduce the size of your design review staff on out-sourced design?
   a. ☐ Yes ☐ No Please explain if necessary:

4. Who performs the following construction quality management tasks in your CMGC projects?

(Check all that apply)	Does not apply	Agency personnel	Designer's staff	CMGC's construction staff	Agency-hired consultant
Technical review of construction shop drawings	☐	☐	☐	☐	☐
Technical review of construction material submittals	☐	☐	☐	☐	☐
Checking of pay quantities	☐	☐	☐	☐	☐
Routine construction inspection	☐	☐	☐	☐	☐
Quality control testing	☐	☐	☐	☐	☐
Establishment of horizontal and vertical control on site	☐	☐	☐	☐	☐
Verification testing	☐	☐	☐	☐	☐
Acceptance testing	☐	☐	☐	☐	☐
Independent assurance testing/inspection	☐	☐	☐	☐	☐
Approval of progress payments for construction progress	☐	☐	☐	☐	☐
Approval of construction post-award QM/QA/QC plans	☐	☐	☐	☐	☐
Report of nonconforming work or punchlist.	☐	☐	☐	☐	☐

5. How do you rate the final quality of work on CMGC projects compared to DBB projects?
   ☐ Better ☐ Same ☐ Worse ☐ No opinion

6. If the answer to 5 is either Better or Worse, explain primary reason for difference:

7. Do you formally evaluate the CMGC's performance quality and use that for future CMGC selections?
☐ Yes ☐ No

8. If the answer to 7 is Yes, do you believe that the performance rating creates an incentive to achieve quality?
☐ Yes ☐ No

Why?

9. Please rate the following factors for their impact on the quality of the CMGC project.

Factor	Very High Impact	High Impact	Some Impact	Slight Impact	No Impact
Qualifications of the CMGC's staff	☐	☐	☐	☐	☐
CMGC's past project experience	☐	☐	☐	☐	☐
Quality management plans	☐	☐	☐	☐	☐
Level of agency involvement in the QA process	☐	☐	☐	☐	☐
Use of agency specifications and/or design details	☐	☐	☐	☐	☐
Level of detail expressed in the procurement documents	☐	☐	☐	☐	☐
Use of performance criteria/specifications	☐	☐	☐	☐	☐
Early contractor involvement in design	☐	☐	☐	☐	☐
GMP contract	☐	☐	☐	☐	☐
Preconstruction services	☐	☐	☐	☐	☐
Warranty provisions	☐	☐	☐	☐	☐

VI. Achieving Value through Project Delivery Method Selection

This section's purpose is to collect expert opinions on each project delivery system's ability to add value to the agency operator's capital project delivery process. If there are more than one person in the interview, the interviewer should require the group to achieve a consensus opinion for the impact of each project delivery system on the agency's final constructed product.

1. In your opinion how does CMGC project delivery method impact the quality of the following project aspects for typical projects at your agency?

For each method, assign one of the following ratings based on the agency consensus: Worst= 1; Worse = 2; Neutral= 3; Better = 4; Best = 5	
Project aspects	**CM-at Risk/CMGC**
Completeness of final design deliverables	
Accuracy of design calculations	
Accuracy of quantities	
Acceptance of design deliverables	
Accuracy of specifications	
Accuracy of as-built documents	
Accuracy/applicability of O&M manuals, etc.	
Implementation of approved QA/QC plans	
Accuracy of preconstruction cost estimates	
Ability to achieve post-award budgets	
Cost growth during design (scope creep, claims, etc.)	
Accuracy of preconstruction schedules	
Ability to achieve post-award schedules	
Material quality	
Workmanship quality	
Aesthetics	
Sustainability	
Maintainability	
Operability	
Security during construction	
Impact on property owners during construction	
Traffic flow during construction	
Interest to potential bidding community	

2. In your opinion how does CMGC project delivery method impact the value of the following preconstruction services for typical projects at your agency?

For each method, assign one of the following ratings based on the agency consensus: Not valuable = 1; Some value = 2; Valuable = 3; Very valuable= 4; Of highest value = 5	
Preconstruction service	**CM-at Risk/CMGC**
Conceptual estimating	
Value analysis/value engineering	
Design charrettes	
Design reviews	
Regulatory reviews	
Security impact studies	
Environmental studies	
Early contractor involvement	
Scope definition/clarification	
Cost engineering reviews	
Budget validation	
Constructability reviews	
Biddability reviews	
Operability reviews	
Life cycle cost analysis	
Subcontractor bid packaging	
Schedule validation	
Coordination with 3rd party stakeholders	
Early awards for critical bid packages (i.e. asphalt materials, steel, etc.)	
Size of plan set	

3. Is there anything else about the CMGC process that you would like to share?

For those agencies that have experience with Design-Build project delivery as well as CM-at Risk/CMGC, we would like to get a comparative analysis of the suite of project delivery methods if possible.

Agency Project Delivery Method Experience

Project Delivery Experience	Design-Bid-Build	CM-at Risk/CMGC	Design-Build	PPP
1 ***Has your agency awarded a project under one of these project delivery methods?*** ❑ A. If yes, how many projects? ❑ B. If yes, what percentage of your total construction budget? ❑ C. How long have you used these methods?	☐ *Yes* ☐ *No* A. ☐1-5 ☐6-10 ☐>10 B. ☐<10% ☐11-25% ☐26-50% ☐>50% C. ☐< 2 years ☐3-5 years ☐> 5 years	☐ *Yes* ☐ *No* A. ☐1-5 ☐6-10 ☐>10 B. ☐<10% ☐11-25% ☐26-50% ☐>50% C. ☐< 2 years ☐3-5 years ☐> 5 years	☐ *Yes* ☐ *No* A. ☐1-5 ☐6-10 ☐>10 B. ☐<10% ☐11-25% ☐26-50% ☐>50% C. ☐< 2 years ☐3-5 years ☐> 5 years	☐ *Yes* ☐ *No* A. ☐1-5 ☐6-10 ☐>10 B. ☐<10% ☐11-25% ☐26-50% ☐>50% C. ☐< 2 years ☐3-5 years ☐> 5 years
2 ***Is your agency restricted on the use of these project delivery methods?*** ❑ A. If yes, what is the restriction? Explain "other" ❑ B. If yes, are you able to obtain a waiver for CM-at Risk/CMGC? Explain "other"	☐ *Yes* ☐ *No* A. ☐ Legislative ☐ Regulation ☐ Policy ☐Other B. ☐ Yes ☐ No ☐ Other	☐ *Yes* ☐ *No* A. ☐ Legislative ☐ Regulation ☐ Policy ☐Other B. ☐ Yes ☐ No ☐ Other	☐ *Yes* ☐ *No* A. ☐ Legislative ☐ Regulation ☐ Policy ☐Other B. ☐ Yes ☐ No ☐ Other	☐ *Yes* ☐ *No* A. ☐ Legislative ☐ Regulation ☐ Policy ☐Other B. ☐ Yes ☐ No ☐ Other

Which of the following were reasons that your agency uses to select each of the following delivery methods? Check all that apply. Which of the below is the **single** most significant reason for selecting each delivery method? (*Interviewer circle the check box*)

	Design-Bid-Build	CM-at Risk/ CMGC	Design-Build	PPP
Reduce/compress/accelerate project delivery period	☐	☐	☐	☐
Establish project budget at an early stage of design development	☐	☐	☐	☐
Constrained budget	☐	☐	☐	☐
Get early construction contractor involvement	☐	☐	☐	☐
Encourage innovation	☐	☐	☐	☐
Facilitate Value Engineering	☐	☐	☐	☐
Encourage constructability	☐	☐	☐	☐
Encourage price competition (bidding process)	☐	☐	☐	☐
Compete different design solutions through the proposal process	☐	☐	☐	☐
Redistribute risk	☐	☐	☐	☐
Complex project requirements	☐	☐	☐	☐
Flexibility needs during construction phase	☐	☐	☐	☐
Third party issues (permits, utilities, etc.)	☐	☐	☐	☐
Reduce life cycle costs	☐	☐	☐	☐
Provide mechanism for follow-on operations and/or maintenance	☐	☐	☐	☐
Innovative financing	☐	☐	☐	☐
Encourage sustainability	☐	☐	☐	☐
Project is a revenue generator	☐	☐	☐	☐
Reduced agency staffing requirements	☐	☐	☐	☐
Reduced agency review/inspection requirements	☐	☐	☐	☐
Other (explain below)	☐	☐	☐	☐

In your opinion how does each project delivery method impact the quality of the following project aspects for typical projects at your agency?

For each method, assign one of the following ratings based on the agency consensus: Worst= 1; Worse = 2; Neutral= 3; Better = 4; Best = 5				
Project aspects	**Design-Bid-Build**	**CM-at Risk/ CMGC**	**Design-Build**	**PPP**
Completeness of final design deliverables				
Accuracy of design calculations				
Accuracy of quantities				
Acceptance of design deliverables				
Accuracy of specifications				
Accuracy of as-built documents				
Accuracy/applicability of O&M manuals, etc.				
Implementation of approved QA/QC plans				
Accuracy of preconstruction cost estimates				
Ability to achieve post-award budgets				
Cost growth during design (scope creep, claims, etc.)				
Accuracy of preconstruction schedules				
Ability to achieve post-award schedules				
Material quality				
Workmanship quality				
Aesthetics				
Sustainability				
Maintainability				
Operability				
Security during construction				
Impact on property owners during construction				
Traffic flow during construction				
Interest to potential bidding community				

Appendix C—Case Studies used in Analysis

This appendix contains the summaries of each of the case studies. Since the case studies were completed for different research projects, the format of the summaries is not the same. The summaries have been left in the same format in which they will be or were published. Additionally, each case study has an appropriate citation at the beginning as to where it can be found

C.1—State Route 89 Case Study; Arizona DOT

Gransberg, D.; Shane, J.; Anderson, S.; Lopez del Puerto, C.; Strong, K.; and McMinimee, J., (2012) “NCHRP Project 10-85: A Guidebook for Construction Manager-at-Risk Contracting for Highway Projects: Interim Report,” Unpublished Report. National Cooperative Highway Research Program.

Project Title: SR 89 Prescott-Chino Valley Highway Center Street – South Chino Valley Limits

Agency: Arizona Department of Transportation (ADOT)

Location: The project is located in the town of Chino Valley on SR 89, beginning south of Center Street and extending south of Road 4 South.

Value: $21,000,000

Schedule (Award of CMR to completion):

Scope: The scope of work includes the reconstruction of SR 89 to a 4-lane section with raised median and sidewalk. Conduit will be placed for future signals at Roads 1, 3, and 4 South and Road 2 South will be signalized. Nine existing drainage structures will be extended or replaced. Medians will receive decomposed granite and sleeves will be provided for future median landscape irrigation. Relocation is required for communication, gas, and electric utilities.

Rationale for selecting CMR: The rationale for selecting CMR on this project were primarily due to the high volume of traffic and the need to obtain contractor input on construction sequence and maintenance of traffic during construction. Additionally, it hoped to get assistance during preconstruction coordinating with utilities and impacted business interests. Table C.1.1 contains an overview of the salient points of this case study project.

Table C.1.1 Overview of Prescott-Chino Valley Highway (SR 89) Project

Factor	
Design completed by:	Consultant
Design contract modified to synchronize with CMR preconstruction services contract	Yes
Procurement procedure	One-Step Process RFQ
Award system	QBS
Weighted evaluation criteria	Yes
Interviews conducted	Yes
Disclose project budget before award	Yes
Self-performance requirement	40%
Subcontractor restrictions	No
Payment Provisions	Unit Price
Point where final GMP is established	Iterative Pricing 30% & 60%- GMP at Final Design

This was the first CMR project performed by the ADOT. The project was a success. The ADOT was careful to document the process throughout the entire project. After the completion of the project, the team members assembled, evaluated the process, and suggested improvements for future CMR projects. As a result, the ADOT has made some significant changes to their program that is reflected in the agency's 2010 CMR Guide. This project was used as the baseline CMR project for the ADOT and another case study was performed on the most current CMR project. The purpose was to capture any learning curve that may have occurred within the ADOT. The learning curve details are outlined in the next section to this chapter.

Lessons Learned: The following are the primary learning points taken from the interviews:

- Bring the CMR in as early as practical to maximize the opportunity for contractor constructability input during design.
- Clearly define the GMP establishment process and how contingencies are developed and expended.
- Modify the design contract to include CMR specific clauses
- Conduct post-project review meeting with all prime partners and document changes to improve future projects.

Summary and Observations of the Researchers: The ADOT is a sophisticated agency with a full toolbox of project delivery methods and the experience to properly and effectively use each of them. This project benefited from that attitude and experience even though switching from the DB lump sum approach to alternative project delivery made maximizing the potential benefits of CMR challenging. The owner's best attribute in this project was its dedication to communication throughout the process and the CMR's most important contribution was to proactively work through the issues encountered as a result of the "pilot nature" of this project. The fact that local municipal agencies like the City of Phoenix and Maricopa County had previous successful CMR experience provided a foundation of knowledge that ADOT was able to draw upon as issues arose.

C.2—State Route 303 Case Study; Arizona DOT

Gransberg, D.; Shane, J.; Anderson, S.; Lopez del Puerto, C.; Strong, K.; and McMinimee, J., (2012) "NCHRP Project 10-85: A Guidebook for Construction Manager-at-Risk Contracting for Highway Projects: Interim Report," Unpublished Report. National Cooperative Highway Research Program.

Project Title: Loop 303 Highway Peoria Avenue – Waddell Road (SR 303)

Agency: Arizona Department of Transportation (ADOT)

Location: The location of the project is on the SR 303 Loop in Maricopa County, extending from Peoria Avenue to Waddell Road and from Waddell Road to Mountain View Boulevard.

Value: $154,000,000 budgeted; signed contract for $128,000,000

Schedule (Award of CMR to completion): 2 years

Scope: The project includes the design and reconstruction of SR 303L between Peoria Avenue and Mountain View Boulevard with three general purpose lanes in each direction and auxiliary lanes between the traffic interchanges. Overpass bridges will be constructed at Cactus and Waddell Roads, and an underpass bridge will be constructed at Greenway Road. The ultimate facility will include four general purpose lanes plus, a High Occupancy Vehicle Land, and an auxiliary lane between the interchanges in each direction. Figure C.2.1 is a plan view of the Loop 303 CMR project and graphically illustrates its scope.

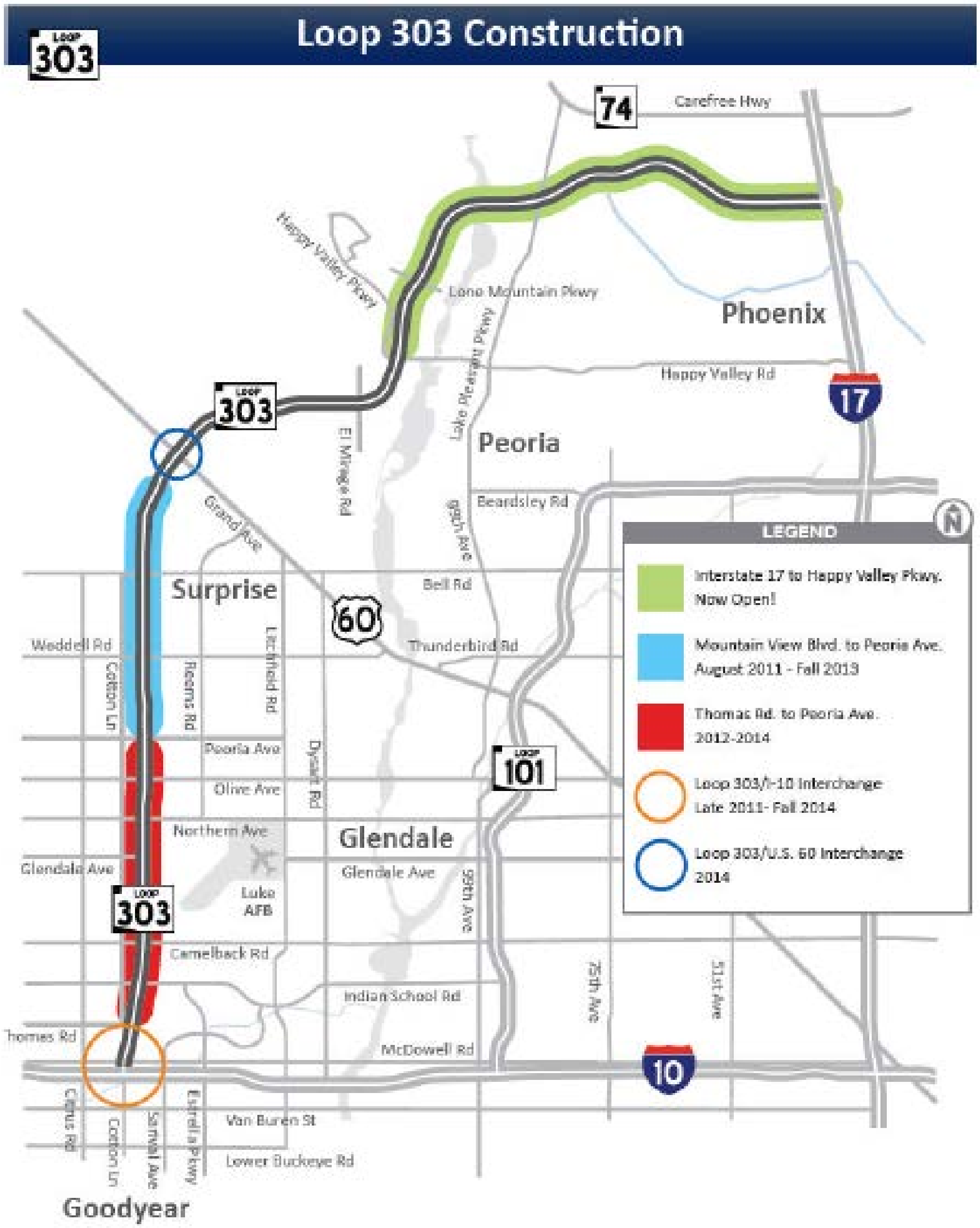

Figure C.2.1 Loop 303 Construction Map

Rationale for selecting CMR: The rationale for selecting CMR on this project can be best described by quoting the agency's CMR guide (2010). CMR is the preferred project delivery method when the following project characteristics are present:

- "there is a need for immediate transportation improvements;

- the design is complex, difficult to define, subject to change and/or has several design options;
- there is a high coordination requirement with external agencies that make cost over-runs and construction schedule a pressing concern;
- the project is sequence or schedule sensitive." (ADOT 2010)

The Loop 303 project satisfied all four conditions and based on previous experience with four CMR projects, ADOT decided to deliver this project using CMR. Table C.2.1 contains an overview of the salient points of this case study project.

Table C.2.1 Overview of Loop 303 Highway Peoria Avenue – Waddell Road

Factor	
Design completed by:	Consultant
Design contract modified to synchronize with CMR preconstruction services contract	Yes
Procurement procedure	One-Step Process RFQ
Award system	QBS
Weighted evaluation criteria	Yes
Interviews conducted	Yes
Disclose project budget before award	Yes
Self-performance requirement	40%
Subcontractor restrictions	No
Payment Provisions	Unit Price
Point where final GMP is established	Iterative Pricing 30% & 60%- GMP at Final Design

ADOT continues to use CMR and improve the process each time and find new benefits from the process. Currently the ADOT has delivered four projects under the CMR delivery method in the past five years and plans to use it more in the future.

Lessons Learned: Some lessons learned include:

- One of the benefits realized by the ADOT was that on their first project, the ADOT did not use the CMR to help with any third party issues that they faced; however, they learned that the CMR was very useful in issues such as permitting and utilities.

- They realized that when they used CMR to deliver a project, they were able to use innovative financing. Since they had a project that spanned two fiscal years, and they were able to have one contract with two separate GMPs.
- The ADOT uses lessons learned from CMR projects and applies those same concepts to other projects of any delivery method to continually improve their program.
- The ADOT learned that it is a good idea to have a licensed contractor on the selection panel to ensure transparency and validate a fair and equitable evaluation.
- The ADOT is seeing many joint ventures on projects so that contractors with no CMR experience can gain some experience, even if they are not the prime on the project.

Summary and Observations of the Researchers: ADOT has a robust system for capturing project issues and feeding them back into the system to change the underlying causes of unforeseen problems and to create an environment that facilitates accruing benefits from contractor involvement in the design process. A good example of this was an interesting issue that arose regarding the system for evaluating CMR qualifications. The typical ADOT selection panel consists of seven members. On the first CMR project (SR 89), there were no problems and all the panel members seemed to be in agreement on the winning proposer. However, on the second CMR project, two of the panel members appeared to be attempting to flip the score by scoring one team extremely low and another team extremely high. Now, the ADOT uses a formula to evaluate the scores, and if an individual evaluator’s number is one standard deviation higher or lower than the average score, then it is thrown out.

C.3—Eisenhower/Johnson Tunnels Case Study; Colorado DOT

Gransberg, D.; Shane, J.; Anderson, S.; Lopez del Puerto, C.; Strong, K.; and McMinimee, J., (2012) "NCHRP Project 10-85: A Guidebook for Construction Manager-at-Risk Contracting for Highway Projects: Interim Report," Unpublished Report. National Cooperative Highway Research Program.

Project Title: I-70 Eisenhower-Johnson Memorial Tunnel (EJMT) Motor Control Cabinets (MCCs) Replacement Project

Agency: Colorado Department of Transportation (CDOT)

Location: I-70, at milepost 213.651, in Summit County, inside the EJMT in the electrical control areas for the south bore (CDOT, 2010a).

Value: $3,308,857 (CDOT, 2012)

Schedule (Award of CMR to completion): November 2010 - December 2011 (CDOT, 2012)

Scope: Replacing 2400 medium volt MCCs. MCCs serve the supply and exhaust ventilation fans inside the tunnel. The south bore ventilation system consists of six supply fans and six exhaust fans that are housed in East and West ventilation equipment rooms located at each end of the portal. There are four 2400 medium volt MCCs, two in each of the electrical equipment rooms (CDOT, 2010a). Figure C.3.1 shows the entrance to the tunnels serviced by this project.

Figure C.3.1 Tunnel Entrance (Photo courtesy of CDOT)

Rationale for Selecting CMR: Table C.3.1 contains an overview of the salient points of this case study project.

Table C.3.1 Overview of I-70 Eisenhower-Johnson Memorial Tunnel Motor Control Cabinets Replacement Project

Factor	
Design completed by:	Combination of in-house and consultant
Design contract modified to synchronize with CMR preconstruction services contract:	Yes
Procurement procedure	One-Step Process RFP
Award system	Best Value
Weighted evaluation criteria used	Yes
Interviews conducted	Yes
Disclose project budget before award	Yes-during selection process
Self-performance requirement	30%
Subcontractor restrictions	Yes – CDOT must approve the proposed subs, but does not interfere in their selection.
Payment Provisions	Unit Price
Point where final GMP is established	Iterative Pricing 30% & 60% - GMP at 100% design

This project was the first CMR project for CDOT. Overall, CDOT was very happy with the results of this project. Specifically, CDOT had 28% overall schedule savings (equivalent to 5 months) and 6% cost savings (CDOT, 2012). The CDOT participants highlighted several important items that should be considered by the agencies pursuing CMR delivery system. Before the project begins, both the agency and the project manager should perform a significant amount of research to get information on the intricacies of the CMR system and potential pitfalls to be able to (i) to make a go or no go decision with respect to the use of CMR system for the upcoming project and (ii) identify strategies to avoid potential pitfalls if they choose to go forward with CMR system. This is especially critical for the very first CMR project of an agency.

Additionally the CDOT project manager indicated that the only way to take full advantage of this system is for the agency and the project managers to take the initiative to educate themselves on this very unique project delivery system. It was noted that in CDOT's case, such education included learning from the experiences of those state DOTs who have successfully implemented CMR, specifically Utah DOT. Mr. McMinimee, who until his untimely death, was a co-principal investigator for this NCHRP study, was instrumental in providing CDOT information with respect to lessons learned in UDOT CMR projects.

Lessons Learned: Some lessons learned include:

- It is important to have a DOT project manager with strong negotiation skills; as the project manager plays a vital role in making critical decisions and during the negotiation of the GMP.
- It is preferable to have a DOT project manager with estimating expertise and background; that enables the project manager better understand all of the assumptions made by the CMR in putting together the GMP estimate and facilitates the negotiation process.
- The agency should require that CMR's staff who will be heavily involved during the construction phase should also be heavily involved during the preconstruction phase. This includes not only the superintendent but for highly technical projects like this one, also foremen for different trades.
- It is very important to get the buy-in for CMR project delivery from the executive staff in the agency.

Additionally, the following important lessons learned are extracted from the report that was submitted by CDOT to FHWA Colorado Division at the conclusion of this project (CDOT, 2012):

- Ensuring that the CMR's construction manager is the same individual during preconstruction and construction.
- Developing a process for vendor selection that is based on best value as opposed to low bid.
- Documenting everything that is addressed/resolved during preconstruction.
- Performing thorough site visits to reduce quantity unknowns.

Summary and Observations of the Researchers: CDOT certainly takes innovative contracting seriously. It has an Innovative Contracting Division as well as an Innovative Contracting Advisory Committee with different subcommittees focusing on CMR, design-build, etc. With such a structured approach to innovative contracting approaches and people passionate about those concepts, CDOT is very likely to embrace and be very successful in innovative contracting. The interviewees reiterated many times that for an inexperienced agency, the CMR system may be the riskiest project delivery system with a lot of moving parts, especially if an agency does not know the intricacies and potential pitfalls of fundamental aspect of CMR like the GMP process. On the other hand, it is the system with the largest potential to result in the best possible project delivery in terms of cost, schedule, and overall quality because of early contractor involvement. Therefore, it is really up to the agency to make or break a project using CMR system.

C.4—M-222 Slope Stabilization Case Study; Michigan DOT

Gransberg, D.; Shane, J.; Anderson, S.; Lopez del Puerto, C.; Strong, K.; and McMinimee, J., (2012) "NCHRP Project 10-85: A Guidebook for Construction Manager-at-Risk Contracting for Highway Projects: Interim Report," Unpublished Report. National Cooperative Highway Research Program.

Project Title: Michigan Route 222 Slope Stabilization Project at the Kalamazoo River, City of Allegan.

Agency: Michigan Department of Transportation (MDOT)

Location: The slope stabilization project is located on M-222, one mile from the city center of Allegan, Michigan. The busy trunkline route connects the City of Allegan with US Highway 131. The Kalamazoo River was migrating and undercutting the slope that supports M-222.

Value: $8.8 million

Schedule (Award of CMR to completion): 14 months (finished 1 month ahead of the schedule)

Scope: The Kalamazoo River was undermining the bank that supports M-222, resulting in a slope failure producing cracks in the road and threatening the roads globe stability. MDOT defined the scope in the Request for Qualifications for the M-222 slope stabilization project (2011) to include:

- Protect M-222 in a cost effective manner by stabilizing the slope between M-222 and the Kalamazoo River;
- Obtain all proper permits to construct the project;
- Protect the Kalamazoo River;
- Eliminate / minimize environmental impacts, while addressing soil erosion and sedimentation impacts; and
- Ensure proper disposal of any confirmed contaminated soil.

Figure C.4.1 shows the completed M-222 project and clearly illustrates the emergency nature of this particular procurement.

Figure C.4.1 M-222 Slope Stabilization post construction. Photo courtesy of MDOT.

Rationale for Selecting CMR: MDOT selected CMR on this project because of the urgent danger of the Kalamazoo River washing out M-222 at this location. MDOT had completed one previous CMR project acting in an oversight capacity for another state transportation agency and as a result realized that CMR was the fastest means available to get work started on a technical geotechnical project that required both special expertise and special equipment. The agency was able to award the CMR preconstruction contract at the same time as it awarded the consultant design contract. Thus, the contractor was able to assist engineer in identifying design solutions that match available materials means and methods. Table C.4.1 contains an overview of the salient points of this case study project.

Table C.4.1 Overview of M-222 Slope Stabilization Project

Factor	
Design completed by:	Consultant
Design contract modified to synchronize with CMR preconstruction services contract:	Yes
Procurement procedure	One-Step Process RFQ – Sealed fee proposal submitted with SOQ
Award system	QBS – Fee proposal opened after award.
Weighted evaluation criteria used	Yes
Interviews conducted	No
Disclose project budget before award	Exact Budget: No; General Range: Yes
Self-performance requirement	30%
Subcontractor restrictions	No
Payment Provisions	Combination of Lump Sum and Unit Price
Point where final GMP is established	Iterative pricing at 30% and 60% design; GMP at 80%

The contractor's advice provided MDOT with significant cost saving (~$500,000) and prevented delays to the project. For instance, the contractor had advised the owner to use solder piles to retain the 25-foot wall that supported M-222. The retaining wall was required to reduce the grade of the slope from the base of the wall to the river. The solder piles were able to be procured three months in advance to the completion of the design, which prevented delays and provided a cost saving to MDOT.

Additionally, MDOT had initially set up the construction of the project utilizing cranes positioned on the road, providing access to the toe of the slope from above. The contractor advised MDOT that increased constructability could be achieved if the crane was moved closer to the cofferdam and recommended the crane be supported on barges in the river directly below the toe of the slope. This option provided easier access to the slope, in addition to a cost saving for MDOT by minimizing the size of the crane required.

Lessons Learned: The following are the primary learning points taken from the interviews:

- The use of a “two envelope” system where the SOQ is envelope 1 and the fee proposal is envelope 2 supports a QBS award process without leaving the all the cost items open to negotiation.
- Schedule a project risk assessment meeting as the first full-team meeting to synchronize the efforts of the owner, the design consultant and the CMR.
- Modify the design contract to include CMR specific clauses that encourage designing around CMR input on constructability and the use of available materials, means and methods.

Summary and Observations of the Researchers: The true success of the project came from all entities participating as a team and their willingness to work together through new issues. This was achieved through the coordination and communication aspects of CMR. The contractor’s construction input during design added value to the project and enabled MDOT to have an increased level of project control. This resulted in a cost savings, decreased schedule, and reduction of risk to all parties. The scheduled risk assessment meeting between the designer, owner, and contractor brought the project team onto the same page. This was a chance where ideas were exchanged and issues could be resolved formally and cooperatively.

C.5—Mountain View Corridor Case Study; Utah DOT

Gransberg, D.; Shane, J.; Anderson, S.; Lopez del Puerto, C.; Strong, K.; and McMinimee, J., (2012) "NCHRP Project 10-85: A Guidebook for Construction Manager-at-Risk Contracting for Highway Projects: Interim Report," Unpublished Report. National Cooperative Highway Research Program.

Project title: Mountain View Corridor (MVC) Project, Utah

Agency: Utah Department of Transportation (UDOT)

Location: The Mountain View Corridor encompasses Salt Lake County west of Bangerter Highway between I-80 and the Utah County border.

Value: $730 million (project still on-going)

Schedule (Award of CMR to completion): Spring 2010- December 2012 (~3 years)

Scope: The Mountain View Corridor (MVC) is a planned highway, transit-way, and trail system in western Salt Lake and northwestern Utah Counties that will serve 13 municipalities in the Project area. The Project is planned to be built in phases as the infrastructure is needed and as funding becomes available. Initial construction includes building two outside lanes in each direction with signalized intersections where future interchanges will be located. This new roadway requires extensive grading and excavation, relocating utilities, acquiring property, constructing drainage systems, building bridges and structures, and laying new pavement. Trail sections will also be built. Future construction will build the remainder of the corridor by adding interchanges and more lanes to achieve a fully functional freeway. The CMR process being used by the Agency could enable the northern terminus of the initial build project to be extended to the north as far as possible.

Construction includes approximately 10 miles of new divided highway and frontage roads. Further work may include, but is not limited to:

- Utility adjustments
- Removals
- Clearing
- Grading
- Drainage
- Structural aggregate courses
- Paving
- Striping
- Signage, fencing, etc.
- Intersection construction
- Reconstruction and realignment of cross streets
- Mainline and overpass structures
- Retaining walls
- Seeding
- Landscaping
- Concrete flat work
- Aesthetic treatments
- Electrical
- Lighting

Figure C.5.1 shows the scale of this urban project.

Figure C.5.1 Plan View of Mount View Corridor Project (UDOT 2011)

Rationale for Selecting CMR: Originally, UDOT considered delivering the MVC project as a DB project, but at the time the decision was being made there was another mega-DB project was in the works and looked like funding would be available at a time where both projects would be underway. Therefore, the decision to use CMR was made out of consideration for the availability of two large DB consortia at the same time. CMR allowed UDOT to contract for design services without the need for the designer to become a member of a DB team and changed the risk profile for the design firm. Table C.5.1 contains an overview of the salient points of this case study project.

Table C.5.1 Overview of Mountain View Corridor Project

Factor	
Design completed by:	Consultant
Design contract modified to synchronize with CMR preconstruction services contract:	Yes
Procurement procedure	One-Step Process RFP
Award system	Best Value
Weighted evaluation criteria used	Yes
Interviews conducted	No
Disclose project budget before award	No
Self-performance requirement	30%
Subcontractor restrictions	No – The CMGC is asked to get at least 3 subcontractor quotes but is not required to do so. UDOT asks for sub selection process in RFP but doesn't require low bid.
Payment Provisions	Unit Price
Point where final GMP is established	Iterative Pricing for each bid package - GMP at Final Design

The UDOT is the DOT with the most CMR experience in the country. Although some members of the team who favored using DB were a bit apprehensive at first, using CMR turned out to be the best for the project since they were able to expand the scope of work as permitted by the CMR finding savings and maintain flexibility during the construction phase. A number of notable cost savings were accrued by UDOT via the CMR project delivery process. The cost savings allowed the scope of work to be expanded without the need for additional funding. Documented savings included:

- A $25M savings through alternative design analysis and construction innovation,
- A $12M cost reduction in utility relocation – protect in place, means and methods analysis with utility owners,
- $6M savings due to schedule compression, and
- $9.5M savings due to elimination of a rail bridge.

Lessons Learned: The following are the primary learning points taken from the interviews:

- Allow the design consultant to participate as a non-voting member of the CMR selection panel
- Modify the design contract to include CMR specific clauses with regard to expanding the project's scope to take advantage of potential savings identified by the CMR's constructability reviews and value analysis.
- The DOT can encourage competitive bidding among subcontractors without imposing specific constraints on the CMR's ability to use the subs with which it is most comfortable.
- Including a set of unit prices for the major pay items in the CMR's proposal simplifies the GMP process by allowing a unit price payment provision and not having to negotiate profit and overhead costs since those are rolled into the unit prices.

Summary and Observations of the Researchers: UDOT has a very robust process for establishing the GMP. It uses a system where the CMR and an independent cost estimator (ICE, usually a retired contractor with local experience and contacts) to literally "bid" against the engineer's estimate. The CMR's bid is called the opinion of probable project cost (OPCC). The OPCC and ICE have elements of their OPCC that varies more than 10% from the engineers estimate, then a conference is convened to conform the quantities used in each OPCC as well as to discuss how each estimator priced the risk for a given feature of work. Once conformance has been achieved the CMR and ICE rebid until the disparity is within the 10% tolerance. The engineers estimate is also revised based on the conformed quantities and risk pricing. Figure C.5.2 shows how the process worked on this case study project.

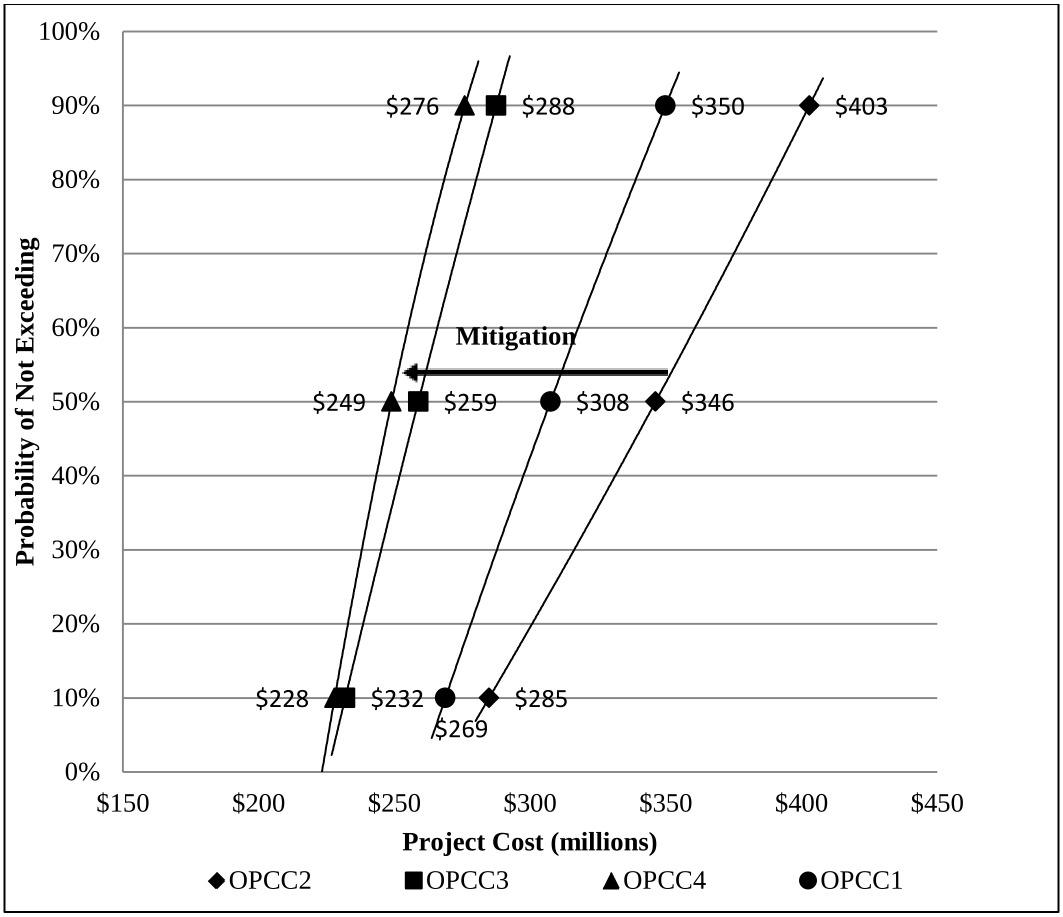

Figure C.5.2 Mountain View Corridor Project cost estimates and mitigation savings

The important fact to note in Figure C.5.2 is OPCC1 is the initial engineer's estimate at roughly 30% design and OPCC2 is the CMR's bid from the same set of documents. If the MVC project had been delivered using DB, this would have been the DB contract construction cost to UDOT. It shows that at the mean value that the CMR priced the risk in this project at 30% design as being worth $38 million. As the design process advanced, the team was able to flush that risk out of the project through various mitigation measures such as bidding out early materials packages to lock in material pricing and retire the escalation risk. This project provides an elegantly articulated example of the benefit of bringing the contractor into the design process before the contract cost is fixed.

Another fact to note is that the UDOT includes the design consultant in the selection of the CMR. Although they are a non-voting member, they still are able to voice their opinion to the selection panel. This is different from most agencies, who do not allow the design consultant to be part of the CMR selection.

C.6—Phoenix Sky Harbor Transit Guideway Case Study; City of Phoenix, Arizona

Gransberg, D.; Shane, J.; Anderson, S.; Lopez del Puerto, C.; Strong, K.; and McMinimee, J., (2012) "NCHRP Project 10-85: A Guidebook for Construction Manager-at-Risk Contracting for Highway Projects: Interim Report," Unpublished Report. National Cooperative Highway Research Program.

Project Title: Phoenix Sky Harbor Transit Guideway

Agency: City of Phoenix

Location: Phoenix, Arizona

Value: $650 million

Schedule (Award of CMR to completion): 5.5 years concurrent design and construction; 3 years construction, 1 year testing

Scope: The scope of work includes cars, elevated airport people mover system, three stations, 4.5 miles of guide way, maintenance and storage facility, 19 train cars in three car configurations.. The general composition of the project is bridge construction and a guide way train system. Figure C.6.1 shows the scale of this urban project.

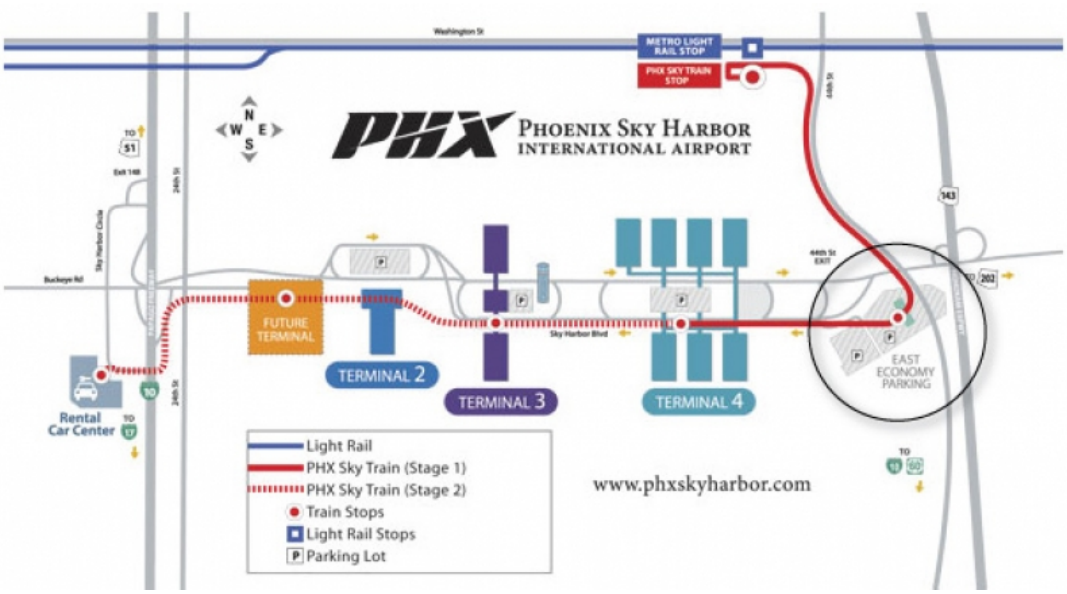

Figure C.6.1 Plan View of the Phoenix Sky Harbor Transit Guideway Project (City 2012)

Rationale for Selecting CMR: The City of Phoenix utilizes an internal decision tool to select project delivery methods based on project characteristics and other factors. CMR was selected for this job because of the complex nature of the project. Not only was it a multimodal facility but much of the construction needed to be completed inside the secure area of the airport. Selecting the contractor and its subcontractors during design permitted two major schedule benefits to be accrued. First the time available for individual security clearance procedures was maximized. Next, the involvement during design by the contractor was made in the context of the special issues inherent to airport projects. This allowed the CMR to make input to means, methods, equipment, and sequence of work that was synchronized with the airport's security and operational constraints. Additionally, it also insured that those constraints were fully priced in the construction costs. Table C.6.1 contains an overview of the salient points of this case study project.

Table C.6.1 Overview of the Phoenix Sky Harbor Transit Guideway Project

Factor	
Design completed by:	Consultant
Design contract modified to synchronize with CMR preconstruction services contract:	No
Procurement procedure	One-Step Process RFQ
Award system	QBS
Weighted evaluation criteria used	Yes
Interviews conducted	Yes
Disclose project budget before award	Yes
Self-performance requirement	40%
Subcontractor restrictions	Yes – CMR is asked to justify not selecting the low sub but not required to.
Payment Provisions	Combination Lump Sum and Unit Price
Point where final GMP is established	Iterative Pricing 30% & 60%- GMP at Final Design

CMR projects in Arizona can only use a Qualifications Based Selection (QBS), which limits the use of Federal funds. The interviewees noted that reducing the project delivery period is the most significant reason to select CMR as the delivery method to use on a project; however, they also noted that reducing the schedule will have cost implications. The interviewees also made the point that even though the City has delivered hundreds of projects using CMR project delivery, the typical transportation project is delivered using DBB.

The minimum self-performance requirement for the CMR is 40%, and there is no maximum requirement. Since by law the City can only use QBS, they like to use some of the remaining work to ensure some sort of bid competition. Interviewing the proposers is not required by law, but the interviewees noted that they do it as a best management practice.

Lessons Learned: The following are the primary learning points taken from the interviews:

- CMR project delivery maximizes the time available for dealing with airport operational and security constraints by permitting the contractor to initiate the necessary processes and procedures during design and have them complete by the time construction starts.
- Developing the GMP cost model before design begins results in greater design efficiencies by making the design team cognizant of the scope of work. It also reduces scope creep by furnishing quantitative alerts as the CMR furnishes target estimates during the GMP process.
- The use of separate contingencies for the owner and the contractor puts the contractor at-risk for construction costs after the GMP is established and the contractor's contingency is expended.

Summary and Observations of the Researchers: The City of Phoenix is very experienced with the use of CMR. The City has delivered hundreds of projects using the CMR delivery method. Approximately 11-25% of the construction budget goes to CMR projects each year. An interesting difference between the City and other agencies that use CMR is that if a price is not agreed upon at the end of design, the City will either put the project out as a DBB project or they will simply retain a new CMR. However, the interviewees noted that this problem has never happened to them. The City provides funds for training its Project Managers on CMR projects, but formal partnering is not required. The City likes to set the GMP as far into the process as possible so that they don't encumber projects funds for contingency. They usually wait until 100% design.

C.7—West Lane Corridor Case Study; Regional Transportation District, Colorado

Gransberg, D.; Shane, J.; Anderson, S.; Lopez del Puerto, C.; Strong, K.; and McMinimee, J., (2012) "NCHRP Project 10-85: A Guidebook for Construction Manager-at-Risk Contracting for Highway Projects: Interim Report," Unpublished Report. National Cooperative Highway Research Program.

Project Title: West Rail Line Corrider RTF FasTracks

Agency: Regional Transportation District

Location: Denver, Colorado Originates at Denver Union Station and extends for 12.1-miles ending at the Jefferson County Government Center.

Value: $709.8 million

Schedule (Award of CMR to completion): Aptil 2008 – December 2012 (4.5 years)

Scope: The scope of this project shown in Figure C.7.1 includes the following:

- 13 Light Rail Transit (LRT) or vehicular bridge structures – primarily steel and concrete girders with more detailed bridges at the South Platte River Crossing and over 6th Avenue (near Simms/Union)
- Two light rail tunnels – Union Blvd and I-70
- Four pedestrian structures (three bridges and one tunnel)
- 12 stations with varying amenities including three parking structures (Sheridan, Wadsworth, Jeffco) and three surface parking lots (Federal/Decatur, Oak, Federal Center)
- 115 retaining walls and more than 10,000 feet of noise wall
- 20 at-grade crossings
- Rebuilding of local streets and roadways adjacent to the trackway
- Significant replacement, relocation, adjustment and protection of existing public and private utilities and underground storm drainage and surface drainage re-grading
- Traction power/distribution, train control and communication systems
- Nine miles of double-tracked and three miles of single-tracked light rail

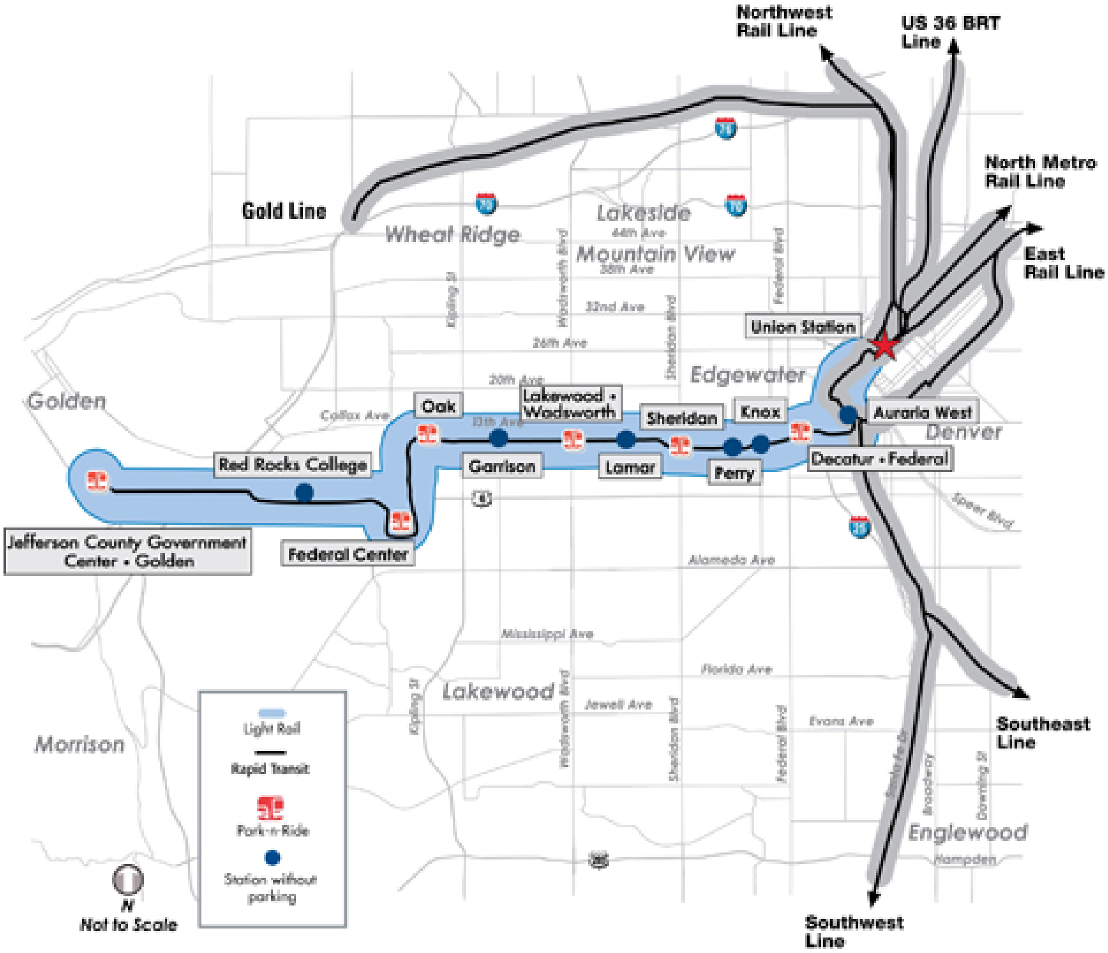

Figure C.7.1 FasTracks West Rail Line Corridor Map

Rationale for selecting CMR: Due to the success of using CMR (called CMGC in Utah) at Utah transportation agencies as was presented in a Federal Transit Administration Construction roundtable, the Regional Transportation District (RTD) decided to pilot the use of CMR for a project in the agency. It was decided that this project delivery method would be piloted in a multi-million dollar project. The West Rail Line Corridor was the first project that was scheduled to be designed and constructed after the decision to pilot the use of CMR was made, therefore CMR was chosen for this project. Table C.7.1 contains an overview of the salient points of this case study project.

Table C.7.1 Overview of the FasTracks West Rail Line Corridor

Factor	
Design completed by:	Consultant
Design contract modified to synchronize with CMR preconstruction services contract:	No – indicated that it will the next time
Procurement procedure	2-Step Process RFQ/RFP to short-list; then interviews to selection
Award system	Best value
Weighted evaluation criteria used	Yes
Interviews conducted	Yes
Disclose project budget before award	No
Self-performance requirement	60%
Subcontractor restrictions	Yes
Payment Provisions	Lump Sum
Point where final GMP is established	Iterative pricing at 50% & 65% - GMP at 90% design

Since this was the first CMR project done by RTD, there was a learning curve for the project team. The designer for this project did not embrace the use of CMR project delivery by not considering the CMR's design suggestions. Even though the project was successful, the opportunity to take advantage of CMR's input was not maximized. The interviewees believed allowing the designer to participate in the CMR selection process would have given that stakeholder a stronger sense of ownership in the process. and modifying the design contract to include CMR specific clauses would reinforce the owner's desire to accrue benefits from the contractor's early involvement.

A peer review of RTD's contracting and procurement practices was performed by the American Public Transportation Association in June 2011 and a report was submitted to RTD subsequently. The report lists the lack of consistency in project delivery methods used by RTD as a weakness that increases workload to RTD staff. The report suggests that "where possible in light of differing contract needs, RTD should attempt to standardize on one or two contract types to enable staff to better manage the contracts and procedures overall" (APTA 2011). As a result of this suggestion, there is a new program directive to consolidate the use of project delivery methods to DB and DBB. It is important to note that agency has been very successful using DB over the last 10 years and would like to make that its project delivery system of choice for future projects, especially for the projects with large dollar amounts, to maximize the potential for success. The agency does not anticipate using CMR in the future.

Lessons Learned: The following are the primary learning points taken from the interviews:

- Allow the design consultant to participate in the CMR selection process
- Modify the design contract to include CMR specific clauses

Summary and Observations of the Researchers: The owner's rationale for selecting CMR for this project seemed to be more out a desire to try something new out of curiosity rather than for project-specific reasons. The design contract had already been awarded before the decision to use CMR was made. Because this pilot project did not demonstrate the anticipated benefits CMR demonstrated in Utah, the agency is hesitant to use CMR in the future. They prefer to use DB which has proven successful for the agency. This case underscores the NCHRP Synthesis 402 (2010) finding that the design contract must be synchronized with the CMR's preconstruction services contact to ensure successful collaboration and to accrue potential constructability and schedule benefits.

C.8—Tuttle Creak Dam Modification Case Study; USACE Kansas

Gransberg, D.; Shane, J.; Anderson, S.; Lopez del Puerto, C.; Strong, K.; and McMinimee, J., (2012) "NCHRP Project 10-85: A Guidebook for Construction Manager-at-Risk Contracting for Highway Projects: Interim Report," Unpublished Report. National Cooperative Highway Research Program.

Project Title: Tuttle Creek Dam Safety Assurance Project

Agency: US Army Corps of Engineers (USACE)

Location: Tuttle Creek, north of the City of Manhattan in Kansas, along the Big Blue River

Value: Original Program Amount was $206M; $175M ($122M for the ECI Portion of Work)

Schedule (Award of CMR to completion): JUN 2004 – DEC 2010 (~6.5 years)

Scope: The Tuttle Creek Dam Safety Assurance Project is the largest Dam Safety, ground modification project on an active Dam that has ever been performed. This project consisted of multiple contracts to make various repairs to the dam. The Ground Modification base contract was awarded in 2005 to Treviicos South for $49M (this was the ECI/CMR Contract). A contract to provide structural reinforcement and bearing rehabilitation on the 18 Spillway Tainter Gates was awarded in 2007 and completed in 2010 for $10M. The wire ropes for the Tainter Gates will be replaced in 2011 and 2012. Figure C.8.1 shows the cross-section of the project and the major features of work.

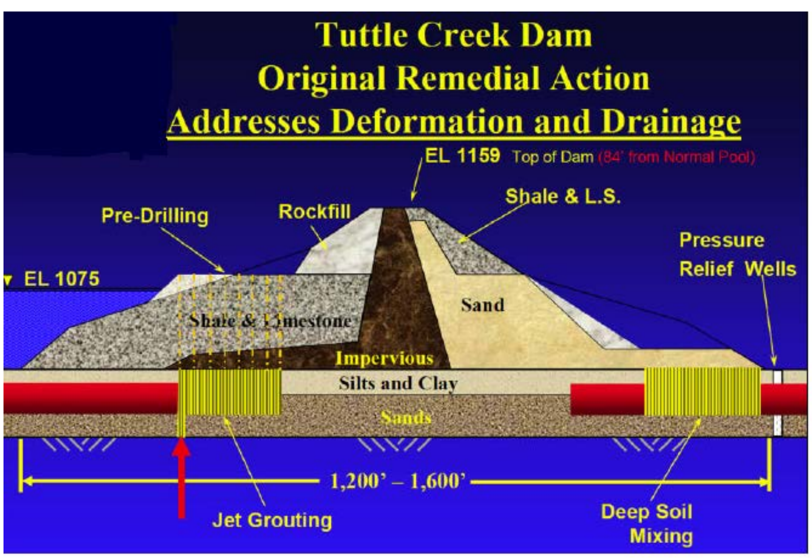

Figure C.8.1 Tuttle Creek Cross-Section

Rationale for Selecting CMR: The primary delivery method was Early Contractor Involvement (ECI), which is the USACE term for CMR. However, it should be noted that this contract contained multiple Contract Line Items, some of which were 100% designed at the time of construction solicitation. The project delivery team felt the project was so complex that it would benefit from having real time construction contractor feedback as the design progressed. The most significant reason for choosing the selected project delivery method was to get early construction contractor involvement. CMR (ECI) was the selected delivery method because the Corps project team felt it needed the construction expertise of a contractor to be a part of design development. This was an in-house design so CMR was the chosen delivery method that could provide the real-time constructor feedback. This feedback was especially necessary given the fact that this was a high risk active dam. Per the solicitation, the contractor's experience in working on high risk dams was taken into account. The interaction between the Corps and the CMR during the design process helped the team develop a design that resulted in an economical fix ($75M under budget) that minimized dam safety concerns with few frivolous/costly modifications. Market research and a pre-solicitation meeting were held. The market research indicated there were qualified contractors available to execute this type of work as CMR. Table C.8.1 contains an overview of the salient elements of this project.

Table C.8.1 Overview of the Tuttle Creek Dam Safety Assurance Project

Factor	
Design completed by:	In-house
Design contract modified to synchronize with CMR preconstruction services contract:	Yes
Procurement procedure	One-Step Process RFP
Award system	Best value
Weighted evaluation criteria used	Yes
Interviews conducted	Yes
Disclose project budget before award	Yes
Self-performance requirement	0%
Subcontractor restrictions	Yes
Payment Provisions	Lump Sum
Point where final GMP is established	Continuous pricing during design – GMP at 90% design

This project was unique in that the design was performed by in-house designers. USACE employs a sophisticated design QM system. One standard aspect is the Agency Technical Review (ATR). An ATR is an independent technical review, which is a critical examination by a qualified person or technical team outside the submitting district that is not involved in the day-to-day technical work that supports a decision document. The ATR can be performed at any stage of product development, even during construction as a measure of quality, confidence, and reliability. In order to receive a certification, the ATR process requires a formalized comment and resolution process. Another tool used on this ECI project was the Independent External Peer Review (IEPR) Like the ATR, an IEPR may be required by upper management. An IEPR is an independent review of the technical efficacy of a decision document by a review organization external to USACE. The Tuttle Creek Expert Advisory Panel is a form of IEPR and their contribution was critical to managing the risk of employing an evolving technology with which USACE had no previous experience and on which the contractor had to develop appropriate means and methods *during construction.* Another unique feature is that there was no self-performance requirement on the project.

Lessons Learned: Some other important lessons learned in this case include:

- The innovative technology used made it difficult to develop a set of contract documents. Similar quality management challenges arose during the design and construction phases in which specifications had to be reviewed or developed to cater to the unique project conditions. The quality management of the design phase required a new performance specification to be developed for a technology that had never been used for the required application before.
- The in-house designers were required to have their work checked by highly experienced technical persons before each design submittal, which resulted in the production of a high quality set of construction documents.
- Quality control checklists were developed for both designers and their checkers to ensure that all considerations are systematically addressed.
- Interdisciplinary coordination is a key element of the design quality control plan. It should be evident throughout the entire design process. The checks are usually conducted

by the design team members who check each other's work for the purpose of assuring compatibility between drawings and specifications produced by the various disciplines.

- A District Quality Control (DQC) review is a quality control measure in which an internal peer review is conducted by a technical element within a district. It consists of a formal procedure or set of procedures intended to ensure that the developed product adheres to a defined set of quality criteria or meets the requirements of the client, customer, and regulations. A DQC is similar to, but not identical to, QA as defined by the FHWA.

Summary and Observations of the Researchers: This particular project demonstrated a CMR project where the designer-of-record was a USACE employee who led and in-house design team. The fact that the project was completed 2 years ahead of schedule shows that given the appropriate external technical review, in-house designers can be successfully used on CMR projects. Because of the early involvement of the contractor and the good communication between the owner and the design team, the project showed a savings of $75 million and was completed two years early by changing the ground modification technology, which was literally developed during construction.

C.9—Sellwood Bridge Case Study; Multnomah County, Oregon

Gransberg, D.; Shane, J.; Anderson, S.; Lopez del Puerto, C.; Strong, K.; and McMinimee, J., (2012) "NCHRP Project 10-85: A Guidebook for Construction Manager-at-Risk Contracting for Highway Projects: Interim Report," Unpublished Report. National Cooperative Highway Research Program.

Project Title: Sellwood Multnomah County Project

Agency: Multnomah County

Location: The project is located 5 miles south of downtown Portland, Oregon. It connects Oregon Highway 43 at its west end to Highways US 99E and Oregon 224 to the east. Furthermore, it connects several SE Portland communities, such as the Sellwood neighborhood and suburban Clackamas County, with downtown Portland, Lake Oswego and Washington County.

Value: $160 million

Schedule (Award of CMR to completion): FEB 2011 – DEC 2016 (~6 years)

Scope: The current 84-year-old, two-lane bridge is experiencing deterioration in the reinforced concrete deck girder approach spans and the concrete deck over the steel truss. The scope includes:

- Design assistance and review through the preconstruction phase.
- Participate in the County's community and business outreach efforts prior to and during construction.
- Develop GMP for project construction.
- Establish and follow procedures for construction cost and schedule control.
- With the County's assistance, develop innovative strategies for maximizing opportunities available to Disadvantaged, Minority, Women-owned and Emerging Small Businesses, and local businesses and workers, as well as administer any applicable County contracting requirements and provide detailed reports in a format agreeable to the County.
- Procure and manage subcontractors.
- Develop sustainable practices for implementation during construction.

- Construct the bridge and associated work.

Figure C.9.1 shows the concept for the shoo-fly bridge suggested by the CMR to save time and money.

Figure C.9.1 Photograph of Document Used by the CMR on the Sellwood Bridge Project to Articulate an Alternate Technical Concept for Furnishing Temporary Shoo-fly Bridge by Reusing the Existing Bridge by Jacking It 90 feet to the Side.

Rationale for Selecting CMR: There were many factors considered when the project deliver method was decided. Some of the factors that drove the use of CMR included schedule issues, technical complexity, third party interface issues, traffic control issues, and the fact that it was easier to incorporate the county's values into the project using CMR. They also wanted to accelerate the project delivery period, acquire the benefit of early construction contractor involvement, encourage constructability, work on risk redistribution, meet the complex project requirements, flexibility during construction phase, and to encourage sustainability. Early procurement was needed, and the compensation for the early procured materials will be paid by certified invoice.

It should also be noted that the owner did not have all the necessary funding in hand when the CMR contract was awarded. Because a CMR preconstruction services contract allows the owner to only obligate the cost of that contract itself, it allows the project to begin without waiting for full funding. In this case, the owner was waiting on a grant of approximately $5.0 million. After the initial design review session, the CMR suggested jacking the existing bridge over to temporary piers rather than building a temporary shoo-fly bridge to carry traffic during construction that needed to be dismantled when the project was completed. This suggestion reduced the project cost by $6.0 million and eliminated the need to obtain the grant before awarding the first construction package. Table C.9.1 contains an overview of the salient elements of this project.

Table C.9.1 Overview of Sellwood Multnomah County Project

Factor	
Design completed by:	Consultant
Design contract modified to synchronize with CMR preconstruction services contract:	Yes
Procurement procedure	One-Step Process RFP
Award system	Best Value
Weighted evaluation criteria used	Yes
Interviews conducted	Yes
Disclose project budget before award	Yes
Self-performance requirement	30%
Subcontractor restrictions	No
Payment Provisions	Unit Price
Point where GMP is established	Iterative pricing for each bid package - GMP at 90% design

Some unique factors on this project include:

- This was the first CMR project for the owner; however, the rest of the team members were all experienced with this project delivery method.
- Because of the early involvement of the contractor, the project showed a savings of $6 million from jacking the bridge 90 feet to the side and eliminating the need for a temporary bridge.

- The use of a scenario in the CMR interview to gauge the preconstruction team to collaborate with the designer's team is an innovative and apparently effective selection technique.
- The contractor's use of MBTI and other formal teaming techniques is the first instance seen by the research team where a contract stakeholder attempted to create high-performance teams who are "naturally" compatible.

Lessons Learned: Some other important lessons learned in this case include:

- The owner, designer, and contractor all had an office in the same building, making communication between the three entities easy.
- The design contract contained liquidated damages clauses to ensure that the design documents were provided on time.
- The contractor noted that there seemed to be little need for the engineer's estimate because the system requires the CM to develop the quantities and the ICE to validate the quantities. Only the engineer's current list of pay items and its initial quantities are utilized during cost engineering and budge reviews, making the engineer's pricing seem redundant. FHWA rules were cited by the owner as the reason the engineer was being paid to generate estimates at design milestones.

Summary and Observations of the Researchers: This project used a number of innovative CMR project delivery tools. The interview process was particularly well thought-out and provided the owner with much more information than other projects. For example, the contenders gave a formal presentation that included the corporate qualification and past projects, the qualification and experience for key CMR personnel, project-specific issues, and preconstruction services components. Also, the contenders were asked to respond to a list of questions specific to the proposal and also some other standard questions. Finally, each contender was given a scenario exercise where they had five minutes to read the scenario, fifteen minutes to develop a solution in conjunction with the design consultant's team members, and then they presented the solution. The owner's project manager indicated that the winning CMR was the only team that actively involved the consultant's personnel in developing and presenting the solution.

The winner was identified with a direct point scoring in weighted categories that was published in the RFP. Price was given 60% of the graded score. There was a protest on this project alleging that one of the scorer's decision was biased by having seen prices during the technical evaluation phase. The protest was denied. The following are observations and ideas developed by the researcher that conducted the case study interviews:

- The issue of the engineer's estimate (EE) presents an opportunity to marginally reduce the preconstruction cost. FHWA EE rules were developed for DBB projects where the EE was used as an independent estimate to compare to the construction contractors' bid prices. Since the CMGC project delivery normally includes an extra preconstruction cost to hire an ICE, it seems that the ICE's estimates satisfy the spirit of the FHWA requirement to have an independent estimate against which the CMGC's target GMP estimates at design milestones can be compared.
- The "shoo-fly" approach used here not only saves time and money, but it also enhances the sustainability of the project by literally recycling the old bridge for a period of time and eliminating the need to consume materials and fuel for a temporary bridge that would be torn down at the end of the project. The RFP contained evaluation criteria for sustainability.
- Since the accelerating project delivery is the primary reason the FHWA's *EDC* program is advocating the use of CMGC, the notion found in this case of applying liquidated damages to the designer's deliverables is profoundly justified. Previous research has shown that the primary reason DB projects experience delays is due to the designer-of-record's failure to meet design milestones (lit cite). It would follow that since the constructor has no contractual control on the designer in CMGC, that the owner can mitigate the design schedule risk by imposing liquidated damages on the design consultant.

C.10—Highway 3 Grand River Bridge Case Study; Ministry of Transportation, Ontario

Gransberg, D.; Shane, J.; Anderson, S.; Lopez del Puerto, C.; Strong, K.; and McMinimee, J., (2012) "NCHRP Project 10-85: A Guidebook for Construction Manager-at-Risk Contracting for Highway Projects: Interim Report," Unpublished Report. National Cooperative Highway Research Program.

Project Title: Highway 3 Grand River Bridge Replacement at Cayuga

Agency: Ontario Ministry of Transportation (MTO)

Location: The Grand River Bridge is located along Highway 3 at Cayuga in Haldimand County, Ontario, Canada.

Value: $20 million

Schedule (Award of CMR to completion): June 2011 – 2014 (~3 years)

Scope: The current five-span truss bridge over the Grand River at Cayuga was built in 1924 and is deteriorating. The project scope involves the structural replacement of the existing 200 meter wide bridge, including up to 330 feet of approach at each end of the bridge. The contractor's responsibilities include:

- Design assistance and review through the preconstruction phase.
- Develop GMP for project construction.
- Develop a detailed construction schedule.
- Procure and manage subcontractors.
- Bridge demolition.
- Construct the bridge and associated work.
- Temporary installation of a modular bridge.
- Maintain existing utilities, including water, gas and telephone, throughout construction, and permanently relocate these to the new bridge.

Figure C.10.1 shows the Grand River Bridge as it looks before starting construction.

Figure C.10.1 Highway 3 Grand River Bridge Current Condition

Rationale for Selecting CMR: CMR was chosen for the Grand River Bridge Project because of the environmental, cultural, and geotechnical complexities associated with the location of the bridge. Innovation and constructability was encouraged in order to deal with factors including fish, mussels, turtles, migratory birds, archaeological sensitivity, and difficult bedrock conditions. The original design for a temporary modular bridge to the side of the existing bridge required a lot of land and additional archaeological salvage. However, CMR allowed the project team to reach an alternative solution that saves an additional $2 million and avoids a one year extension of the project schedule. Table C.10.1 contains an overview of the salient points of this case study project.

Table C.10.1 Overview of the Highway 3 Grand River Bridge Replacement at Cayuga

Factor	
Design completed by:	Consultant
Design contract modified to synchronize with CMR preconstruction services contract:	Yes
Procurement procedure	One-Step Process RFP
Award system	Best value
Weighted evaluation criteria used	No
Interviews conducted	No
Disclose project budget before award	No
Self-performance requirement	No
Subcontractor restrictions	No
Payment Provisions	Combination Lump Sum and Unit Price
Point where GMP is established	Iterative pricing for each bid package - GMP at Final Design

The Grand River Bridge project is the MTO's first CMR project. As a result, MTO has adopted many of the same practices as the Utah Department of Transportation for implementing CMR as a delivery method. The project is currently in the preconstruction phase; however, MTO is already witnessing benefits due to CMR.

Lessons Learned: Some lessons learned from this case study thus far include:

- Budget control is inherent in the CMR model, even though it was not a driving factor in selecting the CMR;
- CMR has had the highest impact on the value of constructability reviews and biddability reviews;
- From an agency point of view MTO has found CMR to be more resource intensive upfront; and
- CMR has been found to be a huge benefit in terms of third party interface issues due to the need to maintain the utilities in the bridge throughout the project.

Summary and Observations of the Researchers: An important consideration for MTO is the linkage between the construction manager contract and the general contractor contract. This is possibly a concern for many agencies that are new to CMR. To ensure linkage between the two contracts MTO had contractors bid key elements in the design to provide an idea of their approach to the project. The linkage between the two contracts may be less of a concern once the agency gains experience with CMR; however, continuity will always be an important factor in alternative project delivery methods. Another difference between this case study and other case studies in this research is that the scoring of the proposals was done using a combination of adjectival rating in weighted categories that were published in the advertisement and a cost-technical trade-off. Most other agencies used direct point scoring in weighted categories.

C.11—Alaska DOT&PF Fairbanks International Airport

Gransberg., D.D. and Shane., J. S., (2010) Construction Manager-at-Risk Project Delivery for Highway Programs, NCHRP Synthesis 402, Transportation Research Board, National Research Council, Washington, DC.

Location: Fairbanks, Alaska

Value: $99 Million

Scope: New construction of an 80,000-square-foot addition to the existing terminal in Fairbanks, Alaska and included reconfiguration of roadways, parking and the airside terminal area. It also involved renovating 65,000 square feet of existing terminal which included demolition of the structure, reconfiguring the mechanical and electrical systems, and adding seismic upgrades to the building. Additionally the project entailed the demolition of those portions of the terminal built prior to 1985 and the construction of an employee parking lot.

Rationale: The Alaska DOT & PF decided to use CMR project delivery on this project and another airport expansion project due to the fact that they were non-typical agency projects being primarily vertical construction. The decision was made prior to 30% design development, and they also considered budget control and the specialized technical content required in an airport project to be other factors for selecting CMR. The major reasons for making the decision were to reduce the project delivery period, get early contractor involvement in the design process, and ensure flexibility during construction for the airport's operational constraints. Less important reasons for selecting CMR were cited as follows:

- Establish project budget at an early stage of design development
- Gain better control over a constrained budget
- Encourage constructability in Alaska's challenging environment
- Redistribute risk
- Gain assistance in dealing with complex project requirements
- Shift the responsibility for dealing with third party issues, primarily the airlines, to the contractor.

Procurement: The project was designed by a consultant who was selected before the CMR and assisted DOT with CMR selection process by evaluating CMR qualifications and references. The CMR was selected from an RFQ asking for qualifications only. They planned to evaluate all responses (i.e. no short-listing). However, they only got responses from three firms. The solicitation documents were short and contained only a description of the scope of work. Competing CMRs were required to submit the following information:

- Organizational structure/chart
- Past CMR project experience
- Past related project experience (non-CMR)
- Qualifications of the Construction Quality Manager

The agency interviewed each candidate in person. The interview consisted of the formal presentation of qualifications, past projects, and key personnel. The winner was determined by the output from the selection panel's direct point scoring in weighted categories published in the RFQ advertisement. Price was not considered in the selection. Additionally, there were no protests of the decision.

Project Administration: This project used a lump sum GMP contract. The GMP was established before 100% design completion. The GMP contained a single transparent project contingency and a management reserve that was controlled by the management above the project level. There was no shared savings incentive. The consultant design contract was modified to include CMR specific clauses on design review by CMR, design milestones coordinated with preconstruction services, coordination of design and subcontractor bid packages, selection of materials in concert with the CMR, and joint coordination with third parties (in this case primarily the airlines). The CMR was not allowed to self-perform any work, but there are no restrictions on the CMR regarding subcontractor selection.

Preconstruction Services: The following preconstruction services were provided:

- Validate agency/consultant estimates, schedules, and design approach
- Prepare project estimates and schedules
- Assist/input to agency/ consultant design
- Constructability reviews
- Value analysis
- Coordinate with 3rd party stakeholders

The preconstruction services fee was negotiated after award. The CMR's post award construction fee was also negotiated after award. No specific training of the CMR's personnel was required and no formal partnering was conducted.

Quality Management: Table C.11.1 shows the distribution of quality management responsibilities among parties to the contract. Alaska DOT&PF hired a consultant to assist it on this project and that consultant essentially represented the DOT across the QA/QC spectrum. The DOT was satisfied with the consultant and felt that CMR producing better quality than DBB because the CMR wanted to be rated in a favorable light as this acts as an incentive for future work.

Table C.11.1 Fairbanks International Airport CMR Project Quality Management Responsibilities.

Quality Assurance/Quality Control Tasks	**Does not apply**	**Agency**	**Designer**	**CMR**	**Agency-hired consultant**
Technical review of construction shop drawings					X
Technical review of construction material submittals					X
Checking of pay quantities					X
Routine construction inspection					X
Quality control testing					X
Establishment of horizontal and vertical control on site					X
Verification testing					X
Acceptance testing					X
Independent assurance testing/inspection					X
Approval of progress payments for construction progress					X
Approval of construction post-award QM/QA/QC plans					X
Report of nonconforming work or punchlist.					X

Summary: The interviewee indicated that the project accrued benefits in both cost and time savings as a result of the CMR's involvement in the design process. Alaska DOT&PF is also delivering a similar project at the Anchorage airport via CMR and based on the outcomes s of these two projects, has interest in applying this project delivery method on its traditional road and bridge projects.

C.12—Downtown Pedestrian Improvements, City of Glendale, Arizona

Gransberg., D.D. and Shane., J. S., (2010) Construction Manager-at-Risk Project Delivery for Highway Programs, NCHRP Synthesis 402, Transportation Research Board, National Research Council, Washington, DC.

Location: Glendale, Arizona

Value: $16.2 million

Scope: The project involved rebuilding the primary downtown road network to accommodate increased pedestrian traffic. It included upgraded lighting, landscaping, sidewalk, curb and gutter, utility relocations, and pavement rehabilitation/replacement. Traffic control was a major portion of the project as well as coordination with impacted property owners and utility companies.

Rationale: The City of Glendale Public Works Department has extensive CMR experience having completed a variety of vertical and horizontal CMR projects. It makes the project delivery method selection decision before starting design. On this project the major reason for selecting CMR was to have a single entity to deal with the myriad of third party entities that ranged from utilities to business owners. The project though seemingly simple was in fact quite complex and had a tight budget and schedule as well as significant traffic control issues that drove the City to use CMR and get the contractor involved in the design process as early as possible. Additionally, the City felt that CMR would also reduce the workload on their in-house engineers, technicians and inspectors. Less important reasons for selecting CMR were cited as follows:

- Establish project budget at an early stage of design development
- Encourage innovative solutions to conflicting requirements
- Encourage constructability, facilitate value engineering, and reduce life cycle costs.
- Redistribute risk
- Gain assistance in dealing with complex project requirements

Procurement: A consultant furnished all design services and was selected before CMR. It assisted City with the CMR selection process by evaluating qualifications as a non-voting member of panel. The CMR is selected as early in the process as possible, immediately after the consultant. The CMR was selected from an RFQ asking for qualifications only. The City put all qualified firms on the short-list and had more than 3 firms. The solicitation documents were short and contained only a description of the scope of work. Competing CMRs were required to submit the following information:

- Organizational structure/chart
- Past CMR project experience
- Past related project experience (non-CMR)
- References from past projects
- Qualifications of the CMR's project manager
- Construction quality management plan.

The agency interviewed each candidate in person. The interview consisted of the formal presentation of qualifications, past projects, and key personnel. The winner was determined by the output from the selection panel's direct point scoring in weighted categories published in the RFQ advertisement. Price was not considered in the selection. Additionally, there were no protests of the decision.

<u>Project Administration:</u> This project used a progressive lump sum GMP contract. The final GMP was established before 100% design completion. However, each work package GMP is established after sub bids are determined. The GMP contained transparent project contingencies for both the owner and CMR. There was no shared savings incentive. The consultant design contract was modified to include CMR specific clauses on design review by CMR, budget review points in the design schedule, coordination of design and subcontractor bid packages, selection of means and methods in concert with the CMR, and joint coordination with third parties. The CMR is allowed to self-perform up to 50% of work, but there are no restrictions on the CMR regarding subcontractor selection.

<u>Preconstruction Services:</u> The following preconstruction services were provided:

- Validate agency/consultant estimates, schedules, and design approach
- Prepare project estimates and schedules
- Assist/input to agency/ consultant design
- Constructability reviews
- Cost engineering reviews
- Value analysis
- Coordinate with 3rd party stakeholders

The preconstruction services fee was negotiated after award. The CMR's post award construction fee was also negotiated after award. No specific training of the CMR's personnel was required and no formal partnering was conducted.

<u>Quality Management:</u> Table C.12.1 shows the distribution of quality management responsibilities among parties to the contract. The agency believed that CMR produces better quality than DBB due to the close collaboration between the designer and the builder on a CMR project.

Table C.12.1 Glendale CMR Project Quality Management Responsibilities.

Quality Assurance/Quality Control Tasks	Does not apply	Agency	Designer	CMR	Agency-hired consultant
Technical review of construction shop drawings			X		
Technical review of construction material submittals			X		
Checking of pay quantities			X		
Routine construction inspection			X		
Quality control testing			X	X	
Establishment of horizontal and vertical control on site			X		
Verification testing			X		
Acceptance testing			X		
Independent assurance testing/inspection			X		
Approval of progress payments for construction progress		X			
Approval of construction post-award QM/QA/QC plans		X			
Report of nonconforming work or punchlist.		X			

<u>Summary:</u> The contractor interviewed on this project agreed with the City in its assessment of enhanced quality, but its reason was that the parties in this project kicked the project off by

holding a “scope definition and clarification” meeting where they essentially negotiated the final technical scope of work before launching into the design and assigned each risk to the party that could best manage it. This resulted in the CMR taking on identifying the underground conditions at a very early stage in design as well as producing a construction sequencing plan that was synchronized with the design schedule. The two allowed the CMR to start digging as soon as possible and this allowed it could identify those conflicts that were previously unknown as early as possible.

C.13—Florida DOT Miami Intermodal Center

Gransberg., D.D. and Shane., J. S., (2010) Construction Manager-at-Risk Project Delivery for Highway Programs, NCHRP Synthesis 402, Transportation Research Board, National Research Council, Washington, DC.

Location: Miami, Florida

Value: $1.7 billion

Scope of Work: This huge project entails road, bridge and interchange construction to upgrade access to Miami International Airport in Miami, Florida, rail component, including heavy rail transportation modes both at grade and elevated, public concourses connecting all transport modes both at grade and elevated; bus facilities; airport landside improvements including arrivals and departures roadways. It also involves constructing the new Miami Intermodal Center (MIC) and Miami International Airport APM Station (MIC-MIA Connector), parking, joint development space involving private sector partners on the MIC site, and rental car facility.

Rationale: The Florida DOT has a respectable amount of CMR experience having completed more than 10 projects using the method. However, most are primarily vertical in nature. It makes the project delivery method selection decision before starting design. On this project the major reason for selecting CMR was the technical nature of the project. The vertical component was substantial and the horizontal portion included light rail transit features, making it a non-typical FDOT project and leading the agency to see the CMR as an additional point of technical expertise. Additionally, complex coordination requirements and the desire to get early contractor involvement contributed to the decision to select CMR project delivery. Less important reasons for selecting CMR were cited as follows:

- Compress the project delivery period
- Establish project budget at an early stage of design development
- Encourage innovative solutions to conflicting requirements
- Encourage constructability, facilitate value engineering, and gain flexibility during the construction phase.
- Redistribute risk

Procurement: A consultant furnished all design services and was selected before CMR. It did not assist with the CMR selection process. The CMR is selected as early in the process as possible, immediately after the consultant. The CMR was selected from a request for letters of interest. FDOT then published a short-list of 3 firms. The solicitation documents contained a description of the scope of work as well as preliminary plans and specifications. Competing CMRs were required to submit the following information:

- Past CMR project experience
- Past related project experience (non-CMR)
- Qualifications of the CMR's project manager

The agency interviewed each candidate in person. The interview was based on a standing list of questions that are asked to all competitors on the shortlist. The winner was determined by the output from the selection panel's direct point scoring in unweighted categories published in the advertisement. Price was not considered in the selection. Additionally, there were no protests of the decision.

Project Administration: This project used a unit price GMP contract. The final GMP was established before 100% design completion and is completed as early as possible. The GMP contained transparent project contingencies for both the owner and CMR. The CMR gets to keep its unused contingency as an incentive savings. The consultant design contract was only modified to show that the design services are in conjunction with a CMR project. The CMR is allowed to self-perform up to 50% of work and must publicly accept bids to conduct subcontractor selection. The preconstruction services fee was negotiated after award. The CMR's post award construction fee was also negotiated after award. No specific training of the CMR's personnel was required and no formal partnering was conducted.

Quality Management: Table C.13.1 shows the distribution of quality management responsibilities among parties to the contract. The agency believed that CMR produces comparable quality to DBB.

Table C.13.1 Miami Intermodal Center CMR Project Quality Management Responsibilities

Quality Assurance/Quality Control Tasks	Does not apply	Agency	Designer	CMR	Agency-hired consultant
Technical review of construction shop drawings		X	X		
Technical review of construction material submittals					X
Checking of pay quantities					X
Routine construction inspection			X		
Quality control testing				X	
Establishment of horizontal and vertical control on site					X
Verification testing					X
Acceptance testing					X
Independent assurance testing/inspection					X
Approval of progress payments for construction progress					X
Approval of construction post-award QM/QA/QC plans					X
Report of nonconforming work or punchlist.					X

Summary: FDOT is generally satisfied with the results of its CMR program and intends to continue to use the project delivery method for those projects where it makes sense. It is also expanding it into its more typical road and bridge projects on a case-by-case basis.

C.14—Oregon DOT I-5 Willamette River Bridge

Gransberg., D.D. and Shane., J. S., (2010) Construction Manager-at-Risk Project Delivery for Highway Programs, NCHRP Synthesis 402, Transportation Research Board, National Research Council, Washington, DC.

Location: Eugene, Oregon

Value: $150 million

Scope: Remove existing decommissioned Willamette River Bridge; construct new 1800-foot long bridge in place of the decommissioned Willamette River Bridge structure; Replacement of the decommissioned Canoe Canal bridge; reconstructing approximately 2,500 feet of roadway approaching and between the bridges; construct modifications of the Franklin Boulevard northbound off-ramp and southbound on-ramp to adjust to I-5 alignment modifications.

Rationale: This is the Oregon DOT's first CMR project. The decision to use CMR was made prior to 30% design completion. The overarching reason for selecting CMR was to gain experience with the project delivery method prior to using it on a much larger and more complex bridge over the Columbia River. Project-specific reasons for selecting CMR for the Willamette River Bridge were project budget and schedule control issues, as well as a desire to redistribute the risk from that normally found in a design-build project. Less important reasons for selecting CMR were cited as follows:

- Compress the project delivery period
- Establish project budget at an early stage of design development.
- Gain better control over a constrained budget
- Get early construction contractor involvement
- Encourage constructability and facilitate value engineering,
- Assign the responsibility for coordinating third party issues to the contractor.

Procurement: A consultant furnished all design services and was selected before CMR. It did not assist with the CMR selection process. In the future they will appoint as non-voting member of panel. The CMR is selected as early in the process as possible after the consultant. The CMR was selected from a RFP which contained 4-5 unit prices for major pay items. ODOT planned to short-list 3 firms but only received 2 proposals. The solicitation documents contained a description of the scope of work quality management roles and responsibilities and design criteria checklists. Competing CMRs were required to submit the following information:

- Past CMR project experience
- Past related project experience (non-CMR)
- Qualifications of the CMR's project manager, construction manager and project principal.
- Construction quality management plan and public relations plan
- Preliminary project schedule
- Proposed preconstruction services fee, post-construction services fee (profit), and general conditions fee

The agency interviewed each candidate in person. The interview was based on a pre-published list of questions that are asked to all competitors on the shortlist. Formal presentation of project-specific issues and details of preconstruction services were took place. The winner was determined by the output from the selection panel's direct point scoring in weighted categories published in the advertisement. Price carried a 15% weight in the selection. There was a protest on this project for ODOT's alleged failure to pursue clarifications requested during proposal preparation that affected the final scoring. The protest was denied

<u>Project Administration:</u> This project used a lump sum GMP contract. The final GMP was established before 100% design completion. The GMP contained a single transparent project contingency and the CMR was allowed to keep any remaining contingency as a shared savings incentive. The consultant design contract was modified to include CMR specific clauses on joint value engineering with the CMR, coordination of design and subcontractor bid packages, selection of means and methods in concert with the CMR, and joint coordination with third parties. The CMR is allowed to self-perform up to 30% of work, but there are no restrictions on the CMR regarding subcontractor selection.

<u>Preconstruction Services:</u> The following preconstruction services were provided:

- Validate agency/consultant estimates, schedules, and design approach
- Prepare project estimates and schedules
- Assist/input to agency/ consultant design
- Constructability reviews
- Cost engineering reviews
- Value analysis
- Coordinate with 3rd party stakeholders

The preconstruction services fee was proposed in the proposal. ODOT fixed the post-construction fee and general conditions at 13.5% of the GMP. There was no negotiation of these items after award. Context sensitive design training for the CMR's personnel was required and formal partnering was conducted.

<u>Quality Management:</u> Table C.14.1 shows the distribution of quality management responsibilities among parties to the contract. The agency had no means of forming an opinion about the comparative quality with DBB as the project was in design when the interview was conducted.

Table C.14.1 Willamette River Bridge CMR Project Quality Management Responsibilities

Quality Assurance/Quality Control Tasks	Does not apply	Agency	Designer	CMR	Agency-hired consultant
Technical review of construction shop drawings					X
Technical review of construction material submittals					X
Checking of pay quantities		X			
Routine construction inspection		X			
Quality control testing				X	
Establishment of horizontal and vertical control on site					X
Verification testing		X			
Acceptance testing		X			
Independent assurance testing/inspection		X			
Approval of progress payments for construction progress		X			
Approval of construction post-award QM/QA/QC plans		X			
Report of nonconforming work or punchlist.		X			

Summary: The contractor interviewed on this project had no objections to the agency fixing the profit and general conditions fee in the RFP. He stated that this took that element out of the competition and allowed his team to focus on demonstrating the value that it could add without worrying about being undercut on the margin amount. The contractor also felt that project quality would be better on CMR than DBB projects because the fundamental design is better and reflects the actual constructed product. One interesting aspect on this project was that the CMR found that it could get permits in about ¼ the time it took the agency because the permitting agencies perceived that the design would not change from that displayed in the permit application if a construction contractor was the one pulling the permit. This is even more interesting when one considers that Eugene, Oregon has some of the most stringent environmental constraints in the nation.

C.15—Pinal County Public Works; Ironwood-Gantzell Multi-Phase Road Improvement

Gransberg., D.D. and Shane., J. S., (2010) Construction Manager-at-Risk Project Delivery for Highway Programs, NCHRP Synthesis 402, Transportation Research Board, National Research Council, Washington, DC.

Location: Florence, Arizona

Value: $63.7 million

Scope of Work: Convert 2-lane highway to 4-lane, construct bridges and approach roads; at-grade intersections and ancillary safety improvements.

Rationale: Pinal County had some prior experience with CMR, having completed 4 previous projects. The decision to use CMR was made prior to 30% design completion. The major reason for selecting CMR was the need to compress the schedule along with the requirement to maintain extensive coordination with third party stakeholders, such as utility companies and the need for positive public interface throughout the project. Less important reasons for selecting CMR were cited as follows:

- Get early construction contractor involvement
- Encourage constructability and facilitate value engineering,
- Sort out complex project requirements
- Gain flexibility during construction
- Assign the responsibility for coordinating third party issues to the contractor.
- Take advantage of innovative financing

Procurement: A consultant furnished all design services and was selected before CMR. It assisted the agency with the CMR selection process by evaluating CMR qualifications, participating as a voting member of the panel and developing the short list. The local Associated General Contractors (AGC) also furnishes a voting member to the selection panel. The CMR was selected from an RFQ and a short-list of all qualified proposers. It is possible in Pinal County to have more than three on the short-list. The solicitation documents contained a description of the scope of work quality management roles, preliminary plans and specifications, quality management roles and responsibilities and a conceptual schedule. Competing CMRs were required to submit the following information:

- Past CMR project experience with references
- Past related project experience (non-CMR) with references
- Qualifications of the CMR's project manager, preconstruction services manager, general superintendent and public relations person.
- Construction traffic control plan and public relations plan
- Preliminary project schedule
- Declaration of self-performed work and subcontracting plan
- Critical analysis of project budget

The agency interviewed each candidate in person and consisted of a formal presentation including: qualifications, past projects, key personnel, details of preconstruction services, and CMR's analysis of potential project issues and how they can be managed. The winner was determined by the output from the selection panel's direct point scoring in weighted categories published in the advertisement. Price was not scored. Pinal County has never had a protest of a CMR selection decision.

Project Administration: This project used a lump sum progressive GMP contract. The final GMP was established before 100% design completion and was the sum of previous work package GMPs and the estimate for the final work package plus contingencies. The GMP contained transparent contingencies for both the owner and the CMR with no shared savings incentive. The consultant design contract was modified to include CMR specific clauses for design review and milestones to facilitate preconstruction services, requirement to notify CMR of major design changes, joint VE with CMR, coordination of design and subcontractor bid packages, and joint coordination with third parties. The CMR is allowed to self-perform up to 45% of work, but there are no restrictions on the CMR regarding subcontractor selection.

Preconstruction Services: The following preconstruction services were provided:

- Validate agency/consultant estimates, schedules, and design approach
- Assist in permitting actions
- Assist in right-of-way acquisition
- Prepare project estimates and schedules
- Assist/input to agency/consultant design
- Constructability and cost engineering reviews
- Value analysis
- Coordinate with 3rd party stakeholders
- Conduct material market survey for cost and availability during design
- Establish sequence of design work to coordinate with construction work packages
- Forecast material/labor pricing to make input to contingencies

The preconstruction services fee and post-construction management fee were negotiated after award. No special training was required, but formal partnering was mandatory.

Quality Management: Table C.15.1 shows the distribution of quality management responsibilities among parties to the contract. The agency held CMR produces better quality than DBB because of better relationships among all project stakeholders.

Table C.15.1 Ironwood Gantzell CMR Project Quality Management Responsibilities

Quality Assurance/Quality Control Tasks	Does not apply	Agency	Designer	CMR	Agency-hired consultant
Technical review of construction shop drawings			X		
Technical review of construction material submittals			X		
Checking of pay quantities		X			
Routine construction inspection				X	
Quality control testing				X	
Establishment of horizontal and vertical control on site				X	
Verification testing		X		X	
Acceptance testing		X			
Independent assurance testing/inspection		X			
Approval of progress payments for construction progress		X			
Approval of construction post-award QM/QA/QC plans		X			
Report of nonconforming work or punchlist.		X			

Summary: The contractor for this project agreed with the owner that the project's quality is better if delivered using CMR because in his words: "Being able to make input to the design creates a sense of ownership in that design." This case study project had the most robust preconstruction services program, involving the contractor is material selection, permitting, right-of-way acquisition and public relations. Both the agency and the contractor agreed that the progressive GMP system allowed the CMR to keep contingencies at a minimum and allowed the project to proceed in those areas where third party issues were settled. This created the reduction of uncertainty and permitted the project's schedule to be compressed to its greatest extant without excessive time-related contingencies.

C.16—Utah DOT I-80

Gransberg., D.D. and Shane., J. S., (2010) Construction Manager-at-Risk Project Delivery for Highway Programs, NCHRP Synthesis 402, Transportation Research Board, National Research Council, Washington, DC.

Location: Salt Lake City, Utah

Value: $130 million

Scope of Work: Add one lane to each side of I-80; Construct six new bridges; improve two interchanges including adding lanes; retaining walls; residential sound/noise walls. Rationale: UDOT had 48 CMR projects either finished or underway at the time of the interview and is very comfortable with the status of its procurement system as well as the provisions in their design and CMR contracts. The decision to use CMR was made prior to 30% design completion. The major reason for selecting CMR on this project was the need to bring in technical expertise and experience with Accelerated Bridge Construction (ABC), a process where a bridge is constructed offsite and driven into place atop a specialized bridge erection vehicle

Additionally, UDOT felt that the need to control budget and schedule on a technically complex project was best met by CMR project delivery. Less important reasons for selecting CMR were cited as follows:

- Get early construction contractor involvement and redistribute risk.
- Accelerate the project delivery period and establish the budget at an early stage
- Encourage innovation, constructability and facilitate value engineering,
- Assign responsibility for third party issues to the CMR.
- Gain flexibility during construction
- Reduce agency oversight requirements during design and reduce life cycle costs

The rationale for using CMR on this project is stated as follows: " [we] chose CMGC because the owner is more involved in the design decision process. As owners we make better decisions when we understand the project and that occurs during design. Furthermore our understanding is enhanced by the contractors experience of how to build it. Evolving the contractor in design is like having a continuous peer review. We catch our mistakes, gain a better understanding of our choices, and make better decisions" (Alder 2009).

<u>Procurement:</u> The project was designed by a combination of consultant and in-house designers with the in-house group initiating conceptual design. Designer selected before CMR and assists DOT with CMR selection process as non-voting member of panel. The CMR was selected by a two step RFQ/RFP process. A short-list of the 3 most qualified firms was formed and then asked to submit a proposal containing 4 to 5 unit prices for major pay items. The process is described by one of its authors as follows:

> Using price in the selection process forces the contractor to think about what they will be building. When we add price they have to apply assumptions, boundaries, quantities, schedules, etc to the project. Price forces the contractor to think through a project like they would have to think through a traditional Design, Bid, Build project. It also adds price completion to the selection process. Associated with this effort we ask them to document assumptions, risks, innovations, and risk mitigation strategies. We are not as concerned about the proposed price as we are about their process in getting there. We want to know if they will open their cost estimating books to us. Will they be good team players and follow an open book process in their cost estimating. Cost is an important part of the design decision process and we need a contractor that shows his cards.
>
> In the design process the engineer and the contractor share price information. We can then compare their prices for the bid items they responded to in the proposal. We also consider assumption used in the creation of those prices and make adjustment where it is justified. In the bid opening process we compare the contractor's price to a cost estimate performed by an Independent Cost Estimator ICE. The ICE is not told contractor prices during the design. The ICE knows measurement and payment information and what is included in each bid item. The ICE is an experienced contractor estimator who bids the project like another contractor. We compare the contractor's price to the ICE for each bid item. We also compare the contractor's price to the bid items he proposed on in the selection process. If Oil or other material costs have gone up then a price increase on HMA [hot mix asphalt] for example is permitted, else we expect the same price at bid opening as we were given at contractor selection.
>
> The process is not perfect and we are looking for ways to improve it. One technique we are developing is a Cost Model being developed by a local university professor.

> We have a model for HMA, PCCP [Portland cement concrete pavement], Storm Drains, and sidewalks. We intend to expand this to 20% of the bid items that represent 80% of a projects cost. The primary purpose of this tool is to force a discussion about assumptions -- like what is the material cost, the labor rates, the production rates and other relevant choices that are used to estimate the cost. This gives the engineer a better understanding of what the construction challenges are. The engineer is then better able to create an estimate from historical data. The contractor is better able to share his cost and create a more accurate construction cost. (Alder 2009).

The solicitation documents contained quality management roles and responsibilities and preliminary plans and specifications. Competing CMRs were required to submit the following information:

- Organizational structure/chart
- Past CMR project experience with references
- Past related project experience (non-CMR) with references
- Qualifications of the CMR’s project manager, preconstruction services manager, general superintendent and public relations coordinator.
- Construction traffic control plan and public relations plan
- Preliminary project schedule
- Subcontracting plan
- Proposed post-construction services fee
- Rates for self-performed work
- Critical analysis of project budget

The agency interviewed each candidate in person and consisted of a formal presentation including: qualifications, past projects, key personnel, details of preconstruction services, and CMR’s analysis of potential project issues and how they can be managed. The winner was determined by the output from the selection panel’s direct point scoring in weighted categories published in the advertisement. Price weight ranges from 26-50%; this project is was about 30%. UDOT has never had a protest of a CMR selection decision.

Project Administration: UDOT uses different contract types based on project type. They have used Unit Price GMP; Unit Price with no GMP; Preconstruction fee only with construction features hard bid by subs. This project used a progressive Unit Price GMP which is assembled incrementally as the design of bid packages are completed and subcontractor bids are received. The final GMP was established after 100% design and there is a single transparent contingency and no shared savings. The contingency was broken down in three categories: material contingency, westbound portion plus ABC, and eastbound portion. UDOT does not modify its typical consultant design contract for CMR. The CMR can self-perform up to 70% of the project and there are no restrictions on the CMR regarding subcontractor selection.

Preconstruction Services: The following preconstruction services were provided:

- Validate agency/consultant estimates, schedules, and design approach
- Prepare project estimates and schedules
- Assist/input to agency/consultant design
- Constructability and cost engineering reviews
- Coordinate with 3rd party stakeholders
- Public relations and public information planning

The preconstruction services fee was negotiated after award. There is no contractual post-construction services fee. In a unit price GMP it is contained in the construction costs provided in the GMP. No special training was required, but formal partnering was mandatory.

Quality Management: Table C.16.1 shows the distribution of quality management responsibilities among parties to the contract. The agency held CMR produces better quality than DBB because CMR believes that the quality of its work reflects on its competitiveness for the next UDOT CMR project.

Table C.16.1 I-80 CMR Project Quality Management Responsibilities

Quality Assurance/Quality Control Tasks	Does not apply	Agency	Designer	CMR	Agency-hired consultant
Technical review of construction shop drawings			X		X
Technical review of construction material submittals		X			X
Checking of pay quantities		X			X
Routine construction inspection		X			
Quality control testing				X	
Establishment of horizontal and vertical control on site			X		
Verification testing		X			
Acceptance testing		X			
Independent assurance testing/inspection		X			
Approval of progress payments for construction progress		X			X
Approval of construction post-award QM/QA/QC plans		X			
Report of nonconforming work or punchlist.		X			X

Summary: The contractor on this project agreed that CMR produces better quality than DBB because the contractor design input can assist in literally designing the quality into the project. It also believed that the progressive GMP allowed for keeping contingencies as low as possible. It also liked breaking out the material contingencies from the time-related contingencies in that it created an open-books method for discussing contingency issues with the state. Finally, the contractor believed that requiring the competing contractors to detail their project approach during the interview was a particularly effective way to differentiate the winner. UDOT agreed that the winner’s approach to the project was the overwhelming reason for its selection.

C.17—Michigan DOT; Oversight - Passenger Ship Terminal Expansion

Gransberg., D.D. and Shane., J. S., (2010) Construction Manager-at-Risk Project Delivery for Highway Programs, NCHRP Synthesis 402, Transportation Research Board, National Research Council, Washington, DC.

Agency Providing Funds: Detroit Wayne County Port Authority

Location: Detroit, Michigan

Value: $10 million

Scope of Work: Construct new wharf and expand service roads that service the new wharf.

Rationale: MDOT had no prior experience with CMR. This project is the first one. MDOT was not involved in the rationale behind the decision to use CMR project delivery. The decision by the Port Authority was made prior to 30% design completion. The major reasons for selecting CMR were the technical complexity of the project and the need to reduce agency staffing to oversee the project.

Procurement: A consultant furnished all design services and was selected before CMR. It assisted the funding agency with the CMR selection process as voting member of panel, evaluating qualification, checking references and evaluating fees after award. The CMR was selected from an RFQ and no short-list was formed. All proposals were considered. The DOT was not involved in the selection decision. The agency interviewed each candidate in person and consisted of a formal presentation including: qualifications, past projects, key personnel, details of preconstruction services, and CMR's analysis of potential project issues and how they can be managed. The winner was determined by the output from the selection panel's direct point scoring in weighted categories published in the advertisement. Price was not scored. There was no protest of a CMR selection decision.

Project Administration: This project used a lump sum GMP contract. The final GMP was established after 100% design completion and after subcontractor bids had been received. The GMP contained transparent contingencies for both the owner and the CMR with a shared savings incentive of the unused contingencies. The consultant design contract was not modified. The CMR is allowed to self-perform up to 35% of work, but there are no restrictions on the CMR regarding subcontractor selection.

Preconstruction Services: The following preconstruction services were provided:

- Validate agency/consultant estimates and design approach
- Prepare project estimates and schedules
- Constructability reviews
- Value analysis
- Coordinate with 3rd party stakeholders

The agency specified a fixed preconstruction services fee of $50,000. It also specified a post-construction management fee of 3.5%. No special training nor partnering were required.

Quality Management: Table C.17.1 shows the distribution of quality management responsibilities among parties to the contract. The agency had no opinion regarding the comparative quality of CMR as the project is not complete and this is the agency's first CMR job.

Table C.17.1 Passenger Ship Terminal CMR Project Quality Management Responsibilities

Quality Assurance/Quality Control Tasks	Does not apply	Agency	Designer	CMR	Agency-hired consultant
Technical review of construction shop drawings			X	X	
Technical review of construction material submittals		X	X		
Checking of pay quantities	X				
Routine construction inspection			X		
Quality control testing			X	X	
Establishment of horizontal and vertical control on site			X	X	
Verification testing			X		
Acceptance testing			X		
Independent assurance testing/inspection			X		
Approval of progress payments for construction progress		X			
Approval of construction post-award QM/QA/QC plans			X		
Report of nonconforming work or punchlist.			X		

Summary: No contractor interview was forthcoming on this project. The agency is evaluating the outcome of this project before deciding if it will apply it to traditional MDOT projects.

C.18—Utah Transit Authority; Weber County Commuter Rail Project.

Gransberg., D.D. and Shane., J. S., (2010) Construction Manager-at-Risk Project Delivery for Highway Programs, NCHRP Synthesis 402, Transportation Research Board, National Research Council, Washington, DC.

Location: Salt Lake City, Utah

Value: $241 million

Scope: The 44 miles of new transitway alignment begins in downtown Salt Lake City at the Inter-modal Hub and extends north along the Union Pacific Railroad right-of-way through Davis and Weber Counties, passing on new elevated structures over the Ogden Yard continuing north of Union Station in Ogden to Pleasant View, UT. Grade crossings and grade crossing protective devices for the commuter rail line are also being constructed or reconstructed as needed. The project also includes 7 stations which include Park and Ride capabilities and an upgrade of an existing maintenance facility and storage site to maintain the Commuter Rail fleet.

Rationale: This project involved coordinating with multiple stakeholders as it passed through 10 different municipalities and shared or abutted on right-of-way owned by the Union Pacific Railroad. The Utah Transit Authority (UTA) had limited experience with CMR, having completed less than 5 previous projects. The decision to use CMR was made before 30% design completion. The major reason for selecting CMR was the project's technical complexity along with the requirement to maintain extensive coordination with the third party stakeholders, such as utility companies, impacted municipalities and the railroad. Finally, there was a the need be ensure continuous public interface as well as desire to compress the schedule to accrue transit/parking revenue as early as possible. Less important reasons for selecting CMR were cited as follows:

- Get early construction contractor involvement
- Establish the project budget for each phase as early as possible.
- Encourage constructability and facilitate value engineering,
- Gain flexibility during construction
- Assign the responsibility for coordinating third party issues to the contractor.
- Reduce agency staffing requirements.

Procurement: A consultant was selected to complete the design. The designers were selected before the CMR. The consultant assisted the agency with the CMR selection process as a non-voting member of the panel The CMR was selected from an RFP and a short-list of three qualified proposers. The solicitation documents contained a description of the scope of work and quality management roles and responsibilities. Competing CMRs were required to submit the following information:

- Past CMR project experience with references
- Qualifications of the CMR's project manager and quality manager.
- Proposed preconstruction fee

The agency interviewed each candidate in person and consisted of a formal presentation including: qualifications, past projects, key personnel, details of preconstruction services, and CMR's analysis of potential project issues and how they can be managed. The winner was determined by the output from the selection panel's direct point scoring in weighted categories published in the advertisement. Price was not scored and UTA has never had a protest of a CMR selection decision.

Project Administration: This project used a lump sum GMP contract. The final GMP was established as soon as practical before 100% design completion. The GMP contained separate transparent contingencies for the CMR and the owner and the CMR with no shared savings incentive. The consultant design contract was modified to include CMR specific clauses for CMR design review, joint value engineering, and joint coordination with third parties. The CMR is allowed to self-perform as much of work as it pleased, and it had no restriction on its selection of subcontractors.

Preconstruction Services: The following preconstruction services were provided:

- Validate consultant design
- Prepare project estimates and schedules
- Assist/input to agency/consultant design
- Constructability and cost engineering reviews
- Value analysis
- Market surveys to assist in material selection design decisions
- Coordinate with 3rd party stakeholders
- Assist in right-of-way acquisition and permitting actions

The preconstruction services fee was proposed before award and post-construction management fee was negotiated after award. No special training was required. Formal partnering was mandated.

Quality Management: Table C.18.1 shows the distribution of quality management responsibilities among parties to the contract. The agency held CMR produces better quality than DBB because of the CMR's ability to work with third parties to reduce permitting delays and maintain the schedule.

Table C.18.1 Weber County Commuter Rail CMR Project Quality Management Responsibilities

Quality Assurance/Quality Control Tasks	Does not apply	Agency	Designer	CMR	Agency-hired consultant
Technical review of construction shop drawings			X		X
Technical review of construction material submittals			X		X
Checking of pay quantities		X			X
Routine construction inspection		X		X	X
Quality control testing				X	
Establishment of horizontal and vertical control on site				X	X
Verification testing				X	
Acceptance testing		X			X
Independent assurance testing/inspection					
Approval of progress payments for construction progress		X			
Approval of construction post-award QM/QA/QC plans		X			
Report of nonconforming work or punchlist.		X			

Summary: The UTA was able to complete this project 9 months ahead of schedule and within budget. They felt that the use of CMR project delivery and especially the early contractor involvement in the design process was largely responsible for project success. The CMR initiated a value engineering study of a large fly-over bridge that crossed the Union Pacific railroad yard. The basis of the savings was a right-of-way swap between UP and UTA that allowed the fly-over to be reduced to two small bridges on three fills. UTA accrued the entire savings of nearly $7 million since it was paying for VE services in the preconstruction services contract. UTA also used an innovative clause in their CMR contract that created an incentive for the contractor to maintain good public relations. The clause effectively put half the CMR's post-construction services fee at risk by requiring a monthly meeting of a stakeholder panel that included the impacted municipalities, the state environmental quality agency, and representatives from the railroad and the federal transit administration. The panel reviewed the issues that arose in the past month and made a recommendation to UTA as to how much of the at-risk fee should be awarded in the monthly progress payment. The clause worked because there was only one month that less than the full amount was applied, and the panel decided to restore it the next month after the CMR had taken aggressive and immediate corrective action to resolve the issue. Finally, it should be noted that UTA's desire to minimize the agency's oversight staff was realized in that the project was successfully completed with only two UTA employees assigned to manage it.

C.19—Memphis Shelby County Airport Authority; Whole Base Relocation Project.

Gransberg., D.D. and Shane., J. S., (2010) Construction Manager-at-Risk Project Delivery for Highway Programs, NCHRP Synthesis 402, Transportation Research Board, National Research Council, Washington, DC.

Location: Memphis, Tennessee

Value: $245 million

Scope: Relocate the 164th Airlift Wing base in its entirety to a new location at Memphis-Shelby County International Airport (MSCIA). New apron and taxiways, three specialized hangars with associated shops to support the C-5 program, and all related administrative base operations; design packages for 15 buildings (560,000 SF) and associated utilities and infrastructure.

Rationale: This project involved multiple stakeholders: the MSCIA Authority, FedEX, Inc., 164th Airlift Wing, Tennessee Air Guard, and Headquarters, Air National Guard, Washington, DC. It also involved mixing private funding with different types of public funding. MSCIA Authority had prior experience with CMR, having completed more than 10 previous projects. The decision to use CMR was made before advertising the design contract. The major reason for selecting CMR was the need to compress the schedule along with the requirement to maintain extensive coordination with the four stakeholders contributing funds to the project as well as third party stakeholders, such as utility companies and the scheduled airlines. Finally, there was a the need be able to track which features in the scope of work were being designed and built from each pot of funds throughout the project. Less important reasons for selecting CMR were cited as follows:

- Get early construction contractor involvement
- Establish the project budget for each phase as early as possible.
- Encourage price competition through competitive bidding by subcontractors.
- Encourage constructability and facilitate value engineering,
- Redistribute risk and sort out complex project requirements
- Assign the responsibility for coordinating third party issues to the contractor.

- Take advantage of available federal and private financing

Procurement: A consultant was selected to act as CM-Agent and represent the MSCIA Authority throughout the course of the project. The project had five phases and the CM-Agent treated each as a separate project procuring phase design consultants to complete the design and requiring full competition for each CMR contract. The designers were selected before the CMR. The CM-Agent assisted the agency with the CMR selection process by evaluating CMR qualifications, checking references, and participating in the interviews as a non-voting member of the panel The CMR was selected from a two-step RFQ/RFP and a short-list of three qualified proposers. The solicitation documents contained a description of the scope of work and preliminary plans and specifications, Competing CMRs were required to submit the following information:

- Organizational Chart
- Past CMR project experience with references
- Past related project experience (non-CMR) with references
- Qualifications of the CMR's project manager, preconstruction services manager, general superintendent and quality manager.
- Construction traffic control plan and construction quality management plan
- Preliminary project schedule
- Declaration of self-performed work and subcontracting plan
- Critical analysis of project budget including target GMP.
- Proposed preconstruction and post-construction fees

The agency interviewed each candidate in person and consisted of a formal presentation including: qualifications, past projects, key personnel, details of preconstruction services, and CMR's analysis of potential project issues and how they can be managed. The winner was determined by the output from the selection panel's direct point scoring in weighted categories published in the advertisement. Price was weighted at 25% of total points and MSCIA Authority has never had a protest of a CMR selection decision.

Project Administration: This project used a lump sum GMP contract for each phase. The final GMP was established by the sum of phase GMPs and the estimate for the final phase contingencies. The GMP contained a single transparent contingency and the CMR with no shared savings incentive. The consultant design contract was modified to include CMR specific clauses for milestones to facilitate preconstruction services, budget review points, coordination of design and subcontractor bid packages, and joint coordination with third parties. Additionally, the MSCIA CMR design contract contained a provision that put up to 10% of design fee at risk based on the quality of the construction documents. This was measured by the number of additive change orders had to issued after 100% construction documents were released for construction. The CMR is allowed to self-perform as much of work as it pleased, and it was required to accept competitive bids from the trade subcontractors. It was allowed to designate a subcontractor whose bid was not the lowest, but the CMR had to reduce its margin be the difference between the low sub and the desired sub.

Preconstruction Services: The following preconstruction services were provided:

- Prepare project estimates and schedules
- Assist/input to agency/consultant design
- Constructability and cost engineering reviews
- Value analysis
- Coordinate with 3rd party stakeholders

The preconstruction services fee and post-construction management fee were proposed before award. No special training or partnering was required. ,

Quality Management: Table C.19.1 shows the distribution of quality management responsibilities among parties to the contract. The agency held CMR produces better quality than DBB because it made the CMR more competitive for future work.

Table C.19.1 Whole Base Relocation CMR Project Quality Management Responsibilities

Quality Assurance/Quality Control Tasks	Does not apply	Agency	Designer	CMR	Agency-hired consultant
Technical review of construction shop drawings			X		X
Technical review of construction material submittals			X		X
Checking of pay quantities				X	
Routine construction inspection				X	
Quality control testing				X	
Establishment of horizontal and vertical control on site					X
Verification testing		X			
Acceptance testing					X
Independent assurance testing/inspection		X			
Approval of progress payments for construction progress		X			
Approval of construction post-award QM/QA/QC plans		X			
Report of nonconforming work or punchlist.		X			

Summary: The MSCIA Authority was able to complete this project ahead of schedule and within budget. They felt that the use of both CMR and CM-Agency in this phased project was largely responsible for its success. The first phase had difficulty getting the design consultant to accept CMR input because it feared that this would compromise the contractual design liability. The second phase CMR design contract contained the provision that put up to 10% of design fee at risk based on the quality of the construction documents. This changed the consultant's attitude from viewing the CMR as technically unqualified interference to seeing the CMR reviews as a valuable contribution to the design quality control system. This contractual innovation along with furnishing the CMR the ability to select a subcontractor whose bid was not the lowest by reducing its own fee created an environment where the CMR's value to the project was significant.

C.20—SR 14 Landslide Repair; Utah DOT

Gransberg D.D. and M.C. Loulakis, "Expedited Procurement Procedures for Emergency Construction Services" NCHRP Synthesis 43-11, Final Report Transportation Research Board, National Academies, Washington, D.C.

This project was selected for inclusion because it demonstrates the use of CMGC as a means to expedite the procurement of a construction contractor and to leverage that capability to mitigate the risk of cost overruns resulting from compressing the project's delivery period to its shortest state. It was also selected because both right-of-way and permitting pose significant potential issues on this project. Again, UDOT is using CMGC delivery as a means of mitigating the delay risk due to third party stakeholders. The project is currently underway.

Value: $15,000,000

Scope: This case study project has been named the "Restore 14 Project." It is in response to an October 2011 landslide that destroyed more than a 1/3 mile section of State Route 14 (SR 14) in Cedar Canyon, dumping debris more than 100 feet deep in some areas (See Figure C.20.1). The landslide material contains boulders that are as large as houses. The work includes stabilizing slopes, moving earth and debris, and constructing a new road. Limited betterments are included to reduce the potential for future landslides and erosion of the base. The project will address four areas along S.R. 14:

- A temporary roadway will be built to carry limited traffic during the construction.
- Main slide area. 400,000 cubic yards of material will be moved to completely restore more than a 1/3 mile stretch of S.R. 14
- Rebuild end of a tunnel located under S.R. 14 and restore shoulder
- Perform slide mitigation
- Install soil nail wall to repair active slide

Figure C.20.1 Aftermath of Landslide on SR 14 (UDOT 2012)

Right-of-Way: The schedule for the repair of the landslide damage is constrained by UDOT right-of-way procurement. The design for the right-of-way that is necessary for the acquisition process started in early January 2012 and sufficient data was assembled to permit the UDOT right-of-way specialists to begin negotiating with land owners by the end of the month. The negotiations are underway and UDOT had secured the necessary permissions to begin preliminary construction operations on March 15th to rough out an access road through the slide areas.

Permitting: Permitting is also an issue on this project. A Stream Alteration Permit is required to restore the bed and banks of the creek that is located below the road. Additionally, permits from the county, the Fish and Wildlife Services and the Utah Department of Wildlife Resources are also required. Finally, Section 106 coordination may be required with the local Native American tribe. To quantify the risk of delay due to permitting, UDOT developed two schedules and named them the “Fast Track” and “Slow Track” permitting packages. These planning packages included right-of-way, environmental documents, and the site grading package, which is dependent on both. The Slow Track schedule is 60 days and the Fast Track schedule is 25 days. Permits were received in time to allow preliminary construction to start on March 15, 2012 to accomplish the removal of excess material and to build a temporary access road.

Rationale: UDOT expressed its rationale for selecting CMGC project delivery in its CMGC RFP as follows:

> "The focus of Streamlined CMGC is to use the contractor's experience in small projects while still maintaining a fair price through open bidding. The selected contractor will partner with UDOT the owner and the designer working for UDOT. The focus is on a partnership in which we minimize risk, improve construction schedule, try new innovations, and stay within budget. An important role of the Contractor is to help acquire the information to reduce risk. Your involvement will help reduce errors in design, improve constructability and meet budget goals… The CMGC team relies on the expertise of the Contractor to deliver a better product in less time and at a lower cost than design-bid-build construction processes…. Because this approach encourages innovations and minimizes risk, the construction cost is expected to be less than a conventional design-bid-build project. The role of the contractor will be to construct the project within the cost proposed, help manage the budget, and propose solutions that will achieve the goal of staying within budget" (UDOT 2011).

Procurement: The project was procured using an expedited version of the typical UDOT CMGC RFP procurement process that was designated "a Request for Streamlined Proposal." Figure C.20.2 illustrates the typical CMGC procurement process with typical timeframes in the major events. One can see that an ordinary CMGC procurement could take from 23 to 26 weeks to get both the design consultant and the contractor on board. Additionally, the contractor must furnish pricing information for specified unit price pay items and its fees.

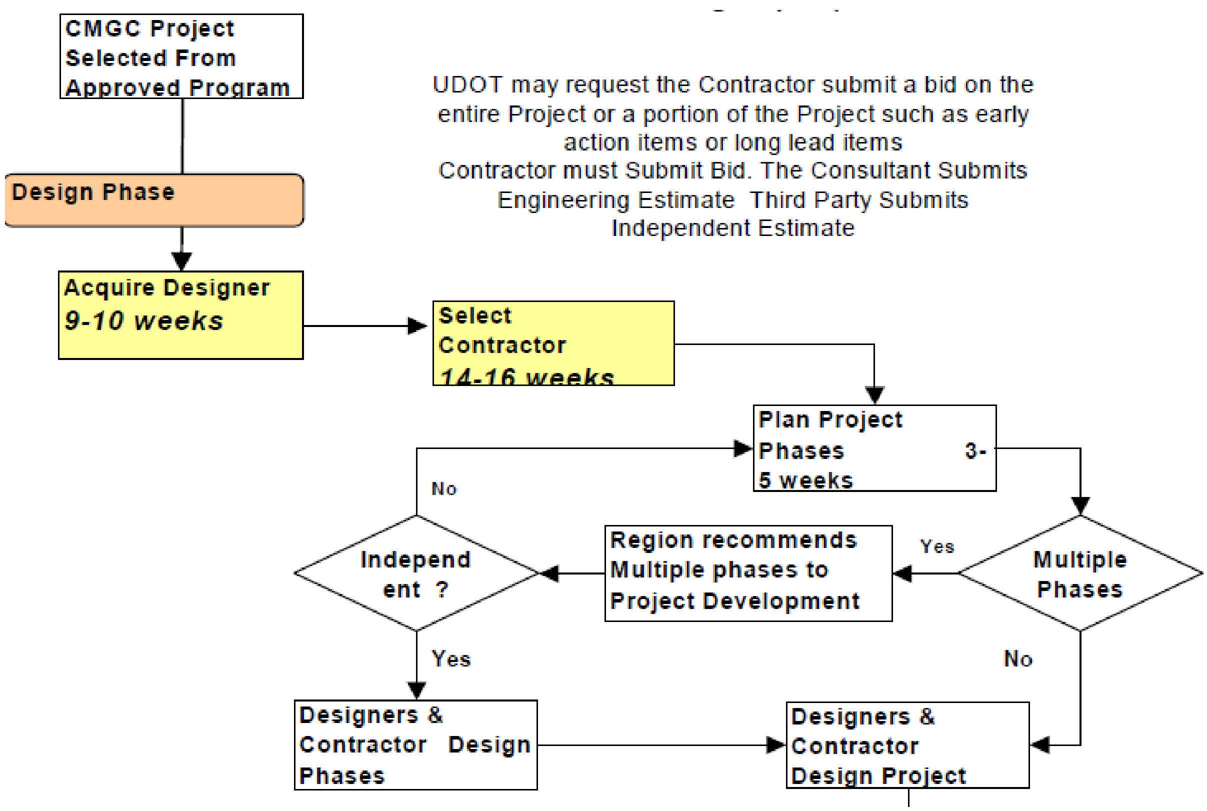

Figure C.20.2 Typical Utah DOT CMGC Procurement Process Timeline (Alder 2007).

The streamlined process compressed the design and construction source selection process to roughly 5 weeks by not only reducing the amount of information required of the competing consultants and contractors but also by mandating an aggressive set of deadlines for the agency to review proposals and make the necessary contract awards. Table C.20.1 in the next section provides the details of the procurement schedule. Figure C.20.3 is a copy of the streamlined price form used in the project. The unit prices contained in this submittal are intended to be carried forward into GMP negotiations as the design is advanced. The proposal evaluation plan allocated 50% of the weight to the technical proposal, which included information on the contractor's project team qualifications, its approach to completing the project, the proposed schedule, and its design support plan. The remaining 50% was allocated to the price submittal shown in Figure C.20.3 as articulated by a narrative "approach to price proposal." This particular narrative explains the contractor's assumptions for means, methods, and materials; its perceived risks and the way those are priced; its proposed cost and/or time savings innovations; its thoughts on the impacts the current marketplace will have on work in such a remote locations; and its plan to achieve a "favorable cost at or below traditional projects" (UDOT 2011).

APPENDIX D – CONTRACTOR PRICE SUBMITTAL

Company Name: ______________________

Date: ______________________

Item No.	UDOT Specification	Item Description	Units	Estimated Quantity	Unit Price (includes profit & overhead)	Total Amount
1	02316M	Roadway Excavation(Total Est. Quantity) See note 1	Cubic Yard	1,100,000		
2	02741	HMA ¾"	Ton	4,400		
3	02721	Untreated Base Course (Plan Quantity)	Cubic Yard	3,300		
4	02056	Granular Borrow (Plan Quantity)	Cubic Yard	72,000		
8	03310	Structural Concrete (Est. Lump QTY: 110 cu yd)	Lump	1		
9	03211	Reinforcing Steel Coated	Pound	27,500		
10		Pre-stressed Concrete Member (58'-10" UBT 42) (Specialty Item)	Each	2		
11		Drilled Shaft 36"	Ft	54		
12	02373	Riprap (realign stream channel)- See note 2	Cubic Yard	19,400		
13		Soldier Piles / Lagging Wall	Square Feet	6,000		
					Total Cost	

Figure C.20.3 State Route 14 Landslide Repair Project CMGC Price Submittal (UDOT 2011)

After award of both the design contract and CMGC preconstruction services contract, the project team agreed to divide the work into the following three design/construction packages.

- Package 1: Primarily grading and building a road base for limited access through the main slide. Issue involved in this package include gaining right of entry permit from private land owners to conduct construction and stabilizing the slide area in a manner that does not create an unsafe work environment. The work is labor intensive and provides the basis for keeping all other work and associated costs in check and on schedule.
- Package 2: Completion of construction elements on both the roadway and adjacent slopes to stabilize the main landslide area.

- Package 3: Structural work to stabilize and repair other slides. The results of geotechnical investigations will define the scope of work for this package.

Time Line: Table C.20.1 shows the timeline of events completed as of this writing and the projected milestones for major events yet to be completed.

Table C.20.1 State Route 14 Landslide Repair Project (UDOT 2011)

DATE	EVENT	REMARKS
October 8, 2011	Landslide closes Cedar Canyon	
October 9, 2011	Project set up and initial funding identified	
October 15, 2011	Aerial Survey	
October 15, 2011	RFQ for design services issued	
October 31, 2011	CMGC RFP advertised	23 days after event
November 1, 2011	Design consultant selected	24 days after event
November 3, 2011	Mandatory preproposal meeting held	
November 19, 2011	Geotechnical investigation started	
November 23, 2011	CMGC proposals received	
December 1, 2011	CMGC selected	38 days after event
December 5, 2011	CMGC preconstruction contract negotiated	
December 20, 2011	Risk analysis started	
January 17, 2012	Environmental document complete	101 days after event
January 21, 2012	Initial funding approved by commission	
January 31, 2012	ROW ready for offers	115 days after event
February 1, 2012	Geotechnical analysis complete	
February 3, 2012	Commission approved final funding	
March 15, 2012	Construction begins on Package 1	
May 31, 2012	Construction begins on Package 2	Projected date
June 1, 2012	Temporary road open to public	Projected date
July 31, 2012	Main slide area paving complete	Projected date
September 2012	Project complete	Projected date < 1 year after event

Case 7 Summary and Major Tools for Expedited Procurement

Summary: The case study project is currently underway and on schedule (UDOT web site 2012). The use of CMGC project delivery furnished UDOT with a procurement method that brought the construction contractor on the team as an active participant during the design process. This has permitted UDOT to effectively control both cost and time.

The following are a list of the major tools used to expedite procurement in this project:

- Streamlined CMGC RFP procedure.
- Used the CMGC proposal evaluation to effectively prequalify the CMGC by assigning a high weight to the contractor's proposed team and past experience.
- Work packaging that supported permitting and right-of-way requirements.
- Managing the risk of permit delays by developing two possible permitting schedules and then coordinating the design and construction work in a manner that could be accelerated if the permits were received earlier than expected by the longer of the two schedules.

C.21—Portland Mall Light Rail; Oregon

Touran, A., D.D. Gransberg, K.R. Molenaar, K. Ghavamifar, D.J. Mason, and L.A. Fithian, *A Guidebook for the Evaluation of Project Delivery Methods*, TCRP Report 131, Transportation Research Board, National Academies, Washington, D.C., 2009.

The team was able to develop information on the nine projects which were worth more than $3.0 billion that represent the cross-section of delivery methods. In fact, the Silver Line project in Boston is a Design-Bid-Build/Multi-Prime project, which while it is not a different delivery method, was a variation on DBB project delivery that was contemplated in the original proposal. Additionally, another enhancement to the original research plan was realized when the team was able to identify projects from more than one delivery method completed by the same agency. Thus, the depth and validity of the interviews were enhanced by permitting the interviewers to gain information that compared and contrasted the benefits and constraints of several delivery methods from a single source.

There were two CMR projects: the Weber County Commuter Rail in Utah and the Portland Mall Light Rail in Oregon. The Utah project had an agency-hired consultant on hand while the Oregon project did not. As a result, there were few trends observable between the two projects. The only one was that both agencies reserved the authority to approve final products and payments and that would be intuitive.

The procurement phase differences between the two CMR projects were quite stark and the result of one agency having a consultant to oversee the CMR's work and the other having to do it themselves. The Oregon project's RFQ/RFP required submission and evaluation of qualifications and a number of proposed management plans including a constructability review plan, a cost engineering review plan, a construction quality management plan and a construction quality control plan. Whereas, the Utah project only asked for the qualifications of the construction quality manager and the firm's past performance record on similar projects.

During the design phase the UTA confined its activities to the review and acceptance of design deliverables and payment for design progress. It used its consultant to review cost engineering reviews by the CMR and furnish recommendations of progress payments before they were made. The CMR also assisted in the review of design deliverables as well as other typical preconstruction services such as constructability reviews and cost estimate validation. TriMet on the Oregon CMR project was much more heavily involved in the design process as a result of not having a consultant assistance. It expected virtually the same amount of preconstruction services out of the CMR as well as specific design quality assurance activities from its designer as part of the final design acceptance process.

The real difference between CMR project delivery with and without a consultant was observed in the construction phase. UTA involved its consultant in virtually every phase of the construction management and engineering process except routine construction inspection, construction quality control and establishing vertical and horizontal control. The agency restricted its oversight activities to schedule review and approval of progress payments as well as the final system for construction quality management. In Oregon, the agency was involved in virtually the same amount of construction engineering tasks as it would in a traditional DBB project.

Thus, from the above analysis, it appears that the decision of whether or not to engage a general engineering consultant to furnish assistance to the transit agency during a CMR project is an important one. The result of adding the consultant seems to be a reduced need for agency personnel to conduct design and construction oversight tasks during project execution. As both projects are performing well, no conclusion can be reached as to the value added by the agency-hired consultant in CMR project delivery.

Table C.21.1 shows the data that was collected from the case study used in this thesis.

Table C.21 1--Project Data taken from Case Study

Project Factors to use CMGC	
Schedule issues	x
Project third party interface issues (utilities, business access, railroads, etc.)	x
Project Monetary size	x
Agency staff availability to oversee project development	x
Project sustainability issues	x
Agency staff experience with delivery method	x
Reasons you select CMGC	
Get early construction contractor involvement	x
Flexibility needs during construction phase	x
Encourage innovation	x
Redistribute risk	x
Complex project requirements	x
Facilitate Value Engineering	x
Establish project budget at an early stage of design development	x
Reduce life cycle costs	x
Encourage sustainability	x

C.22—Atlanta-Hartsfield-Jackson International Airport; Georgia

Touran, A., D.D. Gransberg, K.R. Molenaar, P. Bakshi, and K. Ghavamifar, *A Guidebook for the Selecting Airport Capital Project Delivery Methods*, ACRP Report 21, Transportation Research Board, National Academies, Washington, D.C, 2009.

Airport Information

Airport Name: Atlanta-Hartsfield-Jackson International Airport

Three-letter Code: ATL

Name of Agency:

Type of Organization: City Government

Location: Atlanta, Georgia

Airport Traffic Volume Information

Number of annual operations (take-offs and landings): 967,303

Annual passenger throughput: 86,466,000

Annual cargo throughput: 805,476 tons

Airport Construction Program Information

Annual construction budget: $500 million

Average annual number of projects: 30- 40

Project monetary size range: $1.0 million to $1.2 billion (a CMR project)

Average monetary size of a typical project: $10 to $20 million

Number of professional design/construction staff: 200

Airport Project Delivery Method Experience Information

	Design-Bid-Build	**Construction Manager-at-Risk**	**Design-Build**	**Design-Build-Operate-Maintain**
Number of Projects	>10	1-5	1-5	1
Percentage of Construction Budget	>50%	11-25%	<10%	<10%

Airport Project Delivery Method Rationale Information

Airport Project Delivery Decision-making Process:

- Design/construction personnel make the decision and recommend this decision to the Airport General Manager for approval. The city council will also have to approve the decision who may have questions about an alternative delivery system.
- Usually DBB is used based on tradition and also based on the understanding that it spreads the funding in best possible way among design and construction community.
- If for some reasons the airport decides to depart from traditional approach then they have to start the decision process very early in design, and come up with the justification. The reasons for this decision are presented to the Director and if he is convinced, the decision is presented to the airport General Manager for approval.
- They usually do not need to justify the choice of delivery method if it is DBB.
- In case of CMR, usually the GMP is negotiated with the contractor at 60% design complete.

Project Factors Considered in Project Delivery Decision

(*Italics indicate airport furnished factor)*

Project factors considered in project delivery decision	**Drives use of alternative delivery method**
Project monetary size: Smaller (<$10M) done with DBB	
Project budget control issues	
Project schedule issues	
Project technical complexity	
Project technical content	
Project security issues (outside secure zone vs. inside secure zone)	
Project location (landside, airside, or terminal)	
Project environmental issues	
Project third party interface issues	
Project life cycle issues (maintenance/operations)	
Project generates revenue	✓
Scope control	✓
Technical innovation	✓

Reasons for Selecting Project Delivery Method

(*most significant reason; *Italics indicate airport furnished factor)*

Reason	DBB	CMR	DB	DBOM
Reduce/compress/accelerate project delivery period		✓	✓*	✓
Establish project budget at an early stage of design development		✓*	✓	
Get early construction contractor involvement		✓*	✓	
Encourage innovation			✓*	
Facilitate Value Engineering		✓		
Encourage price competition (bidding process)	*✓			
Compete different design solutions through the proposal process			✓	
Redistribute risk		✓	✓	
Complex project requirements	✓	✓	✓	✓
Flexibility needs during construction phase	✓	✓		
Reduce life cycle costs	✓			
Provide mechanism for follow-on operations and/or maintenance				*✓
Innovative financing	NA			
Encourage sustainability	✓	✓	✓	✓
Project is a revenue generator			✓	
Encourage constructability			✓	
Scope control	*✓	✓		
Need for coordination between various construction components		✓		

Workforce-Related Reasons for Selecting Project Delivery Method

Airport does not consider workforce related reasons when making the project delivery method decision.

Airport Risk Analysis Process Information

Formal Risk Analysis Areas: None

Project Cost Estimate Uncertainty Analysis: None; *But at least in one project, the schedule involved Monte Carlo simulation analysis*

Risk Identification Techniques Used:

- Brainstorming
- Scenario planning
- Expert interviews
- Influence or risk diagramming

Risk Assessment Techniques:

- Qualitative: Risk matrix
- Quantitative: Monte Carlo per above

Risk Management Techniques: None in planning stages but after start of construction phase, they develop a list for potential change orders, their expected costs, etc. in order to manage and control cost overrun

Risk Technique used to Draft Contract: In each project, they develop a list of major risks, study those risks and allocate those to the party in best position to control those risks. This process is usually accomplished through brainstorming**.**

Airport Procurement Process Information

Procurement Constraint	**Low-bid**	**Best Value**	**Qualifications-based**	**IDIQ**	**Remarks**
Requirement to meet DBE goals	The city of Atlanta requires EBO (Equal Business Opportunity). This means that for each project there should be a joint venture with a DBE firm. In addition to this joint venture requirement, the team needs to achieve the pre-set DBE goal that can be higher than 40% of contract value.				

Procurement Preference	**Low-bid**	**Best Value**	**Qualifications-based**	**IDIQ**	**Remarks**
Desire to eliminate firms with poor past records from competition		✓	✓	✓	
Desire to encourage firms with good past records to compete		✓	✓	✓	
Need to ensure selection of well-qualified designers and/or builders		✓	✓	✓	
Need to minimize front-end effort				✓	
Need to appear fair and objective	✓		✓		
Need to be able to justify selection to higher authorities	✓		✓		
Need to be able to justify selection to the public	✓		✓		Low bid for contractor & Best Value for Designer
Need to minimize the number of procurement actions				✓	
Need to be able to rapidly move from concept to construction				✓	

Procurement Method Award Component	**Low-bid**	**Best Value**	**Qualifications-based**	**IDIQ**	**Remarks**
Short-list			✓	✓	
Financial prequalification	✓	✓	✓	✓	Bonds
Evaluation of qualifications			✓	✓	
Schedule evaluation	✓	✓	✓	✓	
Quality management plan evaluation	✓	✓	✓	✓	
Environmental plan evaluation	✓	✓	✓	✓	General conditions req'ts
Security plan evaluation	✓	✓	✓	✓	
Safety plan evaluation	✓	✓	✓	✓	
Price evaluation	✓	✓	✓	✓	
Bonding requirements	✓	✓	✓	✓	
DBE goals	✓	✓	✓	✓	

Airport Project Delivery Method Issue Information

Issues	**DBB**	**CMR**	**DB**	**DBOM**	**Comments**
Project-level: *Benefit*	• Cost control • LEED	• Risk • Sched comp • Sched control • Cost prec • LEED	• Risk • Sched comp • Sched control • Cost prec	• Risk • Sched comp • Sched control • Cost prec	
Project-level: *Constraint*	• Large project • Sched comp • Shed control • Cost prec	• Small project • Cost control	• Cost control • LEED	• Cost control • LEED	
Agency-level: *Benefit*	• Airport staff exp • Airport proj control • 3rd party input		• Airport staff exp		
Agency-level: *Constraint*		• Airport staff exp • Airport proj control • 3rd party input	• Airport proj control • 3rd party input		Airport staff still learning with CMR
Public Policy/ Regulatory: *Benefit*	• Competition	• Competition			
Public Policy/ Regulatory: *Constraint*			• Competition	• Competition	
Life Cycle: *Benefit*	• Life cycle cost	• Life cycle cost		• Life cycle cost	

	• Maintenance • Sustainable design	• Maintenance • Sustainable design		• Maintenance	
Life Cycle: *Constraint*			• Life cycle cost • Maintenance • Sustainable design		
Other: *Benefit*		• Adversarial Relationships	• Adversarial Relationship • Claims		
Other: *Constraint*	• Adversarial Relationship • Claims	• Claims			

Airport Project Delivery Method Value Information

Effectiveness in delivering quality in project aspects

Color Code	Blank = Does not apply	Below Standard = 1&2	Meets Standard = 3	Exceeds Standard = 4&5

Project aspects	DBB	CMR	DB	DBOM
Completeness of final design deliverables	5	4	3	3
Accuracy of design calculations	4.5	4.5	3	3
Accuracy of quantities	4.5	4.5	3	3
Acceptance of design deliverables				
Accuracy of specifications	5	4	2	2
Accuracy of as-built documents	4		5	
Accuracy/applicability of O&M manuals, etc	5	4	3	3
Implementation of approved QA/QC plans	5	3	5	
Accuracy of preconstruction cost estimates	3	4	5	5
Ability to achieve post-award budgets	3	4	5	5
Accuracy of preconstruction schedules	3	4	5	5
Ability to achieve post-award schedules	3	4	5	
Material quality	5	4	3	
Workmanship quality	5	4	4	
Aesthetics	5	4	2	
Sustainability	5	4	3	
Maintainability	5	4	3	4
Operability	5	4	3	4
Security during construction				
Aircraft operations during construction	5			
Passenger traffic flow during construction	5			
Interest to potential bidding community	5	5	3	2
Effectiveness Index	**4.5**	**4.1**	**3.6**	**3.5**

Effectiveness in delivering value in preconstruction phase

Color Code	Blank = Does not apply	Not Valued = 1	Valued =2&3	Highly Valued = 4&5

Preconstruction tasks	**DBB**	**CMR**	**DB**	**DBOM**
Conceptual estimating	3	5	3	
Value analysis/value engineering	3	5	3	
Design charrettes	5	5	3	
Design reviews	5	4	3	3
Regulatory reviews				
Security impact studies				
Environmental studies				
Early contractor involvement	2	5	4	4
Cost engineering reviews	2	5	4	4
Constructability reviews	2	5	4	4
Biddability reviews	5	4	3	3
Operability reviews	5	3	3	5
Life cycle cost analysis	5	4	3	
Value Index	3.7	4.5	3.3	3.8

Summary Comments:

C.23—Boston-Logan International Airport; Massachusetts

Touran, A., D.D. Gransberg, K.R. Molenaar, P. Bakshi, and K. Ghavamifar, *A Guidebook for the Selecting Airport Capital Project Delivery Methods*, ACRP Report 21, Transportation Research Board, National Academies, Washington, D.C, 2009.

Airport Information

Airport Name: Boston-Logan International Airport

Three-letter Code: BOS

Name of Agency:

Type of Organization: Public Airport Operator

Location: Boston, Massachusetts

Airport Traffic Volume Information

Number of annual operations (take-offs and landings): 400,000

Annual passenger throughput: 28,000,000

Annual cargo throughput: 358,000 tons

Airport Construction Program Information

Annual construction budget: $125 million

Average annual number of projects: 100 per year

Project monetary size range: $10,000 to $165 million

Average monetary size of a typical project: >$2.0 million

Number of professional design/construction staff: 70

Airport Project Delivery Method Experience Information

	Design-Bid-Build	**Construction Manager-at-Risk**	**Design-Build**	**Design-Build-Operate-Maintain**
Number of Projects	>10	1-5	0	0
Percentage of Construction Budget	>50%	11-25%	0	0

Airport Project Delivery Method Rationale Information

Airport Project Delivery Decision-making Process:

Decision is made before design by the airport design/construction personnel. They might ask CM help them to choose designer. There is no written procedure. They make the decision through a group meeting which has six members consist of: project manager, program manager, Department Director and three others. It usually needs several meetings conducted over several weeks.

Project Factors Considered in Project Delivery Decision

Project Factor Considered in Project Delivery Decision	**Drives use of alternative delivery method**
Project monetary size	
Project budget control issues	
Project schedule issues	
Project technical complexity	✓
Project type (vertical vs horizontal)	
Project technical content	
Project environmental issues	
Project air traffic control issues	
Project life cycle issues (maintenance/operations)	
Project generates revenue	✓

Reasons for Selecting Project Delivery Method (* most significant reason)

	DBB	**CMR**	**DB**	**DBOM**
Get early construction contractor involvement		*✓		
Encourage innovation		✓		
Facilitate Value Engineering		✓		
Compete different design solutions through the proposal process		✓		
Redistribute risk		✓		
Complex project requirements		*✓		
Flexibility needs during construction phase		✓		
Because of state regulations, the CMR process tends to get longer!				

Workforce-Related Reasons for Selecting Project Delivery Method: None

Airport Risk Analysis Process Information

Formal Risk Analysis Areas: Informal risk analysis is used

Project Cost Estimate Uncertainty Analysis: Use of 25% contingency in planning and design and 5% contingency for bid stage.

Risk Identification Techniques Used:

- Brainstorming
- Scenario planning
- Expert interviews

Risk Assessment Techniques: None, but they consider the change in price of some materials like oil, steel, etc.

Risk Management Techniques: None

Risk Technique used to Draft Contract: None

Airport Procurement Process Information

Procurement Constraint	**Low-bid**	**Best Value**	**Qualifications-based**	**IDIQ**	**Remarks**
	None		Prequalify contractors on security projects.	Use unit price based on hourly rates and materials for IDIQ	

Procurement Preference	**Low-bid**	**Best Value**	**Qualifications-based**	**IDIQ**	**Remarks**
Desire to eliminate firms with poor past records from competition		✓			
Desire to encourage firms with good past records to compete		✓			Massport has the ability to not award the contract!
Need to appear fair and objective	✓				
Need to be able to justify selection to higher authorities	✓				
Need to be able to justify selection to the public	✓				
Need to minimize the number of procurement actions				✓	
Other: Specify	• IDIQ is low bid. There is really no choice here, always low bid! • They should go through the DCAM (Division of Capital Asset Management) process which is for certifying contractors in vertical projects. • If there is a good justification provided to DCAM, Massport may receive the authorization for not awarding the contract to the low-bidder. • IDIQ is mostly unit price or something very similar.				

Procurement Method Award Component	Low-bid	Best Value	Qualifications-based	IDIQ	Remarks
Short-list		✓	✓		
Evaluation of qualifications	✓	✓	✓	✓	Massport requires that bidders meet DCAM certification for vertical projects.
Schedule evaluation		✓	✓		After bid
Quality management plan evaluation		✓	✓		
Environmental plan evaluation		✓	✓		
Bonding requirements	✓	✓	✓	✓	Bonds; DCAM pre-qualification.
DBE goals	✓	✓	✓	✓	If the low bidder cannot provide target DBE goals in his bid, it is given 5 days to meet that goal or justify its position.

Airport Project Delivery Method Issue Information

Issues	DBB	CMR	DB	DBOM	Comments
Project-level: *Benefit*	• LEED	• Project Size • Cost Prec • Cost control • LEED	• Project Size • Sched comp • Sched control		Risk depends on project.
Project-level: *Constraint*	• Cost Prec • Cost control	• Risk • Sched comp • Sched control			
Agency-level: *Benefit*	• Airport staff exp • Airport proj control • Security • 3rd party input	• Airport proj control • Security • Impact on ops • Impact on passengers • 3rd party input			
Agency-level: *Constraint*	• Impact on ops • Impact on passengers	• Airport staff exp			DBB has a negative impact on operations and passengers if the contractor is not a good contractor.
Public Policy/ Regulatory: *Benefit*	• Competition • DBE • Legal	• DBE	• DBE		
Public Policy/ Regulatory:		• Competition • Legal	• Competition		

Constraint					
Life Cycle: *Benefit*	• Life cycle cost • Sustainability	• Life cycle cost • Maintenance • Sustainability			
Life Cycle: *Constraint*	• Maintenance				
Other: *Benefit*		• Adversarial Relationship • Claims			
Other: *Constraint*	• Adversarial Relationship • Claims				

Airport Project Delivery Method Value Information

Effectiveness in delivering quality in project aspects

Color Code	**Blank = Does not apply**	**Below Standard = 1&2**	**Meets Standard = 3**	**Exceeds Standard = 4&5**

Project aspects	**DBB**	**CMR**	**DB**	**DBOM**
Completeness of final design deliverables	4	5		
Accuracy of design calculations	4	5		
Accuracy of quantities	4	5		
Acceptance of design deliverables	4	4		
Accuracy of specifications	4	4		
Accuracy of as-built documents	5	5		
Accuracy/applicability of O&M manuals, etc.	4	4.5		
Implementation of approved QA/QC plans	4	4.5		
Accuracy of preconstruction cost estimates	4	5		
Ability to achieve post-award budgets	4	5		
Accuracy of preconstruction schedules	4	5		
Ability to achieve post-award schedules	4.5	5		
Material quality	4	4		
Workmanship quality	4	4.5		
Aesthetics				
Sustainability	4	5		
Maintainability	4	5		
Operability	4	5		
Security during construction	4	5		
Aircraft operations during construction	4	4		
Passenger traffic flow during construction	4	4.5		
Interest to potential bidding community	5	3		
Effectiveness Index	4.1	4.6		

Effectiveness in delivering value in preconstruction phase

Color Code	Blank = Does not apply	Not Valued = 1	Valued = 2&3	Highly Valued = 4&5

Preconstruction tasks	DBB	CMR	DB	DBOM
Conceptual estimating	4	5		
Value analysis/value engineering	3	5		
Design charrettes	3	4		
Design reviews	3	4		
Regulatory reviews	3.5	4		
Security impact studies	3	3		
Environmental studies	3	3		
Early contractor involvement		5		
Cost engineering reviews	3	4		
Constructability reviews	3	4		
Biddability reviews	3	4		
Operability reviews	3	4		
Life cycle cost analysis	3	4		
Value Index	3.1	4.1		

Summary Comments:

C.24—Port Columbus International Airport; Ohio

Airport Information

Airport Name: Port Columbus International Airport, Rickenbacker International Airport, and Bolton Field Airport;

Three-letter Code: CMH, LCK, TZR

Name of Agency:

Type of Organization: Public Airport Operator

Location: Columbus, Ohio

Airport Traffic Volume Information

Number of annual operations (take-offs and landings): CMH/173,984; LCK/71,340; and TZR/43,233

Annual passenger throughput: CMH/7.7 million; LCK/<10,000; and TZR/none.

Annual cargo throughput: CMH/6,750 tons; LCK/110,000 tons; and TZR/none

Airport Construction Program Information

Annual construction budget: $70-100 million

Average annual number of projects: 50-70

Project monetary size range: $50,000 to $165 million

Average monetary size of a typical project: $1.5 million

Number of professional design/construction staff: 15

Airport Project Delivery Method Experience Information

	Design-Bid-Build	**Construction Manager-at-Risk**	**Design-Build**	**Design-Build-Operate-Maintain**
Number of Projects	>10	1-5	1-5	0
Percentage of Construction Budget	>50%	<10%	<10%	0

Airport Project Delivery Method Rationale Information

Airport Project Delivery Decision-making Process:

Airport authority management ultimately makes the project delivery method decision. It starts with an evaluation process to determine the need to compress schedule. If so, then DB is normally chosen. If there is a strong need to control cost then CMR is selected. All others go DBB; If the airport is unfamiliar with the operations and maintenance requirements for a specific project then DBOM is considered … they have no DBOM experience but are planning to use on and upcoming baggage equipment project.

Project Factors Considered in Project Delivery Decision

Project Factor Considered in Project Delivery Decision	**Drives use of alternative delivery method**
Project monetary size	
Project budget control issues	✓
Project schedule issues	✓
Project technical content	✓
Project life cycle issues (maintenance/operations)	
Project sustainability issues	
Incentives for obtaining federal or state funding	✓
Project generates revenue	✓

Reasons for Selecting Project Delivery Method (*most significant reason*)

	DBB	**CMR**	**DB**	**DBOM**
Reduce/compress/accelerate project delivery period			*✓	
Establish project budget at an early stage of design development		*✓		
Get early construction contractor involvement		✓	✓	
Facilitate Value Engineering		✓	✓	
Encourage price competition (bidding process)	*✓			
Compete different design solutions through the proposal process	✓			
Redistribute risk	✓	✓	✓	
Provide mechanism for follow-on operations and/or maintenance				*✓
Innovative financing				✓
Project is a revenue generator		✓	✓	

Workforce-Related Reasons for Selecting Project Delivery Method: None

Airport Risk Analysis Process Information

Formal Risk Analysis Areas:

- Project Scope
- Project Schedule
- Project Cost
- Contracting Risk

Project Cost Estimate Uncertainty Analysis: None

Risk Identification Techniques Used:

- Brainstorming
- Expert interviews

Risk Assessment Techniques:

- Qualitative: Rare occasions on very large project
- Quantitative: None

Risk Management Techniques: None

Risk Technique used to Draft Contract: Milestones in schedule clause

Airport Procurement Process Information

Procurement Constraint	Low-bid	Best Value	Qualifications-based	IDIQ	Remarks
State law		✓	✓		Competitive bid >$25
Need to obtain federal funding		✓	✓		
Process used to obtain funding	✓	✓	✓		$ must be paid back by tenant revenues
Requirement to meet DBE goals	✓	✓	✓		Federal restriction
Security requirements	✓				Proprietary security equipment
Other: Specify				Only have design IDIQ contracts	

Procurement Preference	**Low-bid**	**Best Value**	**Qualifications-based**	**IDIQ**	**Remarks**
Desire to not change past procurement methods	✓				
Desire to eliminate firms with poor past records from competition		✓	✓		
Desire to encourage firms with good past records to compete			✓		
Need to ensure selection of well-qualified designers and/or builders		✓	✓		
Need to minimize front-end effort	✓				
Need to appear fair and objective	✓				
Need to be able to justify selection to higher authorities	✓				
Need to be able to justify selection to the public	✓				
Need to be able to justify selection to third party stakeholders	✓				
Need to minimize the number of procurement actions		✓	✓		
Need to be able to rapidly move from concept to construction		✓	✓		

Procurement Method Award Component	**Low-bid**	**Best Value**	**Qualifications-based**	**IDIQ**	**Remarks**
Short-list		✓	✓		
Evaluation of qualifications			✓		
Evaluation of design approach		✓	✓		
Schedule evaluation		✓	✓		
Quality management plan evaluation	✓	✓	✓		
Price evaluation	✓	✓			
DBE goals	✓	✓	✓		

Airport Project Delivery Method Issue Information

Issues	DBB	CMR	DB	DBOM	Comments
Project-level: *Benefit*	• Project size	• Project size • Risk • Shed control • Cost prec • Cost control	• Project size • Risk • Sched Comp • Sched control • Cost prec • Cost control	No experience	LEED not applicable in all PDMs
Project-level: *Constraint*	• Risk • Sched Comp • Cost prec • Cost control			No experience	
Agency-level: *Benefit*	• Airport staff exp • Airport proj control • Control ops impact • 3rd party input			No experience	
Agency-level: *Constraint*		• Airport staff exp • Airport proj control • Control ops impact • 3rd party input	• Airport staff exp • Airport proj control • Control ops impact • 3rd party input	No experience	
Public Policy/ Regulatory: *Benefit*	• Competition • DBE • Legal • Method allowed	• DBE	• DBE	No experience	
Public Policy/ Regulatory: *Constraint*		• Competition • Legal • Method allowed	• Competition • Legal • Method allowed	No experience	
Life Cycle: *Benefit*	• Sustainability	• Maintenance • Sustainability	• Maintenance • Sustainability	• Life cycle cost • Maintenance • Sustainability	
Life Cycle: *Constraint*	• Life cycle cost • Maintenance	• Life cycle cost	• Life cycle cost		
Other: *Benefit*				No experience	
Other: *Constraint*	• Adversarial Relationship • Claims	• Adversarial Relationship • Claims	• Adversarial Relationship • Claims	No experience	

Airport Project Delivery Method Value Information

Effectiveness in delivering quality in project aspects

Color Code	**Blank = Does not apply**	**Below Standard = 1&2**	**Meets Standard = 3**	**Exceeds Standard = 4&5**

	Below Standard = 1&2	**Meets Standard = 3**	**Exceeds Standard = 4&5**	
Project aspects	**DBB**	**CMR**	**DB**	**DBOM**
Completeness of final design deliverables	5	4	2	3
Accuracy of design calculations	5	4	2	3
Accuracy of quantities	5	4	2	3
Acceptance of design deliverables	5	4	2	3
Accuracy of specifications	5	4	2	3
Accuracy of as-built documents	3	3	3	3
Accuracy/applicability of O&M manuals, etc.	3	3	3	3
Implementation of approved QA/QC plans	3	3	3	3
Accuracy of preconstruction cost estimates	1	5	2	3
Ability to achieve post-award budgets	2	4	4	3
Accuracy of preconstruction schedules	4	5	5	3
Ability to achieve post-award schedules	4	5	5	3
Material quality	5	2	2	3
Workmanship quality	3	3	3	3
Aesthetics	5	2	2	3
Sustainability	3	3	3	3
Maintainability	3	3	3	4
Operability	3	3	3	4
Security during construction	3	3	3	3
Aircraft operations during construction	4	3	3	3
Passenger traffic flow during construction	4	3	3	3
Interest to potential bidding community	3	3	3	3
Effectiveness Index	3.7	3.5	2.9	3.1

Effectiveness in delivering value in preconstruction phase

Color Code	Blank = Does not apply	Not Valued = 1	Valued =2&3	Highly Valued = 4&5

Preconstruction tasks	DBB	CMR	DB	DBOM
Conceptual estimating	1	5	5	5
Value analysis/value engineering	1	5	5	5
Design charrettes	3	3	3	3
Design reviews	5	5	5	5
Regulatory reviews	5	5	5	5
Security impact studies	5	5	5	5
Environmental studies	5	5	5	5
Early contractor involvement	3	3	3	3
Cost engineering reviews	3	3	3	3
Constructability reviews	3	3	3	3
Biddability reviews	3	3	3	3
Operability reviews	3	3	3	3
Life cycle cost analysis	3	3	3	3
Value Index	3.3	3.9	3.9	3.9

Summary Comments:

This case study applies to a single agency with responsibility for multiple airports.

C.25—Dallas-Fort Worth International Airport; Texas

Touran, A., D.D. Gransberg, K.R. Molenaar, P. Bakshi, and K. Ghavamifar, *A Guidebook for the Selecting Airport Capital Project Delivery Methods*, ACRP Report 21, Transportation Research Board, National Academies, Washington, D.C, 2009.

Airport Information

Airport Name: Dallas Fort Worth International Airport

Three-letter Code: DFW

Name of Agency:

Type of Organization: Public Airport Operator

Location: Dallas, Texas

Airport Traffic Volume Information

Number of annual operations (take-offs and landings): 779,000

Annual passenger throughput: 60 million

Annual cargo throughput: 758,000 tons

Airport Construction Program Information

Annual construction budget: $425 million

Average annual number of projects: 135

Project monetary size range: $8,000 to $100+ million

Average monetary size of a typical project: $2- 5 million

Number of professional design/construction staff: 120

Airport Project Delivery Method Experience Information

	Design-Bid-Build	**Construction Manager-at-Risk**	**Design-Build**	**Design-Build-Operate-Maintain**
Number of Projects	>10	>10	1-5	1
Percentage of Construction Budget	>50%	26-50%	<10%	<10%

Airport Project Delivery Method Rationale Information

Airport Project Delivery Decision-making Process:

Department convenes a group and selects PDM based on “speed” – urgency of need to get construction completed and source of project funds. If there is no “need for speed” then DBB is preferred method. CMR is preferred if “need for speed” and DB is used if “speed is of the utmost importance.” Can only use CMR if bonds are funding project.

Project Factors Considered in Project Delivery Decision

Project factors considered in project delivery decision	Drives use of alternative delivery method
Project monetary size	✓
Project schedule issues	✓
Project technical complexity	
Project security issues (outside secure zone vs. inside secure zone)	
Project location (landside, airside, or terminal)	
Project environmental issues	✓
Project third party interface issues	
Project air traffic control issues	
Project quality assurance requirements	
Project life cycle issues (maintenance/operations)	✓
Project sustainability issues	✓
Incentives for obtaining federal or state funding	✓
Project generates revenue	✓

Reasons for Selecting Project Delivery Method (*most significant reason*)

	DBB	CMR	DB	DBOM
Reduce/compress/accelerate project delivery period		*✓	*✓	
Establish project budget at an early stage of design development		✓	✓	
Get early construction contractor involvement		✓	✓	
Encourage innovation		✓	✓	✓
Facilitate Value Engineering		✓	✓	
Encourage price competition (bidding process)	*✓			
Compete different design solutions through the proposal process			✓	
Complex project requirements		✓		
Flexibility needs during construction phase		✓	✓	
Provide mechanism for follow-on operations and/or maintenance				*✓
Encourage sustainability	✓	✓	✓	✓
Project is a revenue generator		✓	✓	✓

Workforce-Related Reasons for Selecting Project Delivery Method: None

Airport Risk Analysis Process Information

Formal Risk Analysis Areas: None

Project Cost Estimate Uncertainty Analysis: Yes, financial analysis with risk consideration

Risk Identification Techniques Used:

- Brainstorming
- Scenario planning
- Expert interviews
- Collaboration, coordination & communication is their motto

Risk Assessment Techniques: None

Risk Management Techniques:

- Risk register or risk charter
- Risk management plan
- Risk mitigation plan

Risk Technique used to Draft Contract: Yes, if necessary…diesel escalation clause or other project-specific cost or schedule risk.

Airport Procurement Process Information

Procurement Constraint	**Low-bid**	**Best Value**	**Qualifications-based**	**IDIQ**	**Remarks**
Local law		✓	✓		
State law		✓	✓		
Need to obtain federal funding		✓	✓		
Process used to obtain funding		✓	✓		

Procurement Preference	**Low-bid**	**Best Value**	**Qualifications-based**	**IDIQ**	**Remarks**
Desire to encourage firms with good past records to compete	✓	✓	✓	✓	
Need to ensure selection of well-qualified designers and/or builders		✓		✓	
Need to be able to rapidly move from concept to construction			✓		

Procurement Method Award Component	Low-bid	Best Value	Qualifications-based	IDIQ	Remarks
Short-list	✓	✓	✓		DBB-sometimes for special purpose equipment
Financial prequalification		✓	✓		
Evaluation of qualifications		✓	✓		
Alternative design concepts		✓	✓		
Evaluation of design approach		✓	✓		
Schedule evaluation	✓	✓	✓		
Security plan evaluation		✓	✓		
Price evaluation	✓	✓			
Bonding requirements	✓	✓	✓		
DBE goals	✓	✓	✓		

Airport Project Delivery Method Issue Information

Issues	DBB	CMR	DB	DBOM	Comments
Project-level: *Benefit*	• Project Size • Risk • Sched Comp • Sched control • Cost Prec • Cost control	• Sched Comp • Sched control • Revenue generator	• Sched Comp • Sched control • Revenue generator		1 DBOM for people mover
Project-level: *Constraint*	• Revenue generator	• Project Size • Risk • Cost Prec • Cost control	• Project Size • Risk • Cost Prec • Cost control		Size – if GMP must be set early in design process, then CMR/DB puts in too much contingency
Agency-level: *Benefit*	• Airport staff exp • Security • Impact on ops • Impact on passengers • 3rd party input	• Airport staff exp • Airport proj control • Security • Impact on ops • Impact on passengers • 3rd party input	• Airport staff exp • Airport proj control • Security • Impact on ops • Impact on passengers • 3rd party input	• Airport staff exp • Airport proj control • Security • Impact on ops • Impact on passengers • 3rd party input	
Agency-level: *Constraint*	• Airport proj				

	control				
Public Policy/ Regulatory: *Benefit*	• Competition • DBE • Legal • Method allowed	• DBE	• DBE	• DBE	
Public Policy/ Regulatory: *Constraint*		• Competition • Legal • Method allowed	• Competition • Legal • Method allowed	• Competition • Legal • Method allowed	
Life Cycle: *Benefit*	DFW Asset Development Sustainability Initiative – happens BEFORE PDM decision – Sets standards for sustainability – Used on people mover DBOM				
Life Cycle: *Constraint*					
Other: *Benefit*	• Adversarial Relationship • Claims			• Adversarial Relationship • Claims	
Other: *Constraint*		• Adversarial Relationship • Claims	• Adversarial Relationship • Claims		DFW had BAD experience on major CMR project. Felt that CMR was not owner's advocate. Strong distrust of contractors observed.

Airport Project Delivery Method Value Information

Effectiveness in delivering quality in project aspects

Color Code	Blank = Does not apply	Below Standard = 1&2	Meets Standard = 3	Exceeds Standard = 4&5

Project aspects	**DBB**	**CMR**	**DB**	**DBOM**
Completeness of final design deliverables	4	4	4	
Accuracy of design calculations	4	4	4	
Accuracy of quantities	4	4	4	
Acceptance of design deliverables	4	4	4	
Accuracy of specifications	4	4	4	
Accuracy of as-built documents	3	4	4	
Accuracy/applicability of O&M manuals, etc.	4	4	4	
Implementation of approved QA/QC plans	4	4	4	
Accuracy of preconstruction cost estimates	5	3	3	
Ability to achieve post-award budgets	4	4	4	
Accuracy of preconstruction schedules	4	3	3	
Ability to achieve post-award schedules	4	4	4	
Material quality	4	3	3	
Workmanship quality	4	3	3	
Aesthetics	4	4	4	
Sustainability	4	4	4	
Maintainability	4	4	4	
Operability	4	4	4	
Security during construction	4	4	4	
Aircraft operations during construction	4	4	4	
Passenger traffic flow during construction	4	4	4	
Interest to potential bidding community	4	3	3	
Effectiveness Index	4.0	3.8	3.8	

Effectiveness in delivering value in preconstruction phase

Color Code	Blank = Does not apply	Not Valued = 1	Valued =2&3	Highly Valued = 4&5

Preconstruction tasks	**DBB**	**CMR**	**DB**	**DBOM**
Conceptual estimating	4	4	4	
Value analysis/value engineering	3	4	4	
Design charrettes	2	4	4	
Design reviews	3	4	4	
Regulatory reviews	3	3	3	
Security impact studies	3	4	4	
Environmental studies	3	3	3	
Early contractor involvement	1	4	4	
Cost engineering reviews	3	4	4	
Constructability reviews	3	4	4	
Biddability reviews	3	4	4	
Operability reviews	3	4	4	
Life cycle cost analysis	3	3	3	
Value Index	2.8	3.8	3.8	

Summary Comments:

Major issues on PDM is the color of money…they have restrictions on certain types of money that prevent them from using all the PDMs. They relegate the life cycle issues to the front-end planning and development process way before the PDM is selected. So by process it can't influence the decision.

C.26—Denver International Airport; Colorado

Touran, A., D.D. Gransberg, K.R. Molenaar, P. Bakshi, and K. Ghavamifar, *A Guidebook for the Selecting Airport Capital Project Delivery Methods*, ACRP Report 21, Transportation Research Board, National Academies, Washington, D.C, 2009.

Airport Information

Airport Name: Denver International Airport

Three-letter Code: DEN

Name of Agency:

Type of Organization: Public Airport Operator

Location: Denver, Colorado

Airport Traffic Volume Information

Number of annual operations (take-offs and landings): 610,000

Annual passenger throughput: 47.3 million

Annual cargo throughput: 645,000 tons

Airport Construction Program Information

Annual construction budget: $200-300 million

Average annual number of projects: 20

Project monetary size range: $500,000 to $5 million

Average monetary size of a typical project: $2-3 million

Number of professional design/construction staff: 75 + general engineering consultant

Airport Project Delivery Method Experience Information

	Design-Bid-Build	**Construction Manager-at-Risk**	**Design-Build**	**Design-Build-Operate-Maintain**
Number of Projects	>10	1-5	>10	0
Percentage of Construction Budget	>50%	<10%	<10%	0

Airport Project Delivery Method Rationale Information

Airport Project Delivery Decision-making Process:

Airport design/construction personnel ultimately make the project delivery method selection decision based on the following logic:

a. Control over the selection of the contractor is a key concern. When they are doing a project where they need more highly qualified projects, they would like to have more control over who they work with. Example of Concourse C was given that due to size and complexity, they only wanted to work with the best.
b. Nature of the contract size and complexity are main drivers.
c. If it is a sole source contract, they do need to do a justification.

Project Factors Considered in Project Delivery Decision

(*Italics indicate airport furnished factor)*

Project factors considered in project delivery decision	**Drives use of alternative delivery method**
Project monetary size	✓
Project budget control issues	
Project schedule issues	✓
Project technical complexity	✓
Incentives for obtaining federal or state funding	✓
City and regional politics	

Reasons for Selecting Project Delivery Method

(*most significant reason; *Italics indicate airport furnished factor)*

	DBB	**CMR**	**DB**	**DBOM**
Reduce/compress/accelerate project delivery period			*✓	
Establish project budget at an early stage of design development	✓			
Get early construction contractor involvement			✓	
Facilitate Value Engineering	✓			
Encourage price competition (bidding process)	*✓			
Compete different design solutions through the proposal process			✓	
Complex project requirements		*✓	✓	
Flexibility needs during construction phase			✓	
Augment staff		✓	✓	

Workforce-Related Reasons for Selecting Project Delivery Method

DIA uses CMR and DB to augment existing workforce during program funding spikes.

Airport Risk Analysis Process Information

Formal Risk Analysis Areas: None

Project Cost Estimate Uncertainty Analysis: Yes, range cost estimates

Risk Identification Techniques Used: None

Risk Assessment Techniques: None

Risk Management Techniques: None

Risk Technique used to Draft Contract: None

Airport Procurement Process Information

Procurement Constraint	**Low-bid**	**Best Value**	**Qualifications-based**	**IDIQ**	**Remarks**
Local law	They are owned by the City and County of Denver. They have traditionally used low-bid, but they are able to think outside the box without much constraint. They have not been constrained in the choice of procurement method by any of our referenced constraints. Additionally, because such a low level of funding comes from taxes (e.g., their funding comes from airport revenues vs. taxes) they are a state "enterprise" vs. a state "agency." State enterprises are much less constrained by state procurement regulations and laws.				
Need to obtain federal funding	DBEs come into play, but they are not constrained. However with Federal funds they typically low-bid, but again, they do not feel that they are constrained in any way.				

Procurement Preference	**Low-bid**	**Best Value**	**Qualifications-based**	**IDIQ**	**Remarks**
Desire to not change past procurement methods	✓				History has a lot to do with they do things today.
Desire to eliminate firms with poor past records from competition		✓	✓	✓	Not eliminate firms, but to ensure the best firm is selected.
Desire to encourage firms with good past records to compete		✓	✓	✓	
Need to ensure selection of well-qualified designers and/or builders		✓	✓	✓	
Need to minimize front-end effort		✓	✓	✓	
Need to appear fair and objective	✓				
Need to be able to justify selection to higher authorities	✓				

Need to be able to justify selection to the public	✓				
Need to minimize the number of procurement actions				✓	
Need to be able to rapidly move from concept to construction			✓	✓	

Procurement Method Award Component	**Low-bid**	**Best Value**	**Qualifications-based**	**IDIQ**	**Remarks**
Short-list			✓	✓	
Financial prequalification	✓	✓	✓	✓	For contracts over $750 they have a board of prequalification. Contractors are prequalified for 7 different categories of construction and 8 financial thresholds.
Evaluation of qualifications	✓	✓	✓	✓	
Schedule evaluation					Schedules are very constrained on their projects.
Quality management plan evaluation		✓	✓		
Environmental plan evaluation		✓	✓		
Security plan evaluation					Security plans are provided and compliance is ensured.
Price evaluation	✓				
Bonding requirements	✓	✓	✓	✓	
DBE goals					Only for Federally funded projects.

Airport Project Delivery Method Issue Information

Issues	DBB	CMR	DB	DBOM	Comments
Project-level: *Benefit*	• Sched control • Cost Prec • Cost control	• Large project • Sched Comp	• Sched Comp		
Project-level: *Constraint*	• Sched Comp	• Sched control • Cost control	• Sched control • Cost control		
Agency-level: *Benefit*	• Airport staff exp • Airport proj control	• Airport staff exp • Airport proj control	• Airport staff exp		
Agency-level: *Constraint*			• Airport proj control		
Public Policy/ Regulatory: *Benefit*		• Competition • Legal	• Competition • Legal		
Public Policy/ Regulatory: *Constraint*	• Competition • Legal				One civil contractor wins all the DBB work because they are mobilized
Life Cycle: *Benefit*					No life cycle issues
Life Cycle: *Constraint*					
Other: *Benefit*		• Adversarial Relationship • Claims	• Adversarial Relationship • Claims		
Other: *Constraint*	• Adversarial Relationship • Claims				

Airport Project Delivery Method Value Information

Effectiveness in delivering quality in project aspects

Color Code	Blank = Does not apply	Below Standard = 1&2	Meets Standard = 3	Exceeds Standard = 4&5

Project aspects	DBB	CMR	DB	DBOM
Completeness of final design deliverables				
Accuracy of design calculations				
Accuracy of quantities				
Acceptance of design deliverables				
Accuracy of specifications				
Accuracy of as-built documents				
Accuracy/applicability of O&M manuals, etc.				
Implementation of approved QA/QC plans				
Accuracy of preconstruction cost estimates				
Ability to achieve post-award budgets				
Accuracy of preconstruction schedules				
Ability to achieve post-award schedules				
Material quality				
Workmanship quality				
Aesthetics				
Sustainability				
Maintainability				
Operability				
Security during construction				
Aircraft operations during construction				
Passenger traffic flow during construction				
Interest to potential bidding community				
Effectiveness Index				

Effectiveness in delivering value in preconstruction phase

Color Code	Blank = Does not apply	Not Valued = 1	Valued =2&3	Highly Valued = 4&5

Preconstruction tasks	DBB	CMR	DB	DBOM
Conceptual estimating				
Value analysis/value engineering				
Design charrettes				
Design reviews				
Regulatory reviews				
Security impact studies				
Environmental studies				
Early contractor involvement				
Cost engineering reviews				
Constructability reviews				
Biddability reviews				
Operability reviews				
Life cycle cost analysis				
Value Index				

C.27—Tampa International Airport; Florida

Touran, A., D.D. Gransberg, K.R. Molenaar, P. Bakshi, and K. Ghavamifar, *A Guidebook for the Selecting Airport Capital Project Delivery Methods*, ACRP Report 21, Transportation Research Board, National Academies, Washington, D.C, 2009.

Airport Information

Airport Name: Memphis International Airport

Three-letter Code: MEM

Name of Agency: Memphis Shelby County Airport

Type of Organization: Public Airport Operator

Location: Memphis, Tennessee

Airport Traffic Volume Information

Number of annual operations (take-offs and landings): 385,000

Annual passenger throughput: 11 million

Annual cargo throughput: 3.7 million tons

Airport Construction Program Information

Annual construction budget: $22 million

Average annual number of projects: 20-30

Project monetary size range: $100,000 - $20 million

Average monetary size of a typical project: $5 – 6 million

Number of professional design/construction staff: 7

Airport Project Delivery Method Experience Information

	Design-Bid-Build	**Construction Manager-at-Risk**	**Design-Build**	**Design-Build-Operate-Maintain**
Number of Projects	>10	>10	1-5	0
Percentage of Construction Budget	>50%	11-25%	<10%	0

No DBOM experience but planning on doing a DBOM for elevators, escalators and people mover

Airport Project Delivery Method Rationale Information

Airport Project Delivery Decision-making Process:

Airport authority management ultimately makes the project delivery method selection decision. Then the following process is followed:

First project magnitude considered – if small director makes decision

1. perception of "need for speed" – must parallel design and construction
2. design for early contractor involvement
3. type of funding – federal DBB; bonds CMR…recommend alternative to director
4. Need to control the project during construction

Project Factors Considered in Project Delivery Decision

(*Italics indicate airport furnished factor)*

Project factors considered in project delivery decision	**Drives use of alternative delivery method**
Project monetary size	
Project budget control issues	
Project schedule issues	✓
Project technical complexity	
Project type (vertical vs. horizontal)	✓
Project technical content	
Project location (landside, airside, or terminal)	
Project quality assurance requirements	
Incentives for obtaining federal or state funding	
Project generates revenue	✓
Type of funding – federal, state, or local	✓

Reasons for Selecting Project Delivery Method

(*most significant reason; *Italics indicate airport furnished factor*)

	DBB	CMR	DB	DBOM
Reduce/compress/accelerate project delivery period		*✓	✓	
Establish project budget at an early stage of design development		✓	✓	
Get early construction contractor involvement		✓	✓	
Facilitate Value Engineering		✓	✓	
Encourage price competition (bidding process)	*✓	✓		
Redistribute risk		✓	*✓	
Complex project requirements		✓	✓	
Flexibility needs during construction phase	✓			
Provide mechanism for follow-on operations and/or maintenance				✓
Federal funds available for special type projects – like seismic retrofit – designer writes the grant thus DBB or CMR is must	✓	✓		

Workforce-Related Reasons for Selecting Project Delivery Method: None

Airport Risk Analysis Process Information

Formal Risk Analysis Areas: Project Schedule

Project Cost Estimate Uncertainty Analysis: Yes, range cost estimate

Risk Identification Techniques Used:

- Brainstorming
- Scenario planning
- Expert interviews

Risk Assessment Techniques:

- Qualitative: Risk list
- Quantitative: Schedule analysis

Risk Management Techniques: Risk management plan

Risk Technique used to Draft Contract: Yes, schedule analysis used to set "date-certain" delivery milestones in construction. Also design contract clauses requiring redesign to budget as well as a design quality clause that puts 10% of the design at risk for design quality issues.

Airport Procurement Process Information

Procurement Constraint	**Low-bid**	**Best Value**	**Qualifications-based**	**IDIQ**	**Remarks**
Need to obtain federal funding		✓	✓		
Airport procurement regulations	✓				Can disqualify bidder if pending legal action
Requirement to meet DBE goals		✓	✓		

Procurement Preference	**Low-bid**	**Best Value**	**Qualifications-based**	**IDIQ**	**Remarks**
Desire to not change past procurement methods	✓				
Desire to eliminate firms with poor past records from competition			✓		CMR- get GC on quals
Need to ensure selection of well-qualified designers and/or builders		✓	✓		
Need to minimize front-end effort	✓				

Procurement Method Award Component	**Low-bid**	**Best Value**	**Qualifications-based**	**IDIQ**	**Remarks**
Short-list		✓	✓		
Financial prequalification	✓	✓	✓		
Evaluation of qualifications		✓	✓		
Alternative design concepts	✓	✓	✓		Have used ATC one time on Low bid
Schedule evaluation		✓			
Price evaluation	✓	✓			
Bonding requirements	✓	✓	✓		
DBE goals	✓	✓	✓		

Airport Project Delivery Method Issue Information

Issues	**DBB**	**CMR**	**DB**	**DBOM**	**Comments**
Project-level: *Benefit*	• Project Size • Risk • Sched control • Cost control	• Project Size • Risk • Sched Comp • Sched control • Cost Prec • Cost control	• Project Size • Risk • Sched Comp • Cost Prec • Cost control		
Project-level: *Constraint*	• Sched Comp • Cost Prec		• Sched control		
Agency-level: *Benefit*	• Airport staff exp • Airport proj control • Security • Impact on ops • Impact on passengers • 3rd party input	• Airport staff exp • Airport proj control • Security • Impact on ops • Impact on passengers • 3rd party input	• Security • Impact on ops • Impact on passengers • 3rd party input		
Agency-level: *Constraint*			• Airport staff exp • Airport proj control		
Public Policy/ Regulatory: *Benefit*	• Competition • DBE • Legal • Method allowed	• Competition • DBE • Legal • Method allowed	• DBE • Legal • Method allowed		
Public Policy/ Regulatory: *Constraint*			• Competition		
Life Cycle: *Benefit*	• Life cycle cost • Maintenance	• Life cycle cost Maintenance	• Life cycle cost Maintenance		
Life Cycle: *Constraint*					
Other: *Benefit*		• Adversarial Relationship	• Adversarial Relationship		
Other: *Constraint*	• Adversarial Relationship				

Airport Project Delivery Method Value Information

Effectiveness in delivering quality in project aspects

Color Code	Blank = Does not apply	Below Standard = 1&2	Meets Standard = 3	Exceeds Standard = 4&5

Project aspects	**DBB**	**CMR**	**DB**	**DBOM**
Completeness of final design deliverables	4	4	2	
Accuracy of design calculations	3	3	2	
Accuracy of quantities	4	4	3	
Acceptance of design deliverables	3	3	2	
Accuracy of specifications	3	3	2	
Accuracy of as-built documents	4	3	3	
Accuracy/applicability of O&M manuals, etc.	4	4	3	
Implementation of approved QA/QC plans	3	3	2	
Accuracy of preconstruction cost estimates	2	3	3	
Ability to achieve post-award budgets	4	4	3	
Accuracy of preconstruction schedules	4	4	1	
Ability to achieve post-award schedules	4	4	1	
Material quality	4	4	3	
Workmanship quality	4	4	3	
Aesthetics	4	4	2	
Sustainability	3	3	3	
Maintainability	3	3	3	
Operability	3	3	3	
Security during construction	3	3	3	
Aircraft operations during construction	3	3	3	
Passenger traffic flow during construction	3	3	3	
Interest to potential bidding community	4	4	4	
Effectiveness Index	3.5	3.5	2.6	

Effectiveness in delivering value in preconstruction phase

Color Code	**Blank = Does not apply**	**Not Valued = 1**	**Valued =2&3**	**Highly Valued = 4&5**

Preconstruction tasks	**DBB**	**CMR**	**DB**	**DBOM**
Conceptual estimating	3	4	3	
Value analysis/value engineering	2	3	3	
Design charrettes	4	4	2	
Design reviews	3	2	2	
Regulatory reviews	4	4	3	
Security impact studies	1	1	1	
Environmental studies	1	1	1	
Early contractor involvement	2*	4	4	
Cost engineering reviews	1	4	1	
Constructability reviews	1*	4	1	
Biddability reviews	3	4	2	
Operability reviews	1	1	1	
Life cycle cost analysis	1	1	1	
Value Index	2.1	2.8	1.9	
* Airport hires a CM to do constructability reviews on DBB projects during design				

Appendix D—Solicitation Document Content Analysis

This appendix will show the content analysis of the fifty solicitation documents. Although numerous items were recorded for the purposes of the content analysis, only the line items that were directly used in the research in this thesis will be shown.

Furthermore, since there was so much data collected, the table with the results will have letters corresponding to the project information and numbers corresponding to the factors recorded.

- The first table will show the projects and the corresponding letters.
- The second table will show the factors and corresponding numbers.
- The third table will show the actual data collected.

Table D.1. Project information and Corresponding letters

	Project	City and state	Name of Agency:	Date
A	Eagle County Regional Airport Terminal Modifications	Gypsum, Colorado	Eagle County	3/30/2007
B	Tempe Transportation Center	Tempe, AZ	City of Tempe Public Works Department	3/7/2005
C	Southern Corridor- Atkinville Interchange to New Airport, St. George	Utah	UT DOT	3/19/2007
D	I-80; State Street to 1300 East		UT DOT	6/11/2007
E	Security Capital Program	NY and NJ	Port Authority	8/7/2006
F	500 South; 1100 West to I-15; West Bountiful	Davis County, Utah	UT DOT	6/2/2008
G	Greenfield and Chandler Heights Improvements	Gilbert, AZ	Arizona	6/30/1905
H	I-215; 4500 South Structure	Salt Lake County, Utah	UT DOT	1/2/2007
I	5600 West; 4450 South to 4700 South	Utah	UT DOT	10/1/2006
J	Miami Intermodal Center (MIC) Program	Florida	Florida DOT	2/7/2006
K	Redwood Road Reconstruction 2100 South to 3500 South	Utah	UT DOT	4/11/2005
L	Riverdale Road; I-15 to Washington Blvd	Utah	UT DOT	8/30/2007
M	5600 West; 5000 South to 6200 South	Utah	UT DOT	1/8/2007
N	Reconstruction of Cottonwood Lane	Casa Grande, AZ	City of Casa Grande, Arizona	10/24/2008
O	Riggs Road -val Vista to Recker Road	Gilbert, AZ	Town of Gilbert	2/20/2008
P	Pedestrian Enhancements in Downtown Glendale	Glendale, AZ	City of Glendale	6/28/1905
Q	I-15 Bridge Deck Replacement; F-102, F-103, F-104 Spanish Fork	Utah	UT DOT	9/28/2007
R	Parrish Lane (SR-105) Over I-15 Bridge Widening	Utah	UT DOT	8/28/2006
S	I-80, Aria Blvd, Tooele County, New Interchange	Utah	UT DOT	3/1/2007
T	Craycroft Road/River Road to Sunrise Drive	Pima County, AZ	Pima County DOT	2/1/2005
U	SR-9; 300 West to 800 North in Hurricane	Utah	UT DOT	2/292008
V	Syracuse Road; 1000 West to 2000 West, Syracuse	Utah	UT DOT	7/2/2008
W	I-5: Willamette River Bridge	Oregon	Oregon DOT	3/5/2008
X	Bulverde Road Expansion	San Antonio	City of San Antonio	2/17/2009
Y	Terminal Expansion Program at San Antonio International Airport	San Antonio, TX	City of San Antonio	3/21/2007
Z	I-70; Eagle Canyon Bridge		UT DOT	12/8/2008
AA	AT PORT COLUMBUS INTERNATIONAL, RICKENBACKER INTERNATIONAL, OR BOLTON FIELD AIRPORTS	Columbus Ohio	CRAA Engineering Department	9/29/2009
AB	Sacramento International Airport	Sacramento California	Sacramento County Airport System	4/1/2008
AC	TRANSBAY TRANSIT CENTER BUILDING AND RELATED STRUCTURES	San Fransisco, California	TRANSBAY JOINT POWERS AUTHORITY	10/21/2008
AD	I-5: WILLAMETTE RIVER BRIDGE (Lane County) Bundle 220 Key No. 14259	Salem, Oregon	Oregon Department of Transportation	1/25/2008

Table D.1. Project information and Corresponding letters, continued

	Project	City and state	Name of Agency:	Date
AE	Waterfront Park, Ankeny Plaza & Street Improvements	Portland, Oregon	Portland Parks and Recreation	1/18/2007
AF	PEDESTRIAN ENHANCEMENTS IN DOWNTOWN GLENDALE; PROJECT NO. 056006	Glendale, Arizona	Engineering Department	8/22/2006
AG	M-222 Slope Stability Project At the Kalamazoo River, City of Allegan	City of Allegan, Michigan	MDOT	3/3/2011
AH	Project No. STP-0068(16)68 500 South; 1100 West to I-15; West Bountiful	West Bountiful, Utah		5/27/2008
AI	EAGLE COUNTY REGIONAL AIRPORT TERMINAL MODIFICATIONS	Gypsum, Colorado	Eagle County	3/30/2007
AJ	Construction Project Mgmt & Cost Estimating Services	Portland, Oregon	Portland Development Commission	9/9/2008
AK	ANACORTES MULTIMODAL TERMINAL WASHINGTON STATE FERRIES PROJECT NO. XL 1714	Seattle, Washington	The Washington State Ferries	2/1/2005
AL	I-5: WILLAMETTE RIVER BRIDGE (Lane County) Bundle 220 Key No. 14259	Salem, Oregon	Oregon Department of Transportation	1/25/2008
AM	FBR R200-181	Denver, Colorado	CO DOT	10/6/2011
AN	ASSATEAGUE ISLAND NATIONAL SEASHORE	ACCOMACK COUNTY VIRGINIA	FHWA	12/29/2011
AO	IM 0703-383 I-70 Twin Tunnels Widening	Denver, Colorado	CO DOT	12/1/2011
AP	CRUISE SHIP TERMINAL at PIER 27, SAN FRANCISCO	San Francisco, California	Department of Public Works	5/16/2011
AQ	I – 70 Dotsero Bridge	Colorado	CO DOT	8/11/2011
AR	2400 Medium Volt MCC Replacement, Eisenhower Johnson Memorial Tunnels	Dumont, Colorado	CO DOT	3/11/2010
AS	Brownsville Urban System “BUS” Multimodal Terminal Project	Brownsville, Texas	City of Brownsville	3/26/2008
AT	Project No. S-I15-1(84)6 I-15; Dixie Drive Interchange	Salt Lake City, Utah	UT DOT	7/14/2009
AU	Southern Parkway; New Airport to Washington Dam Rd	Washington County, Utah	UT DOT	3/4/2010
AV	Project No. F-I80-4(118)141 I-80 Summit Park Bridge	Salt Lake City, Utah	UT DOT	4/7/2010
AW	POINT BONITA LIGHTHOUSE BRIDGE	Marin, California	FHWA	1/13/2011
AX	Mountain View Corridor, Redwood Road to 9000 South	Salt Lake City, Utah	UT DOT	6/11/2009

Table D.2. Identification Criteria and Corresponding Numbers

1	Project Factors
2	Project monetary size
3	Project budget control issues
4	Project schedule issues
5	Project technical complexity
6	Project type (typical agency project vs. non-typical agency project)
7	Project type (bridge vs. road project)
8	Project technical content (i.e. ITS, seismic features, tolling equipment, etc.)
9	Project location (urban vs. rural)
10	Project environmental issues
11	Project third party interface issues (utilities, business access, railroads, etc.)
12	Project traffic control issues
13	Project quality assurance requirements
14	Project life cycle issues (maintenance/operations)
15	Project sustainability issues
16	Incentives for obtaining federal or state funding
17	Project generates revenue (tolls, special taxes, etc.
18	Agency staff design review/construction inspection requirements
19	Agency staff experience with delivery method
20	Agency staff availability to oversee project development
21	Desire to include specific innovation
22	Project Delivery Method Reasons
23	Reduce/compress/accelerate project delivery period
24	Establish project budget at an early stage of design development
25	Constrained budget
26	Get early construction contractor involvement
27	Encourage innovation
28	Facilitate Value Engineering
29	Encourage constructability
30	Encourage price competition (bidding process)
31	Compete different design solutions through the proposal process
32	Redistribute risk
33	Complex project requirements
34	Flexibility needs during construction phase
35	Third party issues (permits, utilities, etc.)
36	Reduce life cycle costs
37	Provide mechanism for follow-on operations and/or maintenance
38	Innovative financing
39	Encourage sustainability
40	Project is a revenue generator
41	Reduced agency staffing requirements
42	Reduced agency review/inspection requirements
43	Preconstruction Services Included
44	Validate agency/consultant estimates
45	Validate agency/consultant schedules
46	Validate agency/consultant design
47	Design reviews
48	Prepare project estimates
49	Prepare project schedules
50	Assist/input to agency/consultant design
51	Constructability review
52	Cost engineering reviews
53	Value engineering
54	Value analysis
55	Market surveys
56	Coordinate with 3rd party stakeholders
57	Assist in right-of-way acquisition
58	Assist in permitting actions

Table D.3. Data Collected

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX
1																																																		
2																										1		1						1																
3																													1					1	1															
4																										1								1	1						1	1								
5																										1		1		1		1	1					1		1		1							1	
6																											1	1								1														
7																										1		1	1	1			1		1	1	1	1	1	1	1		1	1	1		1	1	1	1
8																										1															1	1							1	
9																										1				1	1							1				1			1					
10																											1	1				1	1						1	1	1	1	1	1			1	1		
11																																1	1	1				1	1	1	1	1	1	1		1	1			1
12																												1		1			1	1						1		1						1		1
13																																										1			1					1
14																														1								1	1	1	1	1	1		1					
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19																										1	1	1		1		1	1		1	1	1	1	1	1		1	1			1	1	1		
20																										1	1	1	1					1					1		1		1	1	1	1	1	1		1
21																										1								1					1	1	1		1	1		1	1	1	1	1
22																																																		
23						1																				1						1	1						1			1		1			1	1		
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25						1																				1		1						1		1							1							
26						1																								1			1					1	1	1			1	1		1	1			1
27						1																				1							1	1					1	1	1		1	1		1	1	1	1	1
28																																1				1	1	1	1	1	1	1	1	1	1	1	1			1
29						1																				1							1	1				1	1	1	1	1	1	1	1	1	1	1	1	1
30																																				1					1	1								
31																																								1			1					1		
32						1																				1	1	1		1			1	1	1			1	1		1	1	1	1	1	1	1	1	1	1
33																												1	1	1													1	1						
34																												1													1						1			1
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Appendix E—Independent Cost Estimate Consultant Questionnaire

This appendix contains the case study questionnaire that was used to obtain the information on the ICE consultant paper.

Independent Cost Estimator Questionnaire

Please pick your favorite project that you have worked on as the Independent Cost Estimator (ICE) and fill out this case study questionnaire. For questions with choices listed, you can either highlight your answer, or delete the answers that are not applicable to your case study.

Definitions:

CMGC: Construction Manager/General Contractor, also known as Construction Manager-at-Risk (CMR, CMAR)

GMP: Guaranteed Maximum Price

DOT: Department of Transportation

1. **City and State in which the respondent is headquartered**:
2. **How many years of estimating experience do you have**?
3. **Approximately how many projects have you been the ICE for**?
4. **Case Study Project Title and Location**:
5. **What agency did you work for on this project**?
6. **General Composition of Project**:
    a. Road Construction
    b. Road Rehabilitation
    c. Bridge Construction
    d. Bridge Rehabilitation
    e. Other, please explain:
7. **Short Description of Scope of Work (4-5 sentences)**:
8. **Contract GMP Value**:
9. **Fee for ICE work as a percentage of the total construction cost**:

10. How is your Fee determined?

a. You bid your fee

b. Your fee is set by the DOT

c. Other, please explain:

11. How were you selected to be the ICE for this Project?

a. Chosen from a pre-qualified set of contenders

b. Responded to a solicitation document

c. Other, please explain:

12. What selection criteria were used?

a. Past ICE experience

b. References from past projects

c. Proposed Fee

d. Other, please explain:

13. At what point in the project were you selected?

a. Before the CMGC

b. After the CMGC

c. At a certain % design completion

d. Other, please explain:

14. What is your participation in the preconstruction phase of the project once you are selected as the ICE? Please select all that apply.

- **Design Related:**
  - o Validate agency/consultant design
  - o Assist/input to agency/consultant design
  - o Design reviews
  - o Design charrettes
  - o Constructability reviews
  - o Operability reviews
  - o Regulatory reviews
  - o Market surveys for design decisions
  - o Verify/take-off quantities
  - o Assistance shaping scope of work
  - o Feasibility studies
  - o Encourage innovation
- **Cost Related:**
  - o Validate agency/consultant estimates
  - o Prepare project estimates
  - o Cost engineering reviews
  - o Early award of critical bid packages
  - o Life cycle cost analysis
  - o Value analysis/engineering
  - o Material cost forecasting
  - o Cost risk analysis
  - o Cash flow projections/Cost control
  - o Shape the project scope to meet the budget
- **Schedule Related:**
  - o Validate agency/consultant schedules
  - o Prepare project schedules
  - o Develop sequence of design work
  - o Construction phasing
  - o Schedule risk analysis/control
- **Administrative Related:**
  - o Coordinate contract documents
  - o Coordinate with 3rd party stakeholders
  - o Public information/public relations
  - o Attend public meetings
  - o Biddability reviews
  - o Subcontractor bid packaging
  - o Prequalifying subcontractors
  - o Assist in right-of-way acquisition
  - o Assist in permitting actions
  - o Study labor availability/conditions
  - o Prepare sustainability certification application
  - o Follow environmental commitments
  - o Follow terms of Federal Grant
  - o Coordinate site visits for subcontractors
  - o Teamwork/Partnering meetings/sessions

15. Does the CMGC get to see your estimate? Why?

16. Do you get to see the CMGC's estimate? Why?

17. Briefly explain the process that happens once you are chosen as the ICE (i.e. 1. Meet with DOT, 2. review design documents, 3. put together the estimate, 4. meet with the CMGC, etc.)

18. After the preconstruction phase is over and construction has started, do you still have a role in cost estimating (i.e. for the cost of change orders)?

19. Are you allowed to offer construction suggestions during the design phase, or are you there solely to provide numbers?

20. Please explain how you incorporate profit and overhead into your estimates? (i.e. does the contractor tell you to use a certain percentage for profit? How do you come up with the numbers that you use?)

21. On this project, did you develop a cost model or contribute to the development of a cost model? Please explain.

22. In your opinion, what is the value of the Engineer's Estimate on a project if the CMGC's price is verified by an ICE?

23. In your opinion, what is the perception of the ICE from the contractor?

24. Is your estimate generally higher or lower than the CMGC's estimate?

25. What type of discussions do you have with the DOT?

26. What type of discussions do you have with the CMGC?

27. What type of discussions do you have with the Engineer?

28. What is your advice on how to maximize the value of the ICE on CMGC Projects?