Risk Management in Alternative Project Delivery Scenarios: A Construction Manager/General Contractor Case Study

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The Construction Manager/General Contractor project delivery method is a relatively new approach for contracting public infrastructure projects in America. While added later to the Federal Highway Administration (FHWA) SEP-14 program to investigate innovative contracting methods, State Departments of Transportation are only now beginning to more widely adopt this methodology. This paper analyzes a case study project to relocate Highway 53 in Saint Louis County, Minnesota – a Minnesota Department of Transportation (MnDOT) project that is one of only a handful of federally funded projects to have been completed under this project delivery method. Based upon first-hand experience, key project participant interviews, and construction document analysis, the authors detail the procedures and processes used to leverage contractor experience/knowledge in order to minimize project risks and utilize project funding more efficiently.

Key Words: Construction Manager/General Contractor, Risk Management, Alternative Project Delivery Methods

Background

Nearly all construction work done for public entities must follow "public bid" laws. These laws generally require a contract award to the lowest responsive and responsible bidder. Unfortunately, awarding contracts in this manner increases the possibility that strained relationships may form between governmental entities and contractors which may, in turn, lead to diminished construction quality. In the mid-1980's, due in part to the contracting practices being utilized in Europe that were thought to contribute to higher quality roadways, the Federal Highway Administration (FHWA), the Transportation Research Board (TRB), and state DOTs began to actively research innovative ways of improving highway construction contracts (Hancher, 2000).

As a result of that research, TRB published a report on "Innovative Contracting Practices" strongly urging states to consider and experiment with alternative or "innovative" forms of contracts. FHWA predicated these practices on improving the quality of construction and minimizing the costs and delays associated with construction disputes. Under the program entitled "Special Experimental Project No. 14" (SEP-14), FHWA would allow selected federally-funded projects to utilize non-traditional approaches to contracting. In the initial phases of the project, SEP-14 focused on cost-plus-time bidding, lane rental, design-build contracting, and warranty clauses (FHWA, 1995). By 2002, each of these alternative contracting methods were ultimately authorized as acceptable operational techniques.

Other alternative contracting practices were later included as part of the SEP-14 program including Indefinite Quantity/Indefinite Delivery, Alternate Pavement Type Bidding, No Excuse Bonuses, Lump Sum Bidding, Best Value, System Integrator Contracts, Construction Manager/General Contractor (CM/GC), and others (FHWA, 2017a). Since 2012, FHWA has approved three of these techniques for introduction into operational usage - alternate pavement type bidding, CM/GC project delivery, and alternative technical concepts (ATC) on design-build projects (FHWA, 2017b).

This paper highlights a recent Minnesota Department of Transportation (MnDOT) project that utilized CM/GC project delivery to relocate Hwy 53 between Eveleth and Virginia in the United Taconite mine area. The paper aims to explain the process by which the state DOT and the CM/GC contractor collaborated to address project risks and deliver a final product in a timely and cost-efficient manner.

Alternative Project Delivery Methods

While many outside the construction industry are familiar with the concept of competitive bidding, whether through public or private contracting, the growth of alternative project delivery methods signify attempts to better address the physical characteristics, the regulatory environment, the risk profile, and the parties involved in the project (Mahdi & Alreshaid, 2005; Hinze, 2010). A significant body of literature exists on describing the various alternative project delivery methods (i.e., methods other than Design-Bid-Build). The next section will briefly describe some of the most common including Design/Build, Construction Management, and Public-Private Partnerships.

Design/Build

The Design/Build (D/B) concept arose from the owner's desire to have a single-point of design and construction responsibility, and to eliminate the finger-pointing battle that often occurs between the construction contractor and the designer. D/B allows for both innovative/alternative design options and the shifting of design risk to the design-builder. When using this delivery method, one contract is awarded for both the design and construction; hence one entity provides both design and construction for the owner (Halsey & Quatman, 1989).

Construction Management

Construction Management developed because of the inability of designers and contractors to use effective management skills (Sweet, 2012). Construction Management was intended to provide a better interface between the contractor and designer. A third party who is experienced in both construction and design is added to the team of owner, designer, and contractor. Outside construction managers contract with the owner to act as their agent or representative throughout the project (AIA, 1992). This method of project delivery is also referred to as Construction Management Agency (CMA). An alternative form of construction management has also evolved over the last few decades – known as Construction Management at Risk (CMR), this approach blends both CMA and Design-Bid-Build principles (Mahdi & Alreshaid, 2005). CMR, sometimes known as Construction Management/General Contractor (CM/GC), will be discussed later.

Public-Private Partnerships

While the existence of Public-Private Partnerships (PPPs) can be traced back almost 200 years (Tang, Shen, & Cheng, 2009), their utilization has rapidly grown in the United States since the mid-1990's. Despite its growing adoption, no single definition of PPP exists. FHWA explains PPPs in terms of the project characteristics - New Build Facilities or Existing Facilities. For New Build Facilities, FHWA states, "These P3s are structured as design-build-finance-operate-maintain (DBFOM) concessions that bundle together and transfer to a private sector partner responsibility for design, construction, finance, and long-term operations and maintenance over the concession period (FHWA, 2017c)." Alternatively, Existing Facilities typically utilize monetary concessions to lease publicly-financed facilities to private entities for a designated time frame. "In exchange, the private partner must operate and maintain the facility and in some cases make improvements to it (FHWA, 2017d)." More broadly stated, the National Council for Public Private Partnership defines PPPs as covering, "the gambit from 'outsourcing', to traditional public-private partnerships, to privatization. In each case, this is a means to apply the resources of the private-sector in meeting the needs of the public (NCPPP, 2002, p. 4)."

Construction Manager/General Contractor Project Delivery

Within the public infrastructure realm, CM/GC is a relatively new method for project delivery (Ghavamifar & Touran, 2008). Used for some time in the building construction sector, this process is more widely known as Construction Management at Risk or CMR and is used synonymously by some experts (AGC, 2004). Approximately 26% of State Departments of Transportation (DOT) allow the use of CM/GC as a project delivery method (Gransberg & Shane, 2010). In fact, it wasn't until January 3, 2017 that FHWA put into effect the final rule relating to CM/GC contracting for projects receiving Federal-aid Highway Program funding (FHWA, 2016). Within the final rule, it stated that, "A contracting agency may award a two-phase contract to a CM/GC contractor for preconstruction and construction services. The first phase of this contract is the preconstruction services phase. The second phase is the construction services phase (FHWA, 2016, p. 86944)."

The purpose of this approach is to, "engage at-risk construction expertise early in the design process to enhance constructability, manage risk, and facilitate concurrent execution of design and construction without the owner relinquishing control over the details of design as it would in a design-build project (Gransberg & Shane, 2010, p. v)." Existing literature details the benefits of the CM/GC process (Farnsworth, Warr, Weidman, & Hutchings, 2016; West, 2012; Schierholz, 2012; Shakya, 2013; Owens, 2013) and the various options for CM/GC contractor selection (Gransberg & Shane, 2015; Alleman, Antoine, Gransberg, & Molenaar, 2017)

As one of the original 14 states with CMGC Authority, Minnesota was an early adopter of this alternative delivery method (Ghavamifar & Touran, 2008). As such, they have executed multiple projects under this process and have refined the best practices for effectively and efficiently administering these contracts for public infrastructure work.

Research Objectives and Methodology

As state DOTs start to use alternative project delivery methods in an attempt to more efficiently utilize shrinking funds for infrastructure maintenance and investment, the challenge of deploying these tools often falls on state employees who may have limited background or experience with the new procedures. The goal of this research is to provide insight into the internal processes that early adopters of the CM/GC alternative project delivery method are utilizing for public infrastructure projects. The researchers hope to answer the following research questions: 1) what steps are state DOTs using to leverage the knowledge and experience of contractors to reduce project risk and develop infrastructure needs more efficiently; and, 2) what beneficial outcomes can be gained through the use of CM/GC alternative project delivery method?

The case study approach was selected as the most appropriate method for this investigation (Yin, 2013). Focusing on a project to relocate Hwy 53 in Saint Louis County, MN allowed the authors to capture real-world data and project documentation in a State that is considered an early-adopter of CM/GC project delivery. While broader surveys or data collection tools would gather information from a larger number of samples, they would not have allowed the depth needed to fully document the evidence of relevant processes and procedures. The authors used project document analysis and key personnel interviews in order to collect the information for this case study. In addition, the first author worked on the project during several months of its construction. Through field and office experiences, the author had a chance to review most of the project contract documents (e.g., design drawings, subcontractor contracts, cost and time performance updates, and risk assessment data), attended project performance controls meetings, and was involved in the impact analyses of selected risk mitigation solutions.

Case Study History and Background

In 1960, the MnDOT built Hwy 53 between Virginia and Eveleth on land owned by iron mining interests. The easement the agency signed to build the original road included a requirement that MnDOT would move the road with three years notice if the mining company needed to get to the ore underneath. In 2010, the mining interests notified MnDOT that the road would need to be moved. Later that year, MnDOT and the mine company agreed to extend the deadline to move until 2017.

From 2011-2014, MnDOT conducted a study of alternatives for roadway realignment. In June 2015, the final design, environmental impact statement, and permitting were completed. As part of the project development process, MnDOT purchased the mineral rights under the new alignment to ensure that the road would not have to be moved again. In preparation for bidding the project that included two bridges, roads, and utilities updates, MnDOT identified CM/GC as a suitable delivery method for the project as it looked ways to improve value and leverage the benefits of integrated design while minimizing the potential for project delays.

CM/GC Processes and Procedures under MnDOT

For MnDOT, CM/GC is a contracting method that involves the State executing a Professional I Technical (PIT) services contract with a firm (Contractor) to provide constructability and other services during the pre-construction phase of the Project. During this preconstruction phase, the Contractor performs a Construction Manager role. The

Contractor works cooperatively with the State, the State's design consultants, and the project stakeholders to mitigate risk, minimize the construction schedule, resolve issues promptly, and deliver a project within budget.

Once the pre-construction phase of the Project reaches the appropriate stage, the Contractor is given an opportunity to provide a proposed cost ("bid") to construct the Project. The State then reviews the bid (including all conditions of contract award) and if agreement is reached, the Contractor becomes the General Contractor for the construction phase of the Project. Their role will be to construct the Project within the Construction Bid Price Proposal and any allowable contract adjustments and propose solutions that will help achieve the goal of staying within the budget.

The State may elect to construct the project through multiple work packages. Work packages are defined portions of the construction services on any aspect of the project, including procuring materials or services. If the State and the Contractor fail to reach agreement on price on any work package, the State has the option to procure the construction of the Project by some other method (design-bid-build or design-build) and solicit bids from other contractors. The CM/GC contractor may bid or propose on the project if procured under design-bid-build or design-build. If there are multiple work packages on a project and an agreement on price can't be reached on a work package, the Contractor will be allowed to continue to perform construction services for previously awarded work packages, but State reserves the right to terminate the CM/GC PIT services contract and procure future work packages by another procurement method.

For this project, the construction company was asked to help the owner and design firm in developing the design documents by providing professional and technical services during the pre-construction phase. The specific tasks were to provide constructability and value engineering reviews including schedule risk assessment with Opinion of Probable Construction Cost (OPCC) estimates. During this phase, the CM/GC Contractor was involved in numerous risk workshops to review project status, goals, funding and project elements. These workshops included:

1. Initial project workshop prior to bridge type selection to:
   - Review project status, goals, funding, and project elements.
   - Gain team input for the baseline risk register and risk analysis with the contractor, state, and designers.
2. Separate risk workshops at 30/60/90% design review for both roadway & bridge work packages.
3. Other workshops as necessary for creation of additional work packages, like the steel girders package.

The baseline risk register and risk analysis were used as tools to mitigate risks. In the first months of this process, the CM/GC Contractor was involved in reviewing the appropriate bridge type and bridge elements for the project, which were determined by MnDOT. The company provided input regarding constructability, quality and schedule impacts for the options discussed to determine the most economical option. OPCC estimates and Critical Path Method (CPM) schedules for each workshop were developed. In addition to the technical responsibilities, the CM/GC Contractor attended public meetings and answered questions regarding the project. The CM/GC Contractor also held four outreach meetings for Disadvantaged Business Enterprise (DBE) firms, throughout the pre-construction process.

A CPM schedule was submitted with each OPCC and was used to determine schedule impacts of various options discussed. Throughout the pre-construction phase, The CM/GC Contractor provided and documented innovations regarding cost, schedule and risk reduction (CSR) improvements by utilizing the department's submission process. Discipline specific task-force meetings and foundation subcontractor consultations were used to evaluate and analyze proposed concepts for the project.

The CM/GC Contractor reviewed with the Independent Cost Estimator (ICE) and Engineer's Estimator (EE) key information such as subcontractor and supplier pricing, construction schemes, cost comparisons, as well as other information to establish the basis of their estimate. The company utilized multiple technical experts for assistance with the girder erection plan, the causeway design and other critical portions of the project. The following information is typical of what was included in the CM/GC Contractor's cost model:

1. Unit prices and quantity take-offs.
2. Material costs, equipment costs, labor costs, hourly labor rates, crew sizes, shifts per day, hours per shifts. Labor rates include employee benefits, payroll taxes and other payroll burdens.
3. Risk assumptions and assignment of risks.

4. Production rates, transportation, and other facilities and services necessary for the proper execution of the work.
5. Copies of quotations from subcontractors and suppliers.
6. Field indirect cost, bonds, taxes and insurance.

The State reviewed the Contractor's bid using the following pre-defined process:

1. State will secure an ICE for the Work. Upon opening the Contractor's bid, State will compare the Contractor's bid with the estimate prepared by the ICE and State. If the proposed pricing is found to be acceptable, the bid will be reviewed for irregularities. If pricing is acceptable and does not contain any irregularities and meets all of the conditions to award a contract, State will accept the Contractor's bid and State will prepare a construction Contract based on the bid. The Contract amount will include funding for provisional contingency items mutually agreed upon by State and the Contractor during pre-bid discussions. However, the Contractor will not be entitled to payment for any provisional contingency items without justification and authorization from State.
2. If the prices are not acceptable, State will enter into a process of risk identification that identifies price differences between the Contractor, the ICE, and State. Following the resolution of these risk issues, the Contractor will have the option to re-bid the project. If the State does not deem the second bid acceptable, the state may procure the construction of the Project by some other method. The state will also reserve the right to terminate the CM/GC professional/technical services contract without penalty or payment (except payment for preconstruction services) and procure the construction of the Project by some other method. If there are multiple work packages on a project, the Contractor will be allowed to continue to perform construction services for previously awarded work packages, but State reserves the right to procure future work packages by another procurement method, which was not the case in this project.

The pre-construction proposal formed the basis for payment during this phase of the work. It included six activity payment items including: risk analysis (10.76%); bridge type selection, (2.42%); stakeholder coordination (1.11%); steel procurement (21.18%); bridge design review (22.30%); highway design review (22.32%); and bid (19.91%). A key project need, which specifically made this CM/GC contract delivery method appropriate, was to verify the preliminary design assumption of a structural steel superstructure for the major bridge. It had been assumed that a steel superstructure was needed to meet the construction timeline. Further, steel procurement timelines meant that the project would have to get in the que for plate manufacturing while detailed design was still being completed and before the project had been authorized to proceed to construction.

Through this process, with this risk management mind set, the main identified risk items and tasks that have been performed at the pre-construction phase were as follows:

Constructability/Value Engineering at 30% Design

The design team developed the main structural systems preliminary design to be analyzed in this stage of design development and the different stakeholders focused on discussing and analyzing various risk areas. The items addressed below summarize the risk areas addressed by the CM/GC Contractor.

1. Evaluating the initial project program by: developing project goals, requirements, scope and priorities; discussing the project approval process and constraints; and assessing the project funding options and requirements.
2. Analyzing both site/environmental requirements and protection plans to address: permit requirements (SWPPP/Fugitive Dust/Utility Tie-Ins/FAA for cranes); site access; and existing conditions.
3. Analyzing construction materials, means and methods to: select the structural system; select the construction materials and methods; evaluate the causeway option in building the main bridge; and explore the materials suppliers' availability and capacity.
4. Analyzing long lead items drawings & specifications to address: steel girder supply options; girder size analysis for manufacturing availability, limitations, and transportation permits; girder lifting, assembly and connection specifications (if special assembly required); transportation, loading/unloading plans; laydown & storage plans; and quality assurance & control plans including required inspections by third parties.
5. Analyzing concrete construction options to address: concrete quality requirements; mass concrete

requirements; concrete supply options; and weather related constraints.

6. Borrowing/waste materials options to address: availability of materials and its quality in the project location; and waste management.
7. Soil report and unforeseen conditions as it relates to soil analysis, site exploration, and exploring the soil risks and potential different site and unforeseen conditions.
8. Project schedule requirements including: owner start/finish constraints; and significant project milestones.
9. Equipment requirements including analysis of different equipment utilization options.
10. Identifying suppliers and subcontractors.
11. Analyzing project budget and cost constraints to address: owner capability, reputation and management systems; and developing rough order of magnitude ("ROM") estimates.

The deliverables of this phase included developing the initial 30% cost estimate, a CPM schedule, and both a project Quality and Risk register. The risk register was developed through: 1) identifying initial contract/project delivery and potential risk factors; 2) performing qualitative risk assessment; 3) performing risk allocation based on opportunities/threats analysis and ROI; and, 4) creating a risk register with a tabulated information. During this stage of the project, both a deeper understanding of the project's requirements/goals and a greater sense of mutual trust developed among the stakeholders.

Value Engineering and Cost Estimate at 60% Design

At this stage, more information had been developed about the various project components. An updated scope with more detail and more accurate quantities was incorporated in the project schedule and cost plan. The process executed during the 60% design review stage included:

1. Updating the Scope by discussing roadway and utility design alternatives; and finalizing the project scope with additional items. In addition to defining the scope of pay items with more accurate quantities.
3. Devolving the project milestones and schedule to identify: the easement and right of the way constraints; the schedule updates based on the detailed info and the duration accuracy; the existing road changing routes/close out; and third parties/utilities relocation and tie-in milestones.
4. Revisiting the quality and risk register to: re-assess both previously identified risks and new risk factors; and identify quality standards, requirements, and procedures.
5. Discussing coordination activities to address: required inspections; submittals and review standards; weekly owner & schedule meetings; monthly mass safety meetings; and QC and QA roles and responsibilities.

The deliverables of this phase included developing the initial 60% cost estimate and the CPM estimate with an updated project quality and risk register. In addition, technical and performance specifications were also refined to further define the final project's final design.

Cost Estimate at 90% Design

As the design phase moved towards completion, cost estimates could now include considerable detail and accuracy. A schedule of values was developed for use during the bidding phase and the CM/GC Contractor completed several other key project review processes including:

1. Revisiting the project schedule.
2. Revisiting the risk management plan.
3. Developing the environmental plan.
4. Developing a quality assurance/control plan.
5. Discussing and developing the project safety plan.

In the complete design documents, the time, cost, quality, safety and risk management plans were finalized with cost and time impacts. In addition, responsibilities and sign off parties were also identified. The CM/GC Contractor developed and submitted the project bid documents with the OPCC estimates.

Findings and Discussion for Future Work

Looking back at the project assumptions and initial plans, several key areas of benefit can be highlighted as a result of early involvement from the CM/GC Contractor. Approved and implemented solutions proposed by the CM/GC Contractor to improve cost, time, quality, and safety risk exposures on this project included in Table (1).

Table (1): Value Engineering & Construction Approved Solutions

#	Approved and Implemented Solutions Proposed
1	Constructing a rock causeway (fill) through the flooded old mine pit. This provided the most economical access to one of the major piers on the project, and allowed for conventional steel erection by land based vs. floating cranes. A temporary falsework tower in the main span was also made practical.
2	Hiring the structural steel detailer used by the designer to prepare the final shop drawings allowed the fabricator to expedite the mill order for structural steel.
3	Using 30” diameter pile in lieu of 24” diameter pile in pier foundations.
4	Using solid column sections for time and cost saving in forms with a mass concrete option to be managed by thermal control analysis.
5	Determining the concrete mix designs needed early on to manage the mass concrete and thermal control specifications.
6	Using Stay in Place (SIP) forms in lieu of a traditional wood formed deck, which reduced both the need for required false deck and the risk/cost of removing that deck formwork.
7	Evaluating cost and schedule impacts of two roadway profile design options being considered by MnDOT (a 4 or 5% grade into the bridge on the east side) to minimize: the amount of common and rock excavation; the right of way take; and the compensation for mineral right acquisition.
8	Using steel framing for a rebar template inside the column rebar cage to provide stability and safety during rebar and formwork installation.

While the specific findings of this case study are difficult to extend to the overall public infrastructure project realm, the system used to administer this CM/GC contract can provide invaluable guidance to those developing similar practices in their own jurisdictions. In addition, anecdotal evidence of the benefits realized in this case can also provide possible incentives to further utilization of alternative project delivery methods.

The use of alternative delivery methods for U.S. public infrastructure projects will continue to grow as governmental agencies look for methods to deliver projects in more efficient ways. Whether through design-build, PPP, CM/GC, or other methods, public entities must be sure to utilize taxpayer money in ways that are consistent with public policy. By using private sector experience in a two-step process, MnDOT was able to better capture, quantify, and plan for project risks than in the traditional competitive design-bid-build approach. This paper highlights the process and outcomes from the implementation of CM/GC project delivery in Minnesota – one of only a few states that have completed multiple projects under this procurement strategy. In addition, it can serve a framework for those public agencies looking to implement similar endeavors.

In all accounts, the Highway 53 Relocation Project has been a successful endeavor to all involved parties. However, the public perception about CM/GC procurement and the wider application of this approach should be studied further. Future research should explore more lessons learned from different stakeholders’ perspectives and more technical analysis of specific project performance data.

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