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A Framework for Guaranteed Maximum Price and Contingency Development for Integrated Delivery of Transportation Projects

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Abstract: This paper discusses the components of a guaranteed maximum price (GMP) and proposes a framework for the development of GMPs as contract payment provisions for construction manager-at-risk (CMR) and design-build (DB) contracts for transportation projects. The framework is the synthesis of a comprehensive literature review, a content analysis of CMR and DB solicitation documents and contracts, and case study project output from twelve projects in nine states worth $3.1 billion. The research also discusses the development of three common types of contingencies that are often utilized in projects with GMPs. The study concludes that owners should specify the structure of the GMP and its components to enhance clarity and understanding of the GMP's composition. It recommends that this structure be included in the CMR and DB solicitation documents so that pricing proposals can be formulated in a manner that is consistent with the contract payment provisions that will be useful to practitioners that need to implement GMP-based contracts.

Keywords: Estimating; guaranteed maximum price, contingency, design-build, construction manager-at-risk

I. INTRODUCTION

A. Highway Project Payment Provisions

Highway construction projects are typically delivered using design-bid-build (DBB) project delivery and historically are awarded to the low bidder [19]. In the past decade, more highway projects have been delivered using design-build (DB) and all of these were awarded on a lump sum basis, which requires the design-builder to fix the price before design is complete. Doing so forces the inclusion of contingencies for scope growth during design and this type of project payment provision does not include a mechanism for the owner agency to be able to know the size and character of these contingencies. If they are unrealized, then the agency must pay for having shed this specific risk. Additionally, a lump sum DB contract also places the risk of construction cost escalation during the design phase on the design-builder. Thus, additional contingencies must be added to the price to mitigate this risk. Thus, a contract payment provision that creates a transparent accounting of actual costs would greatly benefit the owner because it could then share rather than shed the scope creep and escalation risks.

B. Building Project Payment Provisions

The vertical construction industry as well as the airport and transit sectors in transportation has used guaranteed maximum price (GMP) contract payment provisions successfully on a variety of projects [20]. This technique is usually a feature of projects delivered using CM-at-Risk (CMR), which is also called construction manager/ contractor (CM/GC). However, both airport and transit projects have used this method on DB projects as well [20]. The major advantage to the owner of a GMP is that it can require an "open-books" form of cost accounting that makes the contingencies transparent and allows them to be reduced by not forcing the constructor to commit to a given price until the design has advanced to a point where the potential for scope change is minimized. A framework for GMP structure is presented for DB and CMR transportation projects to furnish a theoretical basis from which transportation agencies can develop their own specific GMP based on project, statutory, and policy constraints. Thus, the objective of this paper is to report the findings of twelve studies of transportation projects where GMP contract payment provisions were used and generalize the specifics of each case study project.

II. DEFINITION OF GMP

A. Terminology

The term "guaranteed maximum price" is often misunderstood and has many different components suggesting the need for development of a common framework. "Most Owners see having a Guaranteed Maximum Price (GMP) as equivalent to having a stipulated sum cost [lump sum fixed cost]" [18]. In the eyes of the uninitiated, the word "guaranteed" implies that the owner will *never* have to pay more than the GMP. This leads to the impression articulated by Strang [18] that the owner effectively shifts the risk for the total cost of the project to the prime contractor, regardless of the nature of the realized risks. However, in integrated delivery with DB or CMR, the GMP amount corresponds to a quantified scope of work

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expressed in the design documents at the time the base cost estimate was completed [2]. So, if a substantial scope change occurs, the prime contractor is due fair compensation for that cost of increased work. The literature supports the idea that it is important for the owner and contractor to lay out the details of how the GMP will be assembled and ultimately established in both the solicitation documents and the contracts for preconstruction and construction services [1, 2, 12,].

B. Basic Definition

Kwak and Bushey [10] furnish a very simple definition for the components of a GMP: "The GMP is composed of [the cost of] work, overhead, profit, and a contingency." Breaking these elements out assists the owner to understand the relative magnitude of each component and furnishes a framework from which the owner can assess the reasonableness and realism of each element. A typical GMP clause from a transportation project request for proposals (RFP) reviewed in the content analysis defines the GMP in the following manner:

> "The Contractor's Fee as an established percentage shall be applied to the Cost of the Work plus contingency. The sum of the Cost of the Work plus contingency, plus Contractor's fee shall establish the basis of the Guaranteed Maximum Price (GMP) for the project prior to construction start" [7].

This is the definition for simplest possible GMP: total project cost, contingency, and fee, which includes the contractor's general conditions/overhead. The construction industry has a number of variations on the basic GMP. But, the least complicated GMP would have the following elements:

- Project direct costs
  - Subcontract work package costs
  - Constructor self-performed work package costs
- Indirect costs: Prime contractor's general conditions/overhead costs
- Profit: Percentage mark-up or lump sum fee
- Project contingency

C.GMP Components

The components of a GMP can vary from agency to agency and from project to project. How various costs and risks are quantified in a formula for a GMP determines how the owner and its designer and/or constructor will relate the cost components of the project to its progress. They also determine the level of transparency that is brought to the cost accounting process for project costs and contingencies. In this vein, a variation on GMP assembly is the progressive GMP 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 [1, 12]. Therefore, it is important to standardize a framework for developing a GMP that is both flexible to project needs and understandable by both the owner agency and its design and construction service providers.

III. Objective and Methodology

A. Purpose

This paper synthesizes existing GMP assembly approaches into a single framework that can be used as a structure upon which to build a GMP for a given transportation project. The findings of this study were developed by drawing conclusions from a triangulation of three research instruments: a literature review, a solicitation document content analysis, and structured interviews of the case study project participants. The literature review was used to first understand the topic, and later validate ideas from the other sources of information. Solicitation documents from a number of projects were obtained to conduct a content analysis. These documents were from transportation and non-transportation projects. The final source was the case studies completed on the twelve transportation projects, shown in Table I that used integrated delivery methods with GMP contract payment provisions.

B. Solicitation Document Content Analysis

Content analyses of public solicitation documents were also completed to quantify the state-of-the-practice regarding the procurement phase of GMP projects and to create a basis for identifying GMP effective practices. The content analysis involved reviewing solicitation documents from DB and CMR projects that used GMP pricing provisions. This instrument furnished quantitative measurements of agency requirements for GMP component factors. This analysis was used to develop "valid inferences from a message, written or visual, using a set of procedures" [14]. The solicitation documents were parsed for keyword, whose frequency of appearance permit the researchers to infer the content of each document with regard to the specific topics of interest and allows an inference to be made about a given owner's approach to structuring the GMP. The output from the content analysis was then compared within the case study project sample to identify the way contract payment provisions are articulated in project-specific solicitation documents.

Two types of solicitation documents were included: Requests for Qualifications (RFQ) and RFPs. RFQs ask for qualifications, past experience, and other evaluation factors. RFPs add some form of cost or pricing information submittal to the typical factors found in the RFQs. A total of 31 documents related to a transportation project from twelve different states and Canada were analyzed. Additionally, 41 documents from seventeen states related to non-transportation projects.

TABLE I
CASE STUDY PROJECTS

Agency	Case Study Project	Location/ Size ($)	Primary Type	Project Delivery Method	Procure-ment Process	Contract Payment Provision
Alaska DOT&PF	Fairbanks Intl Airport Expansion	Fairbanks, AK $99.0 million	Building	CMR	QBS	GMP
Florida DOT	Miami Intermodal Center	Miami, FL $1.3 billion	Building, Rail, Road, Bridge	CMR	QBS	GMP
City of Glendale	Glendale Pedestrian Improvements	Glendale, AZ $16.2 million	Road, Utilities	CMR	QBS	GMP
Dallas-Fort Worth Int'l Airport	Terminal D Expansion	Dallas, TX $627 million	Building, Road, Bridge	CMR	QBS	GMP
Michigan DOT	Passenger Ship Terminal	Detroit, MI $10.0 million	Building, Marine, Utilities	CMR	QBS	GMP
Memphis Airport Authority	Whole Base Relocation	Memphis, TN $245.0 million	Runway, Building	CMR	BV	GMP
Mineta -San Jose Int'l Airport	Terminal Area Improvements	San Jose, CA $185 million	Building, Roads, Parking	DB	QBS	GMP
Oregon DOT	I-5 Willamette River Bridge	Eugene, OR $150.0 million	Road, Bridge	CMR	BV	GMP
Pinal County Public Works	Ironwood-Gantzel Road (US 60)	Florence, AZ $63.7 million	Road, Bridge	CMR	QBS	GMP
Tampa Int'l Airport	Taxiway B Rehab, Bridge & Road	Tampa, FL $40 million	Taxiway, Bridge, Road	DB	QBS	GMP
Utah DOT	I-80 State St to 1300 East. Reconstruction	Salt Lake City, UT $130.0 million	Road, Bridge	CMR	BV	GMP
Utah Transit Authority	Weber County Commuter Rail	Salt Lake City, UT $241.0 million	Rail, Road, Bridge, Building	CMR	BV	GMP

BV = Best Value; CMR = CM-at-Risk; DB = Design-build; QBS = Qualifications based selection; DOT = Department of Transportation

Table II shows a summary of the content analysis and one can see that transportation project values were larger than those of the non-transportation projects. This underlines the need for clear guidance on GMP formation in solicitation documents due to the greater amounts of money involved.

TABLE II
SOLICITATION DOCUMENT POPULATION AND CASE STUDY ANALYSIS RESULTS

Project Type	Case Study Project (Trans-portation)	Content Analysis (Trans-portation)	Content Analysis (Non-Trans-portation)
Type of Organization			
State DOT	5	17	NA
Other Public	7	14	41
Type of Procurement			
RFQ only	6	15	17
RFP only	4	16	16
RFQ + RFP	2	0	8
Monetary Range			
Low	$10 million	$0.9 million	$0.8 million
High	$1.3 billion	$2.16 billion	$114 million

C. Structured Interviews of the Case Studies

The case studies were collected using Yin's methodology for case study research data collection [25]. Therefore, the information gleaned from the case studies is coupled with information collected in the literature review and content analysis to internally validate any conclusions drawn from the case studies. Structured interviews were conducted with the agencies that had implemented projects with GMP pricing provisions and when possible, the prime contractors who completed the case study projects. The interview outlines were developed as prescribed by the US General Accounting Office [6]. The GAO method specifies this instrument where "information must be obtained from program participants or members of a comparison group… or when essentially the same information must be obtained from numerous people for a multiple case-study evaluation" [6]. Both these conditions apply, making it an appropriate tool for the research.

D. Internal and External Validation

The final step in the methodology was to return to the literature review and use that output as internal validation of the framework derived from the intersection of the case study and document analysis. This furnished a reality check to ensure that proposed GMP framework retained the same advantages as were reported in previous research. The disadvantages found in the literature were also compared to the framework to determine if it added value to the process by generalizing GMP structure for a transportation DB or CMR project. The framework was externally validated by a panel composed of ten DOT and industry experts experienced with GMP payment provisions. The proposed framework is the output from that external review and validation process.

IV. RESULTS OF THE ANALYSIS

A. Output of the Research

The output from the interviews and the content analysis were combined to identify trends in GMP structure and application for DB and CMR projects. Tables III and IV show the results of that analysis. Scanning the tables shows the detailed information obtained from the case studies tracks with the information gleaned from the content analyses. For example, lump sum GMP is the most frequent contract pricing provision in both the content analyses and case study structured interviews. Progressive GMP is utilized in roughly the same frequency in the content analysis (4 of 12) and case projects (5 of 12). Also, Table IV shows that the fees were more often negotiated after award in both the content analysis and case studies.

TABLE III
COMBINED RESULTS OF GMP ISSUES RELATED TO PROCUREMENT

GMP Issues	Content Analysis	Case Studies	Total
GMP Factors Required in Proposal*			
Preconstruction Fee	15	3	18
Construction Fee	15	0	15
Profit Only	1	1	2
Contract Pricing Provisions			
Lump sum GMP	14	10	24
Unit Price GMP	0	2	2
Cost + GMAX	3	0	3
Point GMP Negotiated			
Before 100% design	12	11	23
After 100% design	6	1	7
Progressive GMP?			
Yes	4	5	9
No	8	7	15

* The numbers will not add up to the total projects because a single project could use multiple factors or the content analysis could not discern any of the factors of interest.

TABLE IV
COMBINED RESULTS OF GMP ISSUES RELATED TO FEES AND CONTINGENCIES

GMP Issues	Content Analysis	Case Studies	Total
Preconstruction Services Fee			
Agency has fixed rate	1	1	2
CMR proposes fee at selection	3	4	7
Fee is negotiated after award	4	7	11
Other	2	0	2
Construction Services Fee			
Agency has fixed rate	0	2	2
CMR proposes fee at selection	0	2	2
Fee is negotiated after award	4	7	11
Other	0	1	1
Transparent Contingencies			
Yes	2	12	14
No	0	0	0
Contingencies Used			
Single project	2	3	5
Owner & Prime	0	7	7
Management reserve +contingencies	0	2	2
Shared Savings?			
Yes	2	4	6
No	0	8	8

TABLE V
RESULTS OF THE LITERATURE REVIEW CONCERNING GMP USAGE

Advantages	# cites
Early knowledge of costs	12
Ability to bid early work packages	11
GMP creates cost control incentive	6
Reduces design costs	5
Open books contingency accounting	4
Spirit of trust	4
Competitive bidding possible	4
Disadvantages	**# cites**
Actual cost not known until GMP is set	5
Contingencies difficult to allocate	2
CMR may underestimate cost of preconstruction services	1
Reduced competition among subs	1

B. Literature Review

As shown in Table V, the literature review found twelve papers citing early knowledge of costs as an advantage of integrated delivery using GMP provisions. Table III shows that only one third of the case studies (4 of 12) were awarded considering price in the selection decision. It is also important to note that in three of the four instances where price was used, it constituted less than 25% of the overall weight in the award algorithm [8]. Additionally, the idea that a GMP creates an effective cost control measure was cited six times. Thus integrated delivery using a GMP aims to establish the cost at an early stage of design rather than to minimize costs.

Another inference from the interviews and content analysis validated by the literature was the use of a progressive GMP. Five of twelve case studies and four of twelve documents used this approach. The interviews with the agencies that used progressive GMPs revealed that the rationale for use was directly related to escalation risk control by bidding out early work packages. In fact the Utah DOT uses this technique on all its projects where material price volatility is an issue. The Memphis Airport did the same thing on its project. This factor was cited eleven times in the literature validating the conclusion. Table V is a consolidation of the number of times a given advantage or disadvantage was cited in the literature.

Table III lists the major components found in typical integrated projects with GMPs. In the GMP factors required in proposal component, only one reference to a cost that is not either an indirect cost or a contingency was found and that is the requirement to furnish unit prices for self-performed work required in the Utah DOT project. This leads to the conclusion that the direct cost portions of the GMP are assumed by the agency to be relatively constant between competing contractors. Additionally, Table IV shows all but one case study project used transparent contingency accounting, which creates an "open-books" project cost control system between the owner and the prime. The literature validated this conclusion citing four instances advocating open books contingency accounting and another four indicating an enhanced spirit of trust.

V. CONTINGENCY DEVELOPMENT

A. Owner's Perspective

Contingency estimating may be the least understood piece of the GMP from the owner's perspective. Many agencies make no attempt to estimate a project-specific contingency and merely use a standard percentage of mark-up that is added to the engineer's estimate to reach a project budget. For example, the US Army Corps of Engineers mandates a 5% contingency [22]. Hence, understanding exactly what a contingency represents is vital to being able to accurately develop one using a logical process. The literature has many definitions for contingencies from a variety of sources. However, the US Department of Energy

(DOE) neatly fits the DB and CMR GMP context as it binds the contingency issue to the project's characteristics:

> "The [contingency is the] amount budgeted to cover *costs that may result* from incomplete design, unforeseen and unpredictable conditions, or uncertainties within the defined project scope. The amount of the contingency *will depend on* the status of design, procurement, and construction; and the complexity and uncertainties of the component parts of the project." [4 italics added].

This definition narrows the contingency to only those costs that *may occur* due to uncertainties, *not* those that *will occur*. Additionally, the amount of contingency is not fixed in this definition. The DOE requires the amount to depend on the project's current completion status. Thus, a project where no design has been completed would have a larger contingency than one where the construction is ready to commence [11]. Thus, the DOE definition can be construed to mean that a contingency is the probable cost of the unknowns at the time the GMP is established. This is an important distinction and aids in determining how an agency will want to develop its contingency estimating policy.

As a CMR contract has three prime players: the owner, the designer, and the builder, it has become customary to split the project's total contingency into logical proportions that relate to the specifics of its status within the delivery process. For example, some CMR specifics added to the contingency definition are as follows:

> "Design contingency accounts for estimating inaccuracy due to both quantitative error (take-offs) and qualitative error (design intent). Construction contingency accounts for inaccuracy due to both unforeseen site conditions and contractor risk. Owner contingency accounts for … things that are overlooked, scope creep, regulatory change, and so on. Escalation is different. *Contingencies are for what may happen. Escalation is for what shall happen.* Escalation accounts for the persistent inflation of construction costs. The value is reduced to zero when all [subcontractor] bids are in." [16].

These authors differentiate between contingency and escalation using the DOE discriminator that a contingency covers what might happen, but as construction cost inflation is nearly certain during the design phase, money to cover the change in prices due to inflation is better termed escalation. Table IV shows that nine of twelve case study projects chose to break up the overall contingency and assign a contingency pool to itself and a separate one to the prime contractor. This demands that the agency defines what uncertainties each contingency can be used to cover.

B. Accounting Practice

"Open books" is a term that was used extensively in the literature [5, 11, 23]. It indicates a level of collaboration characterized by "[s]haring project [cost] information openly, defining risk and profit appropriately, and creating a high level of trust among all the parties" [5]. It also means that the project execution method is transparent to all parties and it discourages "hidden agendas" [11]. This leads back to the joint development of the preconstruction cost model. If all parties understand the intricacies of the cost model, they will more closely understand the impacts as estimated costs are replaced by actual costs. Ladino et al. [11] state: "Open books accounting eliminates hidden agendas." Van Winkle [23] describes it as follows:

> "Open Book accounting is a two-edge sword. Pricing knowledge benefits the owner to confirm cost reasonableness and serves as a basis for change order pricing. However, every variance may be viewed as a change to GMP… The solution is to define who owns each risk" [23].

C. Contingency Types

The study found three possible contingency options as follows:

- Prime's contingency
  - Termed contractor's contingency or construction contingency in CMR projects
  - Termed design-builder's contingency in DB projects
- Owner's contingency (sometimes called a design contingency)
- Management reserve

Three of twelve case study projects used a single project contingency. Seven had separate contingencies for the Prime and the Owner and two had all three. The two projects that added a management reserve to the separate owner's and CMR's contingencies were the Fairbanks Airport project and the Miami Intermodal Center. The Alaskan management reserve is a fund controlled by a panel of individuals who are not directly involved in executing the project. Its stated purpose was to furnish resources to take advantage of previously unseen opportunities to improve the overall operations of the airport as well as to resource *force majeure* events due to Alaska's challenging climate [27]. The Florida management reserve was created to fund specific owner design changes to the GMP scope [13]. In all cases, the contingency accounting system was transparent and there was some system in place to authorize the use of contingency funds for their intended purpose as well as cross balance them between contingency pools if necessary.

1) Prime's Contingency: The Prime's contingency may be the only contingency in the GMP. In which case, its purpose is to cover all eventualities. However, if the agency decides to separate the Prime's contingency from an owner's contingency, then it effectively turns the Prime's contingency into a construction contingency focused on the uncertainties of the market. This may include a separate escalation component which is reduced as material pricing and subcontractor work packages are finalized. Typical uncertainties assigned to the Prime's contingency are:

- Labor availability [11]
- Material pricing [11, 21]
- Schedule delay costs not attributed to the owner [19, 21]
- Subcontractor coordination/conflict issues [16].

2) Owner's Contingency: In CMR project delivery the owner holds the design contract and as a result, the design contingency discussed above is normally assigned to the owner's pool. Some agencies have chosen to break a design contingency out of this pool of funds [16]. In this case, the agency might give control of that contingency to the design consultant and use it as a sort of GMP on the design contract to discourage scope creep. None of the case study projects with separate owner's contingencies used this technique. Typical uncertainties assigned to the Owner's contingency are:

- Design errors and omissions [4]
- Scope creep [4, 16]
- Owner directed scope enhancements [11, 13]
- Force Majeure [17]
- Regulatory change [16].

3) Management Reserve: The management reserve is an interesting feature if used. The fundamental concept is to identify a source of funding to cover the cost of changes, improvements, and operational requirements that impact the project but do not spring from the execution of the project's intended scope of work. In federal procurement jargon, this might be called a cardinal change contingency. "A cardinal change occurs when the proprietor effects alterations in the works so drastic they effectively require the contractor to perform duties materially different from those originally bargained for" [24]. Thus, including this form of contingency in a DB or CMR contract gives the owner much wider latitude to take advantage of unforeseen opportunities as they arise. Van Winkle [23] calls the management reserve a "budget for discretionary purposes." An example occurred in the Weber County Commuter Rail project in Utah. The CMR was able to create a substantial savings during preconstruction through value engineering. The savings flowed to the owner's contingency where it was used to add park-n-ride structures that were not in the original scope of work, that is, execute a cardinal change to the benefit of the project. While Utah Transportation Authority (UTA) did not have a separate management reserve fund, its owner's contingency was structured in such a fashion that it could and did function as one.

A management reserve is also appropriate when the agency needs to establish a GMP at an early stage of design. In transportation, this sometimes occurs for bond-funded projects. In this case, "a design contingency is often held *outside the GMP* [making it a management reserve] to be drawn against as the exact scope of the work becomes better defined" [3, italics added). Doing this allows the Prime to reduce its contingencies because funds are available from the management to increase the GMP amount for significant scope changes. The Miami Intermodal Center case study project used its management reserve in this manner. Minchin et al. [13] described the function of this type of contingency as follows:

> "There is a contingency *within* the GMP to cover unexpected but justifiable costs, and a *contingency above the GMP allows for owner changes*. As long as the subcontracts are within the GMP, they are reimbursed to the CM, so the CM represents the owner in negotiating inevitable changes with subcontractors. The key element in the CMAR system on this project is the contingency fund (10% on this project). Without that, an adversarial atmosphere would appear on the project. Instead of the prime contractor or the CM looking for changes as on a DBB project, the subcontractors are doing so, but a strong CM insulates the owner from this problem." [13 italics added].

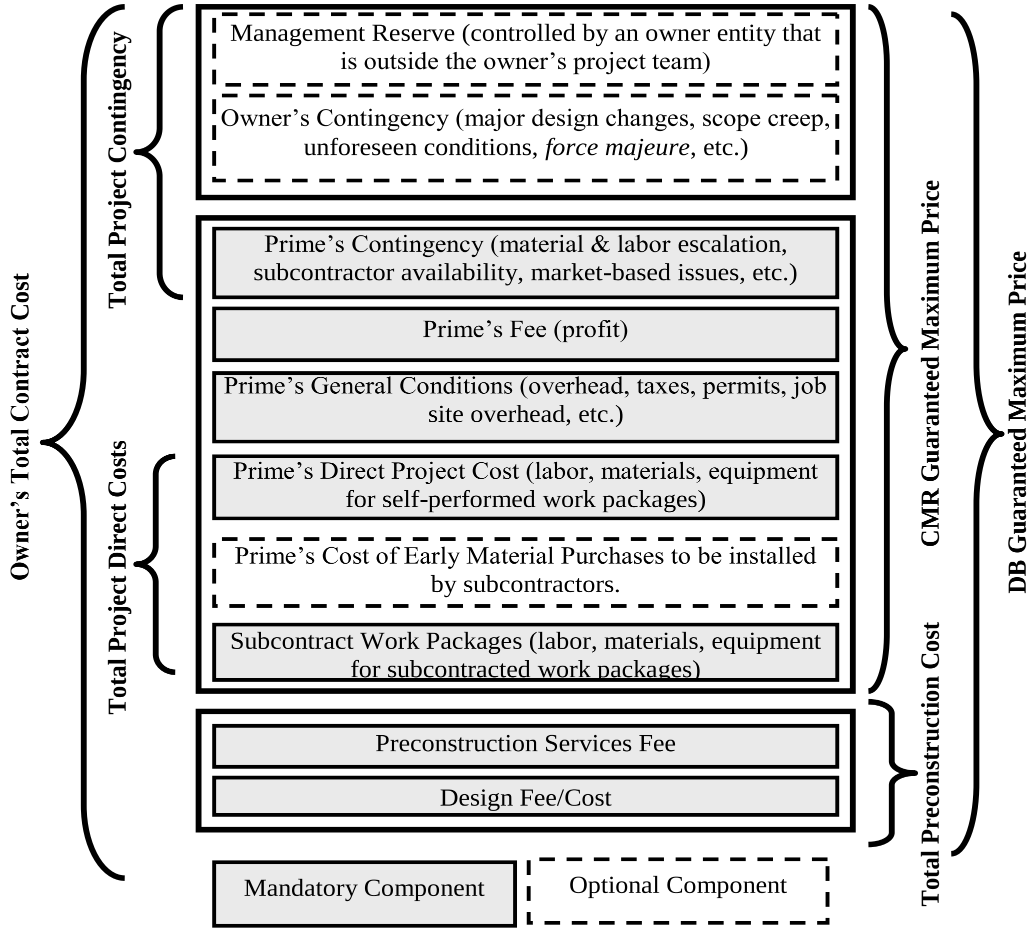
A third situation where a management reserve would be helpful is a project where construction has started without a full suite of permits. If one of the permits creates a scope increase or major delay, the management reserve could be established to specifically assign that risk to the owner. In fact, its magnitude may be able to be estimated based on an analysis of possible outcomes from the permit review [20]. Again, by quantifying the uncertainty and planning to resource it, the prime contractor will not need to inflate its contingency to cover that risk. There may also be some time savings to the owner in terms of the funding and contracting process by having a "preapproved" source of funding for a possible but not probable scope change.

VI. Proposed GMP Framework

Based on the above discussion, the components of a GMP can be identified and structured into a model that can be used to explain the rationale that stands behind a GMP payment provision. Figure 1 graphically illustrates the possible components of an integrated project delivery GMP based on those found in the case study projects. The figure is meant to be inclusive, not restrictive. So, some of specific elements shown in the figure are not present in every GMP contract. However, those common to most transportation project GMPs are identified in the figure and text.

The elements that are shown in Figure 1 can be used as the foundation for a specific project's cost model. Modeling the costs in the context of the available budget before making fundamental design decisions is imperative to the success of projects delivered using a GMP [11]. The project-specific cost model can then be used to validate the owner's project budget at a point where design effort is not lost and where the constructor can furnish up-to-date market within the project's available funding [11].

FIGURE I
Integrated Transportation Project Delivery Guaranteed Maximum Price Framework



information that will help achieve the project's function within the project's available funding [11].

A. Project Direct Costs

As previously stated, project direct costs, while the largest piece of the GMP, are the least controversial. The major issue found in the study was the lack of owners' definition for the costs that will be accounted for as direct versus those that will be accounted for in a different category. This issue is easily resolved by the owner including these definitions in the projects solicitation documents [3].

Developing the direct cost portion of a GMP for the integrated delivery of a transportation project is highly dependent on the level of design development that has been completed at the time the GMP is established. Since the amount of engineering data available at the early stage is limited, Harbuck [9] describes the use of a "design allowance" to "account for the level of design information that is available at this stage of project development." The allowance is not expressed in dollars. It is added to the quantities to cover the inevitable scoop creep during design. It may also be used to account for unforeseen items of work that develop as the project progresses through the various stages of design.

Ripley [15] uses the same concept but calls it a "material take-off (MTO) allowance." Ripley states that it is the engineer's responsibility to ensure that the cost estimate is based on the final as-designed quantities and that he believes the use of a MTO allowance furnishes this ability at a very early stage of design development. The point here is that the design allowance is not contained in the contingency. It is a tool to account for the impact to final quantities of the iterative design process and a means of estimating the final quantities.

B. Prime's General Conditions Costs

The primary issue with general conditions/overhead costs is determining what types of costs an agency is allowed to reimburse. The federal model allows general conditions/overhead costs to be reimbursed if they are "allowable, allocable and reasonable" [22]. The definitions for these three terms are as follows:

- Allowable: "a normal cost that a firm would incur in the normal operation of that type of business."
- Allocable: "a cost that would be normally charged for the service to be received and benefits the contract."
- Reasonable: "a cost that does not exceed that which would be incurred by a prudent person in the conduct of competitive business."

The important factor here is to ensure that competing firms are aware of exactly what can and cannot be included in this portion of the GMP. Again, defining these costs in the project solicitation is one technique to communicate those facts to the construction community and avoid controversy after award.

C. Prime's Fee/Profit

This portion of the GMP is not to be confused with the fee paid for preconstruction services. This is the profit that the prime contractor will earn by successfully delivering the project. Fee is a function of both cost and risk and a business is entitled to a profit on all its costs [23]. A simple way to avoid having to negotiate the fees is to make it a part of the selection process and set the fees upon award. Eight of the case studies established the construction fee in some manner before the contract was awarded. A typical transportation contract clause for converting the fee to a fixed cost at construction contract award was found in the content analysis and is as follows:

> At such time the GMP construction contract is executed, the Contractor's Fee shall be converted from a percentage expression to a stipulated sum amount within the GMP. This fee will not be subject to reduction if the Cost of the Work can be reduced through the efforts of the design/construction team via design refinement or procurement efforts. Abandonment or significant reduction in the scope or magnitude of the project will result in a negotiated reduction of the fee. Conversely, the fee shall not be increased for changes in scope which can be absorbed by the Contingency amount. The fee is only subject to increase should a significant additive scope change occur which would necessitate a change order to the GMP [7].

Two case study agencies (Michigan and Oregon) published a fixed rate in the solicitation documents. Additionally, two of the interviewed contractors had completed projects with non-case study agencies that fix the maximum amount of fee in the same manner and indicated that they had no issues with the practice. One contractor stated that it took one element of uncertainty out of the project. That being how much fee the owner will consider fair and reasonable. In other words, to fix the rate forces the construction industry to make a "bid-no bid" decision. As a result, the agency will know that those that do propose are willing to accept that profit level and the issue is no longer open to negotiation. Four other case study agencies require that the construction fee be proposed and evaluated in the selection process. The Utah DOT does not include a profit factor in their unit price GMP contracts. They expect the CMR to roll this into the unit prices that it furnishes. It also requires competing CMRs to propose unit prices for four to five major pay items as part of the selection process.

VII. Progressive GMPs

The case study analysis found that nine of twelve agencies required the GMP before 100% design. However, of those, five waited until subcontractor bids were received on the major packages in the job, and four allowed the CMR to set the timing based on its assessment of the risk of quantity growth in those packages that were not complete. The other agencies set the timing contractually. The content analysis found that there are number of different GMP timing clauses and these create a range in possible application options. Design detail drives the amount of contingency that is contained in the GMP. Some agencies, like the Utah DOT, use a progressive GMP to keep project contingencies as low as possible. In essence, a progressive GMP is nothing more than breaking the project down into phases or work packages and asking the prime contractor to generate individual GMPs for each phase/package as its design is completed. The final GMP becomes the sum of the individual GMPs plus any remaining project-level contingencies. This allows the design to progress without undue pressure and allows the prime contractor to furnish GMPs on phase design packages as soon as they are ready. "Practitioners have recommended that the GMP is more accurate when certain design elements are completed to 100 percent, rather than having all design elements partially completed, allowing the CM to lock in subcontractors and reduce the estimation involved in developing the GMP" [21]. The five of the case study agencies (UDOT, City of Glendale, Pinal County, San Jose Airport and Tampa Airport) used progressive GMPs. The interviews with these agencies and their contractors confirmed that this was a key feature in controlling costs on DB and CMR projects. Given the success of these cases, the use of a progressive GMP seems to be very attractive. This leads to the conclusion that agencies planning to use DB-GMP or CMR seriously consider incorporating a progressive GMP into their procurement package.

VIII. Conclusions

Integrated delivery using GMP contracts is not new to the building sector, but the transportation sector is just beginning to explore this alternative, as shown by the limited literature available describing the components of a transportation GMP. This paper presents a framework that can be used as a structure upon which to build a GMP for a given transportation project and discusses the contingency type presented in the framework. Practitioners can utilize the framework to standardize the components of the GMP and to clearly articulate the manner in which it will be formed on a given project in their solicitation documents. This will add an element of consistency to the procurement process that will make it easier for industry to understand and evaluate a given transportation project's contract payment provisions.

It appears that QBS procurement method lends itself well to integrated delivery when coupled with GMP pricing provisions. This is seen through the fact that many of the projects investigated were awarded using QBS and even when price was considered in the selection decision, eighteen of nineteen cases, price constituted less than 25% of the overall weight in the award formula.

Many transportation agencies used progressive GMPs to effectively control escalation risk by bidding out early work packages. In fact, highly experienced agencies with a GMP contract payment provision such as the Utah DOT and The Memphis Airport use this technique on all their projects where material price volatility is an issue.

The direct cost portions of the GMP are assumed by the case study owners to be relatively constant between competing contractors. This is confirmed by four literature citations that cite the ability to competitively bid the subcontractor and material supplier work packages as an advantage of integrated delivery with GMP.

The sizes of the contingencies contained in the GMP are directly related to the amount of design completed at the time the GMP is set. Therefore, a progressive GMP can be used to reduce these contingencies on projects with tight budgets.

Defining and describing the accounting process with which costs will be classified in the project solicitation reduces potential confusion. The framework described in Figure 1 can be used to structure the definitions and cost accounting categories.

REFERENCES

[1] R. Alder, "UDOT Construction Manager General Contract (CMGC) Annual Report", Utah Department of Transportation Project Development Group, Engineering Services and Bridge Design Section, Salt Lake City Utah, pp. 4-39, 2007.

[2] W. Bearup, M. Kenig, J. O'Donnell, "Alternative Delivery Methods, a Primer", Proceedings, Airport Board Members and Commissioners Annual Conference, Airports Council International - North America, Chicago, IL, pp. 78-82, 2007.

[3] Construction Management Association of America (CMAA), "Construction Delivery Approaches", 2007, http://www2.mvr.usace.army.mil/WaterControl/Districts/MVR/SAME/construction/ConstructionDeliveryApproaches.pdf [May 21, 2009].

[4] Department of Energy (DOE), "Cost Estimating Guide", DOE G 430.1-1, Department of Energy, Washington, D.C., pp.11.1, 1997.

[5] D. Doren, M. Bridgers, M. Napier, " FMI/CMAA Sixth Annual Survey of Owners," Construction Management Association of America, 2005, http://cmaanet.org/user_images/owners_survey_6.pdf [November 16, 2008].

[6] General Accounting Office (GAO), "Using Structured Interviewing Techniques", GAO/PEMD-10.1.5, General Accounting Office, Washington, D.C., pp. 191, 1991.

[7] Grand County, Colorado, "CM/GC Fee Structure Sample", Grand County, Colorado, pp. 1-3, 2007, http://co.grand.co.us/GM-GC/Fees_&_Agreements_Updated_4-6-07/CMGC_Sample_Fee_Structure_Grand_County.pdf [May 19 2009].

[8] D.D. Gransberg, J.S. Shane, "Construction Manager-at-Risk Project Delivery for Highway Programs", National Cooperative Highway Research Programs (NCHRP) Synthesis Report 402, Washington, D.C, pp. 139, 2009.

[9] R.H. Harbuck, "Using Models in Parametric Estimating for Transportation Projects" 2002 AACE International Transactions, Portland, Oregon, pp. EST 05.1-05.9, 2002.

[10] Y.H. Kwak, R. Bushey, "Construction Management at Risk: An Innovative Project Delivery Method at Stormwater Treatment Area in the Everglades, Florida," Proceedings, Construction Congress VI Orlando, Florida, pp. 477-482, 2002.

[11] M.J. Ladino, K.A. Reedy, J.E. Carlson, "Alternate Project Delivery in Horizontal Construction," Presentation, Annual Meeting Associated General Contractors of America, Las Vegas, Nevada, pp. 25, 2008.

[12] P.H. Martinez, R.Y.V. MacMurray, "Construction Manager's Responsibilities: Pre-Design, Design and Pre-Construction Phase" American Bar Association, pp. 58, 2007.

[13] E. Minchin, K. Thakkar, R. Ellis, "Miami Intermodal Center-Introducing CM-At-Risk to Transportation Construction", in *Innovative Project Delivery Systems*, ASCE Press, pp. 46-59, 2007.

[14] K.A. Neuendorf, "The Content Analysis Guidebook", Sage Publications, Thousand Oaks, California, pp. 300, 2002.

[15] P.W. Ripley, "Contingency! Who Owns and Manages It?" 2004 AACE International Transactions, Washington, DC, pp. CSC.08.1-CSC.08.4, 2004.

[16] S. Spata, F.A. Kutilek, "Solutions to Managing Construction Cost Escalation Tools, Strategies, and "Selective Scoping" Help Manage Risk," Tradeline, Inc., 2006, http://www.tradelineinc.com/reports/B045DC52-2B3B-B525-8F91436EBCDCEA9B [May 20, 2009].

[17] G. Storm, "New Contracting Experience Guides Fairbanks Airport Project," Pacific Builder and Engineer 2007, http://www.acppubs.com/article/CA6480230.html?industryid=48546 [September 22, 2008]

[18] W. Strang, "The Risk in CM at-Risk", *CM eJournal*, Construction Management Association of America, p. 1-9, 2002.

[19] A. Touran, "Owners Risk Reduction Techniques Using a CM", CMAA Research Report, Construction Management Association of America, Washington, D.C., pp. 55, 2006.

[20] A. Touran, D.D. Gransberg, K.R. Molenaar, K. Ghavamifar, D.J. Mason, L.A. Fithian, "A Guidebook for the Evaluation of Project Delivery Methods", TCRP Report 131, Transportation Research Board, National Academies, Washington, D.C., pp. 240, 2009.

[21] Trauner Consulting Services, "Innovative Procurement Practices Alternative Procurement and Contracting Methods", California Department of Transportation Report No. 53A0104, Sacramento, California, pp. 10-12, 2007.

[22] US Army Corps of Engineers(USACE), "*Engineering Instructions Construction Cost Estimates"*, CEMP-E/CECW-E EI 01D010, US ACE, Washington, D.C., pp. 121, 1997.

[23] H.V. Winkle, "Alternate Project Delivery Systems," Proceedings, 2007 ACI Annual Conference, Airports Council International, Kansas City, Missouri, pp. 7-41, 2007.

[24] M. Whitten, "Cardinal Change", Construction Law Section Seminar Workbook, The Commercial Bar Association, pp. 1-14, April 22, 2004, http://new.vicbar.com.au/pdf/CLE_Seminar22042004.pdf, [May 21, 2009].

[25] R.K. Yin, "Case Study Research: Design and Methods", Sage Publications Beverly Hills, California, pp. 289, 1994.