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The use of Alternative Contracting Methods (ACM) to deliver US transportation projects has reached a point where a definitive set of best practices can be identified to leverage the lessons learned by early ACM adopters. The most pressing need is for guidance on how public agencies organize to implement ACMs in a budget-constrained environment where the possibility of increasing the number of public agency engineers is nil. This paper is based on mining the survey response data from 6 National Cooperative Highway Research Program (NCHRP) synthesis reports on ACM topics and proposes a framework for analyzing ACM practices deemed effective by peer-reviewed research to determine if each practice can be classified as a best practice. Importance index theory provides the analytical foundation for the framework and provides a ranking of candidate best practices in order of each practice's importance and effectiveness. Nine effective ACM practices were identified and evaluated with only one, "appointing an agency ACM champion," meeting the objective criteria for a best practice. The paper's major contribution is to provide the suite of 1 best and 8 effective practices that can be employed when developing the organization for an agency that has decided to implement ACM project delivery.

Keywords
Alternative contracting methods, best practices, organizational structure, index number theory

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Conference Paper

Organizational Best Practices for Transportation Projects Delivered Using Alternative Contracting Methods

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Abstract

The use of Alternative Contracting Methods (ACM) to deliver US transportation projects has reached a point where a definitive set of best practices can be identified to leverage the lessons learned by early ACM adopters. The most pressing need is for guidance on how public agencies organize to implement ACMs in a budget-constrained environment where the possibility of increasing the number of public agency engineers is nil. This paper is based on mining the survey response data from 6 National Cooperative Highway Research Program (NCHRP) synthesis reports on ACM topics and proposes a framework for analyzing ACM practices deemed effective by peer-reviewed research to determine if each practice can be classified as a best practice. Importance index theory provides the analytical foundation for the framework and provides a ranking of candidate best practices in order of each practice's importance and effectiveness. Nine effective ACM practices were identified and evaluated with only one, "appointing an agency ACM champion," meeting the objective criteria for a best practice. The paper's major contribution is to provide the suite of 1 best and 8 effective practices that can be employed when developing the organization for an agency that has decided to implement ACM project delivery.

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1. Introduction

"Issues in statewide transportation planning have become more complex and the tools to analyze these issues require greater and more varied technical competencies. At the same time, most state departments of transportation have decreased staff sizes and many experienced professionals have retired" (Pederson 1999). Nearly two decades later, the internal staffing issue with US state departments of transportation (DOT) has

not changed (Torres et al. 2015). To add fuel to the fire, the US transportation network is deteriorating at a pace that made rapidly renewing it the top issue in the 2016 US presidential campaign (Dodson, 2017). In 2010, the Federal Highway Administration (FHWA) launched its *Every Day Counts* (EDC) initiative, which included incentives for DOTs to increase their use of alternative contracting methods (ACM) such as construction manager/general contractor (CMGC), design-build (DB) and alternative technical concepts (ATC) as a mechanism to accelerate the rehabilitation of the nation's highways. The change in presidential administration increased the momentum by introducing programs that seek to attract private capital to public works called public private partnerships (P3). The result is the perfect storm for massively increasing the workload of public agencies whose strength has remained capped by legislative mandate since the "reinventing government" movement of the late 1990's (Warne 2003). All of this leads to a need to organize those precious few public engineers in a manner that permits them to deliver future infrastructure projects using ACMs in a highly efficient and effective manner. Thus, the objective of this paper is to evaluate organizational staffing practices that have been found to be effective in past ACM research and identify those that qualify as best practices for organizing DOT human resources to deliver ACM projects.

1.1. Brief Review of Alternative Contracting Methods

A project delivery method (PDM) is defined as "the comprehensive process of assigning the contractual responsibilities for designing and constructing a project…a delivery method identifies the primary parties taking contractual responsibility for the performance of the work" AGC (2004). Individual PDMs are further defined by their specific contractual structure, as well as each party's assigned roles and responsibilities. This paper will address the four major PDMs used on highway projects: Design-Bid-Build (DBB), DB, CMGC (also termed Construction Manager-at-Risk or CMAR) and P3.

1.1.1. Design-Bid-Build

Public transportation projects are usually procured using the design-bid-build (DBB) delivery method. In DBB, the owner produces a final design with either in-house or consultant design resources in the form of a set of "biddable" construction documents, which are then offered for bid to construction contractors by issuing an Invitation for Bids (IFB). The winning contractor is typically the lowest, "responsive" and in some

cases, "responsible" bid. In DBB, there is no contract privity between designer and contractor. DBB with a low bid award is considered the "traditional" PDM. The research literature contains many evaluations of DBB and its shortcomings, such as no possibility for contractor involvement in the design phase (Schierholz et al. 2012; Gambatese et al. 2002), a linear delivery schedule that drive longer durations (Venturato and Schroeder 2007), inherent adversarial relationships that lead to litigation, and a higher average cost growth than projects delivered using alternative PDMs (FHWA 2006). Nevertheless, a California study found that states using alternative PDMs continued to deliver the bulk of their annual construction budget (>95%) using DBB (Gransberg and Molenaar 2008).

1.1.2. Construction Manager/General Contractor

CMGC projects involve a two-part contract between an owner and a construction contractor that is at risk for the project's cost and schedule. In CMGC, the owner authorizes the construction manager to contribute ideas during project design. The design effort will be satisfied by either in-house design personnel or out-sourced to a design consultant. Generally, the contractor is chosen on a best-value basis. CMGC project delivery involves two contracts. The first is for preconstruction services during design and the second is for the construction itself.

CMGC project contract pricing structures vary as required by the owner's needs for given project. A typical pricing provision asks the CMGC contractor to stipulate a target price above which the owner is not liable for payment if the project's scope does not change after the target price is established. Another applies when the owner chooses to incentivize the contract. Termed a guaranteed maximum price (GMP) pricing provision, the owner and contractor split the savings if the final project price is less than the GMP. Other options include a standard lump sum or unit price contract pricing provision that relies on the CMGC contractor to furnish real-time pricing information during preconstruction to keep the project's as-designed cost below the owner's authorized budget.

1.1.3. Design-Build

DB is a project delivery method where both design and construction services are procured in a single contract from a legal entity referred to as the design-builder. Songer and Molenaar (1996) found that the public owners chose DB to accelerate project

schedules. A later FHWA study found that DOT's chose DB for the following reasons: "The greatest motivation and realized benefit to a contracting agency of using design-build ...is the ability to reduce the overall duration of the project development process by eliminating a second procurement process for the construction contract, reducing the potential for design errors and omissions, and allowing for more concurrent processing of design and construction activities..." (FHWA 2006).

1.1.4. Public Private Partnerships

The inclusions of private financing to the project distinguishes P3 project delivery from other PDMs. Additionally, P3 projects typically include long-term post-construction operation and maintenance periods. This change also drives a significant public procurement culture shift. In other PDMs, project funding springs from public sources, which then presses a fiduciary responsibility upon the agency to conduct due diligence and guarantee Value for Money (VfM) in the completed project. With P3, the question of where the public agency's VfM responsibility shifts to P3 concessionaire is germane. For projects on the national highway system, the DOT still has a duty to ensure that the final constructed product meets all standards and, in theory at least, should the concessionaire default, the facility's operation and maintenance can be taken up by the agency without a need to make significant structural modifications to bring it up to standards (Loulakis et al. 2015). On the other hand, if the concessionaire is bound to provide post-construction operations and/or maintenance, then it is reasonable to presume that the need to strictly adhere to DOT standard design details and specifications has been removed.

1.2. Brief Review of Organizational Structure Practices for Implementing ACMs

US DOTs have successfully employed a variety of organizational structures to deliver ACM projects. A recent study (CASE, 2016) found a variety of centralized and decentralized project development and execution and the use of outsourced project development and program management. The ACM organizational structure is a function of the given DOT's current organizational structure, amount of ACM projects per year, and the DOT's experience using ACMs. DOT organizational structures were found to evolve as ACM experience is gained. The CASE study (2016) also found that "...independent of the organizational structure, two critical common elements needed are having an ACM

champion and staff trained that are familiar with ACMs." Characteristics of effective ACM structures were found to include the ACM champion, staff familiarity with ACMs, and a culture of adaptability and flexibility, perhaps the most difficult attribute to attain. Instilling such culture requires an investment in training and internal organizational communications. Project managers require appropriate skills to be able to assume the responsibilities specific to the type of ACM used. DOTs vary in the size of the staff assigned to ACMs; most augment internal staff with consultants. The CASE study neatly summarized the ACM staffing challenge by stating: "regardless of the size of the ACM program, it is important to build a team with members having diverse backgrounds and an attitude of innovative problem solving" (CASE, 2016).

1.3. Best Practices Semantics

The definition of "best practice" is a thorny semantic issue, which when used is often followed by the rejoinder "according to whom?" There are many definitions in the literature. Michaelson and Stacks' (2011) definition consists of two objective criteria, and allow one to identify a best practice from a practice that a given author believes is merely sound: "A method or technique that has *consistently* shown *results superior* to those achieved with other means, and that is used as *a benchmark*." The terms "superior to other means" and "used as a benchmark" provide a way to differentiate a best practice from all others when conducting document content analysis. As expected, for a given practice to be both consistently superior and a benchmark is a high standard that will be difficult to attain, making it an appropriate standard for purposes of this paper.

Because of issues regarding the term "best practice," many authors have adopted the term "effective practice" to identify practices found in the research literature that were observed and documented as commonly used. Accardo (2015) proposes an appropriate definition for effective practices: "Research-based practices identified through high quality quantitative study, but not yet meeting the strict criteria needed to become a benchmark." When compared to the previously cited best practice definition, both definitions use an objective criterion, "benchmark" to differentiate between "effective" and "best," as well as the requirement that the practice be "identified through high quality quantitative study" to qualify as "effective." As such, this paper will first identify practices as effective if they are validated as actually in use based on DOT survey and documentation information. From that population, each effective practice will be analyzed to determine if it qualifies as a best practice.

2. Methodology

The study methodology provides a rigorous means to differentiate between ACM practices that are observed, those that qualify as effective practices, and those that deserve to be classified as best using the above definitions. The research relied on textual content analysis of material found in the academic literature and of material found in state DOT ACM policy/procedure documents. "Researchers regard content analysis as a flexible method for analyzing text data" (Hsieh and Shannon, 2005). Content analysis results in a base on which frequency of occurrence measurements can be made on ACM practices. It also permits the analyst to evaluate the context in which a given practice is discussed. Neuendorf (2002) maintains that content analysis results in "valid inferences from a message, written or visual, using a set of procedures." The protocol is founded on topic groupings into which words observed in the ACM document's text can be categorized. After which, the frequency of each word's appearance becomes the output used "to infer the content of the document" (Weber, 1990).

2.1. Content Analysis

This study conducted its content analysis in three stages. First, the researchers collected a set of ACM effective practices that were identified in six NCHRP Syntheses. NCHRP requires the authors of syntheses to identify commonly observed practices that were reported to be effective based on a survey of all state DOTs (TRB 2011). Syntheses also include comprehensive literature reviews. The analysis yielded 24 candidate practices, based on the combined surveys of state DOTs. The synthesis reports represent a summary of the national experience for each ACM topic. Next, the candidate ACM practices were then separated into those that applied to organizational structure issues and those that dealt with other aspects of ACM delivery. Each organizational structure practice was then evaluated to determine if it qualified as an effective practice per the previously cited definition by Accardo (2015). The last stage was to impose an additional condition to the definition for purposes of this study. The condition was that the practice had to have been observed as used by more than a single state DOT based on the six NCHRP Syntheses survey results. The condition was imposed to eliminate the possibility of identifying those practices that only apply to a single agency because of its unique statutory constraints. Nine candidate practices remained upon which the subsequent analysis was applied. The total population of 24 candidate

practices was also evaluated to provide a comparison of the organizational practices importance rankings within the overall ACM program.

2.2. Importance Index Theory Analysis

Once the final list of candidate organizational structure practices was identified, they were ranked using a rubric termed the "Importance Index" (II) (Assaf and Al-Hejji, 2006). The II is a combination of the frequency at which a specific practice was observed in the content analysis of the literature and its influence measured by the number of state DOTs that have adopted the practice. As such, the II holds that practices that are used frequently and are of high influence are more important that low frequency, low influence practices. This permits an objective ranking of effective practices that can be used to infer the relative importance of adopting a given practice. The II is computed by first calculating a Frequency Index (FI) and an Adoption Index (AI) based on Equations 1 and 2, which become input to the II calculation (Equation 3):

$$Frequency\ Index\ (FI)\ (\%) = \sum (n/\ N)^{*}100/T_n \quad (1)$$

Where: n =Number of observations of a practice in a specific category

N =Total observations of all practices in a specific category

T_n = Total observations of all practices in all categories

$$Adoption\ Index\ (AI)\ (\%) = \sum (d/\ D)^{*}100/T_d \quad (2)$$

Where: d =Number of DOTs using a practice in a specific category

D =Total DOTs using all practices in a specific category

T_d = Total DOTs using all practices in all categories

$$Importance\ Index\ (II)\ (\%) = (FI\ ^{*}AI) \quad (3)$$

The result is a list of ranked candidate practices within the organizational structure category. To test the criterion proposed by Accardo (2015) regarding "high quality quantitative study," a Research Index (RI) and a Verification Index (VI) are proposed using Equations 4 and 5 based on the Assaf and Al-Hejji's (2006) II theory.

$$Research\ Index\ (RI)\ (\%) = \sum (c/\ C)^{*}100/T_c \quad (4)$$

Where: c =Number of literature citations reporting a practice in a specific category

C =Total literature citations using all practices in a specific category

T_c = Total literature citations using all practices in all categories

$$Verification\ Index\ (VI)\ (\%) = (RI^{*}II) \quad (5)$$

3. Results Of The Analysis

The six surveys administered received responses from every state DOT except Connecticut and Wyoming, plus the District of Columbia, Puerto Rico, and American Samoa. Table 1 shows the survey results by source. Table 2 shows the candidate practices and synthesis, literature, and policy document data.

Table 1: Survey Result Sources.

NCHRP Synthesis Survey	Year	ACMs in Survey	DOT Survey Responses	DOTs Using ACM
376: Quality Assurance in Design-Build Projects	2008	DB	47	31
402: Construction Manager-at-Risk Project Delivery for Highway Programs	2010	CMR, CMGC, DB, P3	47	11
429: Geotechnical Information Practices in Design-Build Projects	2012	DB, P3, CMGC, ATC	42	35
438: Expedited Procurement Procedures for Emergency Construction Services,	2012	DB, CMGC, ATC	42	25
455: Alternative Technical Concepts for Contract Delivery Methods	2014	DB, CMGC, P3, ATC	41	24
473: Indefinite Delivery/Indefinite Quantity Contracting Practices	2015	DB, CMGC, IDIQ	43	37

Table 3 contains a summary of the ranking analysis described in the methodology, as well as a composite rank for the organizational practices within the overall population, which is merely the mathematical average of the four index numbers for each practice.

4. Discussion of the Analysis

Table 2 validates all nine organizational practices as having met the test to be classified as effective. Table 3 provides the output for determining which if any meet the above described definition as a best practice. The highest ranked organizational practice was "appoint an ACM champion," which was observed in 15 DOT survey responses, 7 research studies, and 12 DOT documents. The practice relates to the two other practices regarding centralized project development. The literature shows that champion is typically in charge of the central project development process (CASE 2016). Additionally, research found that assigning a single individual the responsibility to lead the DOT's ACM program creates consistency and permits lessons learned across the agency to be applied to all its ACM projects (Gad et al 2015). Lastly, a survey recently

Table 2: Candidate Practices and Synthesis, Literature, and Policy Document Data.

Organizational Effective Practices			
A = No. of DOTs in Synthesis survey using practice; B = No. literature citations on practice; C = No. of DOT ACM Policy/Procedure Documents that include practice.	A	B	C
Appoint a champion for alternative contracting practices.	15	7	12
Centralized ACM project development and execution	5	4	5
Centralized ACM project development and decentralized execution.	9	5	9
Decentralized ACM project development and execution	10	5	4
Outsource ACM project document development and/or program management	12	4	12
Provide formal ACM training for DOT staff	8	5	10
Provide formal ACM training for design and construction industry partners	3	4	7
Establish quantitative performance measures	11	4	7
Formal industry outreach during development of ACM policy and procedures	13	2	7

Table 3: Results of Effective Practice Ranking Analysis

Candidate Effective Organizational Practices	Category Rank		Overall Rank		Rank
Index	II	VI	II	VI	Composite
Appoint a champion for alternative contracting practices.	1	1	5	4	2.75
Outsource ACM project document development/program management	5	4	6	7	5.5
Centralized ACM project development - decentralized execution.	3	7	10	12	8
Provide formal ACM training for DOT staff	6	5	11	13	8.75
Decentralized ACM project development and execution	4	3	16	15	9.5
Centralized ACM project development and execution	2	2	18	18	10
Establish quantitative performance measures	8	8	12	14	10.5
Formal industry outreach during development of ACM policy/procedures	9	9	9	16	10.75
Provide formal ACM training for private industry partners	7	6	19	19	12.75

conducted for NCHRP Synthesis 48-04: *Staffing for ACMs*, (unpublished) found that 38 of 47 DOTs have a designated ACM champion, which validates the practice as a national benchmark and qualifies it a best practice.

Outsourcing ACM documentation/program management is the second ranked effective practice. However, it probably does not qualify as a national benchmark because it is normally a reaction to spikes in DOT workload rather than a fundamental business practice. It is difficult to justify recommending that all DOTs outsource these two activities when experience has shown that internal staff are perfectly competent to satisfactorily complete these tasks without external assistance. Much of the same logic can be used to not classify the remaining effective practices as best.

5. Conclusions and Limitations

This paper has shown that implementing ACMs brings along a need to alter the typical DOT organizational structure. Nine practices reported in the literature were proven to be effective using an extended variant of II theory and one, appointing and ACM champion, was judged to be properly classified as a best practice based the definition that it was proven by rigorous quantitative research and qualified as a national benchmark. The conclusions can only be generalized to US DOTs and will require further research to extend these findings to other public agencies. Additionally, the reader must recognize that implementing most of the practices is subject to the specific statutory and political constraints that exist in the geographical area in which they will be used. This paper's contribution to the ACM body of knowledge reside primarily in the identification of the 9 effective practices. The extension of II theory to this particular topic and the derivation of the research, verification, and composite indexes represent contributions to the field of research methods and content analysis.

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