# Analysis of Existing Project Delivery and Contracting Strategy (PDCS) Selection Tools with a Look Towards Emerging Technology

**Pardis B. Pishdad, Ph.D. Candidate and Yvan J. Beliveau, Ph.D., PE.**
Virginia Polytechnic Institute and State University
Blacksburg, Virginia

This paper presents the results of literature-based research and gap analysis performed on the existing Project Delivery Contracting Strategy (PDCS) selection tools and outlines the areas in need for future research. Through a combinatorial approach, the scattered and resounding information from the literature is aggregated, categorized, and put into a framework structure. Given the current state of art and future direction of the industry, the framework is then analyzed to determine its thoroughness with respect to its elements, their alternatives, and the selection factors affecting the choice of the PDCS for a particular project. The gap analysis indicates that the three emerging areas of green, integrated information, and life cycle cost considerations are not fully developed within the existing PDCS selection tools. Future study is needed to investigate the impacts of these emerging areas on the choices of PDCS elements. Furthermore, the existing selection tools are mainly developed around the 'macro pieces' of the PDCS tools such as organizational structure, contract type, and selection method. However, there are 'micro' pieces to the PDCS tools as well. Future research is needed to incorporate the micro elements such as task assignment, risk allocation/mitigation, contractual reinforcement, and process management into the PDCS selection tools.

**Keywords:** Project Delivery, Contracting Strategy, Decision Support Tool, Pre-Project Planning, Integrated Information

## Introduction

Owners who need to embark on a construction project need to make an important decision on the project delivery of choice. According to Oyetunji & Anderson, "The decision made in the selection of a project delivery system for a project impacts all phases of execution of the project and greatly impacts the efficiency of project execution"(Oyetunji & Anderson, 2006, p. 3). Often an owner chooses a particular project delivery method because of history, momentum, and hard-headedness. That means that they usually tend to choose a PDCS method because they are used to it and not because of its appropriateness and suitability with the project condition. For this reason various PDCS selection tools have been developed by researchers to address this issue. These tools serve as the decision support tools for owners. They include selections factors, PDCS elements, their alternatives, and an evaluation matrix which correlate the selection factors with the appropriate project delivery method and contracting strategy. Different PDCS selection tools have been developed; each selection tool adds new elements and advances pre-existing tools to another level of sophistication.

The history of project delivery evolution indicates the fast-paced nature of project delivery changes especially in the last few decades. There are lots of reasons for this; the rapid development of the information technology world produces new technologies, means, and tools which at the same time requires new cultures and procedures to effectively and efficiently utilize these advancing technologies. People are getting more sophisticated, and their demands are growing. Consequently, the project requirements and the success criteria are evolving. It is critical to

continually visit the changes of these new tools, cultures, procedures and demands and to develop a PDCS that would embrace these changes.

Project delivery and contracting strategies need to be redeveloped continuously in order to successfully satisfy emerging expectations and to utilize cutting edge technological tools and procedures in implementing the project. Existing selection tools need to reflect current project objectives, selection factors, tools for implementing the project and new project delivery choices.

## *Literature Review*

The purpose of this research is to study and analyze the existing PDCS literature in order to identify existing gaps within the field. This study will provide a future direction for research that improves the existing PDCS selection tools, benefiting the owners.

### *Project Delivery Definition*

Project delivery has been defined in various statements throughout literature. As Kenig (2007) argued "there is no consensus on generally accepted definition of [the] term 'delivery method'." The old definition of project delivery describes it as "how a project will be planned, designed, and built". The more current definition, however, is more thorough and includes the operation and maintenance as well. Different research definitions on the project delivery method indicate its various attributes. Some definitions are more comprehensive while some are more focused around a specific attribute of project delivery method. The following are a few selected definitions taken from the existing literature and categorized under defining characteristics:

- Management process: "A system for organizing and financing design, construction, operation and maintenance activities that facilitate the delivery of goods or services" (Miller, Garvin, William Ibbs, & Mahoney, 2000, p. 59).
- Procurement and risk allocation strategy: "A method for procurement by which the owner's assignment of "delivery" risk & performance for design & construction has been transferred to another party (parties)" (Mahdi & Alreshaid, 2005, p. 564).
- Packaging & sequencing: The way design, procurement, construction tasks are packaged for execution (Bowers, Bhargava, & Anderson, 2003) & (Al Khalil, 2002) & (Oyetunji & Anderson, 2006) & (The Construction Industry Institute Project Delivery and Contract Strategy Research Team, 2001)
- Team building strategy: Type of services that the Owners retain for the execution of the tasks, (Bowers, et al., 2003) how project teams form**,** project team procurement, project team working relationship & levels of involvement, (Korkmaz, Horman, & Riley, 2009) & (Mahdi & Alreshaid, 2005) & (Bowers, et al., 2003) parties that are directly contracted with the owner to form the project team/organizational structure, (The Construction Industry Institute Project Delivery and Contract Strategy Research Team, 2001) incentive to encourage contribution (Korkmaz, et al., 2009)
- Roles & responsibilities: Means of contractually communicating expectation and basis of reimbursement, (Kenig, 2007) roles & responsibilities of parties involved (Oyetunji & Anderson, 2006) & (The Construction Industry Institute Project Delivery and Contract Strategy Research Team, 2001)
- Financing Strategy: Owner financing vs. third party financing (Bowers, et al., 2003)

From these past definitions and thoughts, this research defines project delivery method as follows:
Procurement approach, financing strategy and a management system developed for accomplishing the project's objectives and tasks in order to deliver a project that is successful throughout its life cycle from concept to implementation, operation and maintenance.

### *Contracting Strategy Definition*

The terms "Project delivery" and "contracting strategy" are often used together. In fact contracting strategy is a supporting mean for successful implementation of project delivery approach. Following are a few selected contracting strategy definitions from the existing literature:

- How the owners pay for the services rendered by service providers; compensation approach for each contractual relationship (Bowers, et al., 2003)
- Means of contractually communicating expectation and basis of reimbursement (Kenig, 2007)
- Allocation of the financial risks between the owner and the service providers (Bowers, et al., 2003)
- Incentive to encourage contribution (Korkmaz, et al., 2009)

This research defines contracting strategy as follows:
Contracting strategy describes the roles and responsibilities of the contracting parties; it determines the risk allocation strategies, methods of payment, basis for reimbursement, and incentive strategies for encouraging enhanced contribution.

## *Project Delivery and Contracting Strategy (PDCS) Development*

Most owners lack sophistication to understand different aspects of project delivery and contracting strategy. They usually prefer to use the project delivery system they know well or have used in their previous projects regardless of the fact that project delivery systems are not one size fits all. Each project has its own special characteristics with different entities involved; consequently, different project delivery and contracting strategies should be studied to offer viable delivery method for each type of project/owner. As Rubin and Worders argued, owners need to understand that different project delivery systems organize the building process differently, and each system allocates risk differently (Rubin & Wordes, 1997).

Gordon is among the initial contributors who offer a fundamental and viable approach for PDCS development. In the "Choosing Appropriate Construction Contracting Method" article developed by Gordon, he argues that, "the construction contracting method is defined as having four parts- scope, organization, contract, and award. An owner must choose a particular organization, contract, and award for each project and combine them into the desired and appropriate contracting method for that project" (Gordon, 1994, pp. 196-197).

## *Existing Literature on PDCS Selection Approaches*

According to *A Guidebook for the Evaluation of Project Delivery Methods*, "The relevant literature [on PDCS] can be divided into two groups: (1) literature that compares project delivery methods on the basis of observed performance measurements collected from a group of projects and (2) literature that provides a list of criteria and a framework for decision making. One of the best examples of the first kind of literature is a paper by Konchar and Sanvido (1998) in which a set of criteria is defined for a performance comparison of different delivery methods (i.e., DB, DBB, and CMR) in 351 building projects. These criteria are mostly objective and measurable such as cost growth, construction speed, and schedule growth. Some criteria are also defined to incorporate the quality performance of the delivery methods, such as difficulty of facility start up, number and magnitude of call backs, and operation and maintenance cost. Konchar and Sanvido (1998) divided the projects into six different groups (e.g., light industrial, complex office, and heavy industrial) in order to see clearer trends in each group" (Touran, et al., 2009, p. 16). The existing literatures on the second group present a variety of selection tools for owners. Following are some examples of the second type literature that provide a list of criteria and a framework for decision making.

Bowers, Bhargava, Anderson develop a framework to characterize eleven PDCS options used in practice and the criteria that led to their selection. Project phasing, team relationship, and compensation methods are the defining elements of the PDCS characteristics. The list of selection factors presented include budget constraints, change management, confidentiality, early cost guarantee, local conditions, owner's control, owner's internal resources, owner's project definition, performance accountability, project location, project size, risk allocation, schedule execution, site conditions, technology, complexity, early procurement. Using a relative index rating (RIR), the project objectives are prioritized. The PDCS option most appropriate for the high priority project objectives is then selected (Bowers, et al., 2003).

Loulakis presents a project delivery evaluation and selection matrix in order to assist owners. Previous research results on comparing different delivery methods like DBB, DB, Multiple prime, and CM are considered in order to rank and prioritize their appropriateness for different selection factors. The selection factors are categorized under three major criteria: project goals, owner characteristics, and marketplace condition (Loulakis, 2005).

Mahdi and Alreshaid examine the compatibility of various project delivery methods with specific types of owners and projects. In this study, the analytical hierarchy process is provided to assist in selecting the proper delivery method for a project. Typical combinations of delivery methods (organizational structures) and procurement selection criteria are presented. Characteristics, advantages and disadvantages of DBB, DB, CMR, and CMA are presented. Selection factors are categorized under owner characteristics, project characteristics, design characteristics, regulatory, contractor characteristics, risks, claims and disputes (Mahdi & Alreshaid, 2005).

Warne and Beard, through the *Project Delivery Systems Owner's Manual* provide valuable information to assist owners in their consideration of project delivery system to use, given the owner's needs and specific project goals. Identifying project goals is defined as the first step in the decision making process. The project goals presented are quality, cost control, design expertise, schedule, specific product or outcome, risk, legal requirements, political direction, safety and security, and sustainability. The five project deliveries (organizational structures) considered are DBB, DB, Design/Contract-Build, CMR, DBO. In addition, selection and procurement/purchasing methods are considered (Warne & Beard, 2005).

Oyetunji and Anderson develop a decision support tool for identifying the optimal delivery solution for capital industrial and general building projects. Their approach utilizes a multi criteria decision analysis known as Simple Multi-Attribute Rating Technique with swing weights (SMARTS) for evaluating project delivery alternatives. The alternatives are the combinations of different organizational structures (DBB, CMR, DB/EPC, Multiple-prime, Turnkey, and Fast track), procurement timing, and management option (PM, CM). The selection criteria presented includes controlling cost growth, ensuring lowest cost, delaying or minimizing expenditure rate, facilitating early cost estimating, reducing/transferring risks to contractors, promoting early procurement, easing change incorporation, capitalizing on expected low levels of changes, protecting confidentiality, capitalizing on familiar project conditions, owner's controlling role, owner's involvement, project scope, number of contracted parties, and efficiently coordinating project complexity or innovation (Oyetunji & Anderson, 2006).

Kenig talks about different components of project delivery and contracting strategy, such as delivery method, management options (CMA, PM, Turnkey), selection method (low bid, best value, qualification), and contract type (firm fixed price, GMP, Cost plus fee, T&M). He presents the characteristics of the delivery methods - DBB, DB, CMR - in terms of their components features and their phasing strategy. He argues that these components and their different alternatives would create various hybrids of delivery contracting methods (Kenig, 2007).

Mafakheri, Dai, Slezak and Nasiri present a decision aid model for selecting an optimal project delivery system using the analytical hierarchy process (AHP) coupled with rough approximation concepts. The model ranks the alternative delivery systems by considering both benchmark results and owner's opinion. Numerous factors are identified as having impact on the selection of a project delivery system (organizational structure). These factors are cost, schedule, quality, complexity, scope change, experience, value engineering, financial guarantee, risk management, uniqueness, external approval, project size, and culture. The project deliveries (organizational structures) evaluated in this research, are DBB, DB, CM/GC, CM/PM (Mafakheri, Dai, Slezak, & Nasiri, 2007).

The NCHRP synthesis presents by Anderson summarizes the PDCS state of practice for highway project that can potentially accelerate project completion. It also identifies driving factors, such as project type, size, complexity, completion date for selecting one type of alternative contracting technique over another. It presents a summary chart that identifies the compatibility of different project deliveries (organizational structures), procurement strategies, and contract management techniques with a list of project objectives, types and selection criteria (Anderson, et al., 2008).

Touran, Gransberg, Molenaar, Ghavamifar, Mason, and Fithian study different project delivery methods (organizational structures) DBB, DB, CMR, DBOM for transit capital projects. They evaluate their advantages and disadvantages in terms of their compatibilities with several criteria; these are mainly categorized under five aspects: project level, agency-level, public policy/regulatory issues, life cycle issues, and other issues. The decision process presented offers three tiers: analytical delivery decision approach, weighted matrix delivery decision approach, and optimal risk-based approach (Touran, et al., 2009).

## Method

As discussed previously, this is a literature-based research with the inclusion of current trends. It reviews the existing literature on PDCS selection tools produced by many authors. The selection factors, project delivery and contracting strategy elements and their alternatives are captured from the literature. Through a combinatorial approach, the captured information is then aggregated, categorized and structured to reflect pattern that is integrated into a framework format. The framework serves as a knowledge map to put background information of the field into perspective. The initial literature-based framework is then analyzed to examine its inclusiveness and thoroughness based on the current state of practice.

## Results

### *PDCS Framework in a Textual Format (Brief Version)*

The captured knowledge from the literature indicates scattered and often resounding information. As it is seen in the literature section, the wealth of information can be overwhelming and confusing, especially as the list grows. In order to understand the wealth of information, a structure for analyzing the existing literature and identifying the existing gaps is developed.

The PDCS tools in general consist of three parts: 1. Independent selection factors, 2. dependant PDCS elements and their alternatives, and 3. a decision support framework. The appropriate alternatives of PDCS elements are selected through a decision support framework. The framework is developed based on the existing knowledge regarding the characteristics of PDCS elements and their compatibility with the selection factors. The decision support frameworks utilized in these tools include variety of means such as series of tables, charts, figures, spreadsheets, and matrices to assist the decision-makers in prioritizing the project objectives, defining the relative importance of selection factors, identifying and ranking the appropriate PDCS alternatives relative to the desired objectives/selection factors, and ultimately selecting the appropriate choice of PDCS.

The existing PDCS selection tools in the literature offer different combinations on independent selection factors and dependent PDCS elements and alternatives. The dependent PDCS elements presented in the existing tools mostly involve macro elements. While the macro elements define the general characteristics and the context of the contract, the micro elements are also needed to address the implementation details required to ensure performance within the desired contract context.

These tools also utilize variety of decision analysis techniques in their decision support tools. The decision analysis techniques utilized in these tools mostly include multi-criteria decision analysis techniques -- such as analytical hierarchy process (AHP), simple multi-attribute rating technique with swing weights (SMARTS), multi attribute utility theory, and other techniques such as geometric mean, preference cones, and outranking method -- relative index rating (RIR), and sensitivity analysis.

To conclude, the current frameworks lack both PDCS micro elements and current trends in the industry. The PDCS framework developed through this research, however, includes both the various PDCS elements in the existing tools as well as the current trends which may not be currently included in these tools. The PDCS framework as presented in this work introduces three major categories of elements: 1. selection factors (independent primary influential factors), 2. PDCS macro elements, and 3. PDCS micro elements. The overall framework runs to several figures and pages. Due to the space constraint, the framework in its entirety is not included here. Instead a textual format with only a summary list of the included elements is presented below.

### ***1.*** *Selection Factors* (*Independent primary influential factors)*

**1.1.** Project characteristics: project type, project size, complexity, uniqueness, location (distance from owner's resources), site condition, technological advancement, scope (well defined/poorly defined), completion rate of construction drawing before construction starts, degree of risk and uncertainty of unknown, potential for changes, building system characteristics, and building green features.

**1.2.** Project objectives: time related, cost related, time value of money, life cycle considerations, product quality (functionality/performance quality, aesthetic, degree of innovation, green, sustainability, energy efficiency), service quality(design/construction/turnover/operation quality, collaboration, team relation, coordination, Integrated information, constructability/ value engineering: early construction input, minimize interference with existing operation, minimize dispute/ adversarial relationship), safety & security (people safety, protect confidentiality of project document/proprietary technology), and stakeholders' satisfaction.
**1.3.** Owner's characteristics: owner's tendency towards applying a particular PDCS method, owner's desire for control over the project, owner's level of involvement, owner's in-house resources, owner's behavior towards risk, owner's attitude towards sustainability, and owner's choice on the number of contracting parties (single point of responsibility vs. multiple.
**1.4.** Market condition: availability of required service/commodity providers, and current state of the market.
**1.5.** Cultural/political/regulatory: political/regulation constraints, and culture of the society and institution.

### *2. Macro Elements of PDCS*

**2.1.** Organizational structure: DBB, DB, CMR, CMA, DBO, DBOM, Multiple prime, Turnkey, Turnkey with finance, pure O&M, BOT, BOO, DBOT, BOOT, PPP, and IPD.
**2.2.** Phasing & sequencing strategy: linear (traditional), fast track (some aspects of actual construction precede the completion of design work), parallel (some preconstruction services are delivered while design work is incomplete), staged development, and early procurement.
**2.3.** Contract type (method of payment): fixed price (lump-sum, GMP, unit price, bid averaging, cap), and reimbursable (cost plus, time & material).
**2.4.** Award (selection) strategy: price oriented (low bid, best value, negotiation, design, construction, general condition, fee, contingency), design oriented, time oriented, prequalification (construction experience, financial capability, history of claims, team experience), and competitive qualification.

### *3. Micro Elements of PDCS*

**3.1.** Task assignment: pre-project planning, finance, procurement, managing of the contracts, design (conceptual, detailed), engineering, precon. advisory (schedule, budget), construction, constructability/value engineering, project management (cost, schedule), coordination, close out, and operation and maintenance.
**3.2.** Risk measurement/allocation/sharing/mitigation: risk measurement and mitigation (insurance and contingency), and risk allocation/sharing between parties.
**3.3.** Contractual reinforcement strategy (policies & procedures): incentive, rewards/saving shared model, disincentive, penalty clauses, liquidated damage, lost shared model, warranty, dispute resolution, info/document ownership, and basis of compensation (target cost, amount of contribution, accomplishment of assigned task).
**3.4.** Process management (policies & procedures): decision making (integrated, linear), information management (shared database vs. segmented info, accessibility of info, ownership of info/document), collaborations means and methods, leadership, and outside management option (program manager, project manager, CMA).
**3.5.** Contract characteristics: classical, neoclassical, and relational.

## Discussion

It is observed through the literature that most of the existing PDCS tools have focused on the macro elements, with the most emphasis on the organizational structures. These tools and guidelines provide good insight into the characteristics, advantages, and disadvantages of the macro elements and their correlations with the selections factors. However, they do not fully address the micro elements of the system. Project delivery and contracting strategy development must go further beyond the macro elements.

Project Delivery Contracting Strategy (PDCS) framework developed through this research suggests consideration of both the macro and micro elements (see figure 1).

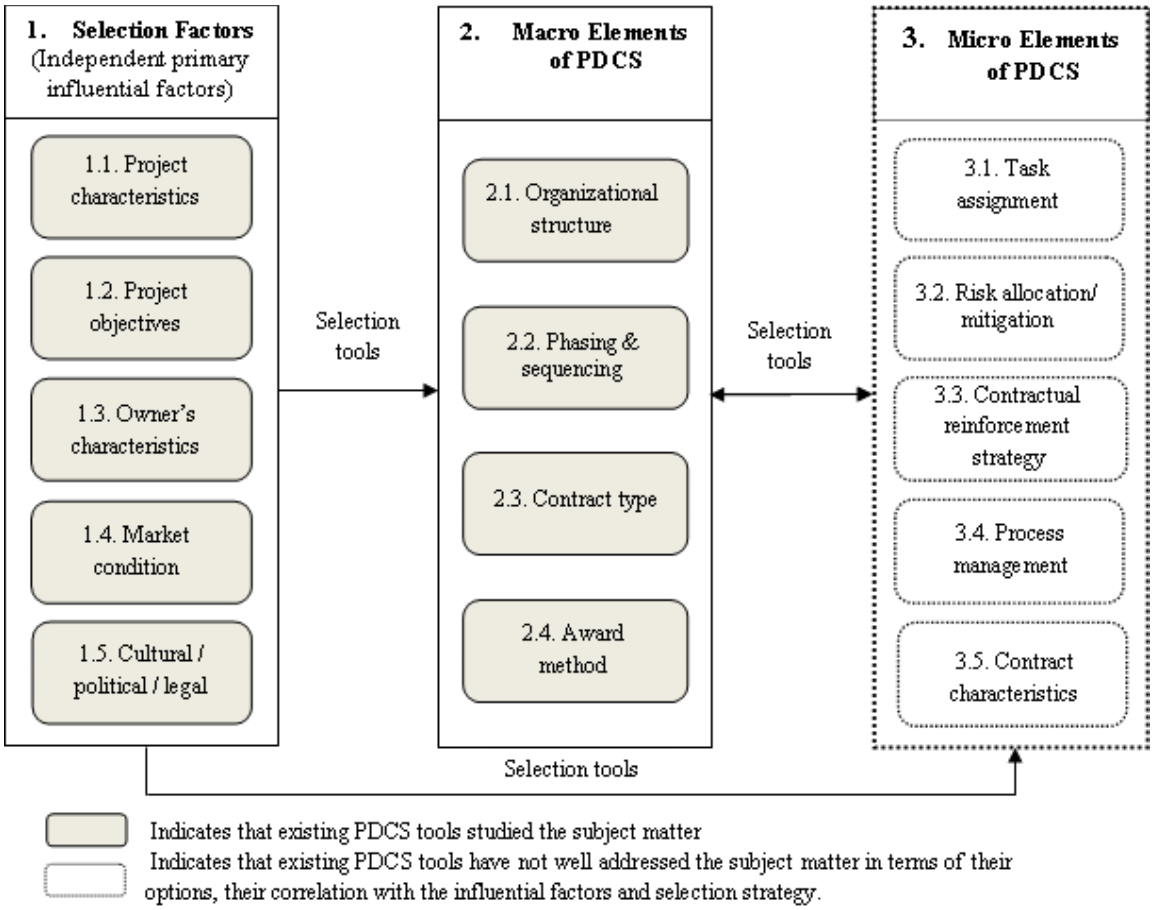


*Figure 1:* Framework and Gap analysis diagram on the existing project delivery and contract strategy

The framework presents a schematic and comprehensive process for project delivery and contracting strategy development. As depicted in figure1, the process of PDCS development involves two major selection cycles for macro and micro elements. Each selection cycle involves a series of decision making to choose the appropriate alternatives of various elements within that cycle. The choices of selection factors have direct impact on the choices of alternatives within each selection cycle. The results of each cycle may or may not influence the results of the other cycle. The PDCS selection cycles for macro and micro elements could be run independently or integrated relative to each other depending on the decision makers' choice and the situation. It is suggested that future research would study the micro elements, their options, characteristics, advantages/disadvantages, and their compatibility with both the independent selection factors, and the macro elements. Such a study would identify how certain selection factors and macro elements would lead to the selection of certain alternatives of micro elements.

Existing PDCS tools and guidelines do not include today's demands, standards, objectives, and new technological tools and elements. It is concluded that the PDCS tools and guidelines need to be periodically reviewed and updated to reflect current trends of the present time. For instance, green building, integrated information, and life cycle cost consideration are three major trends in today's industry. The result of the literature review indicates that the existing PDCS selection tools have not fully addressed these three emerging trends as project objectives. Future research is needed to identify or to develop the compatible project delivery and contracting strategy elements both at the macro and micro level for successfully accomplishing these emerging project objectives.

The authors believe that understanding risk-related issues associated with integrated information are among the major challenges in today's industry. Furthermore, the authors' access to the emerging case study projects, which are utilizing integrated information and having contacts with insurance companies, who are trying to figure the new risks model for these projects, offers an excellent opportunity for in-depth research. This work is going to progress to its next phase through understanding the risk related strategies– risk identification, risk measurement,

allocation/sharing, and mitigation -- for the projects with integrated information and building information modeling. Such a study would identify the correlation between integrated information as one of the emerging project objectives with the risk related strategies as one of the micro elements of PDCS framework.

## Reference


Al Khalil, M. I. (2002). Selecting the Appropriate Project Delivery Method Using AHP. *International Journal of Project Management, 20*(6), 469-474.

Anderson, S. D., Damnjanovic, I., National Research Council (U.S.). Transportation Research Board., National Cooperative Highway Research Program., American Association of State Highway and Transportation Officials., & U.S. Federal Highway Administration. (2008). *Selection and evaluation of alternative contracting methods to accelerate project completion*. Washington, D.C.: Transportation Research Board.

Bowers, D., Bhargava, R., & Anderson, S. (2003). *Characteristics of Integrated Project Delivery and Contract Strategies* (No. Research Report 165-11. A Report to CII). Austin, TX: The University of Texas

Gordon, C. M. (1994). Choosing Appropriate Construction Contracting Method. *Journal of Construction Engineering And Management, 120*(1), 196-210.

Kenig, M. (2007, March 21). Understanding Project Delivery Method Retrieved October 15, 2009, from http://www.agc.org/galleries/projectd/Kenig-20070321-PDS.pdf

Korkmaz, S., Horman, M., & Riley, D. (2009). *Key attributes of a longitudinal study of green project delivery.* Paper presented at the Seattle, WA: Journal: Building a Sustainable Future; Proceedings of the 2009 Construction Research Congress.

Loulakis, M. C. (2005). Construction Project Delivery Systems: Evaluating the Owner's Alternatives. Reston, VA: A/E/C Traininig Technologies.

Mafakheri, F., Dai, L., Slezak, D., & Nasiri, F. (2007). Project delivery system selection under uncertainty: Multicriteria multilevel decision aid model. *Journal of Management in Engineering, 23*(4), 200-206.

Mahdi, I. M., & Alreshaid, K. (2005). Decision support system for selecting the proper project delivery method using analytical hierarchy process (AHP). *International Journal of Project Management, 23*(7), 564-572.

Miller, J. B., Garvin, M. J., William Ibbs, C., & Mahoney, S. E. (2000). Toward A New Paradigm:Simultaneous Use Of Multiple Project Delivery Methods. *Journal of Management in Engineering, 16*(3), 58-67.

Oyetunji, A. A., & Anderson, S. D. (2006). Relative Effectiveness of Project Delivery and Contract Strategies. *Journal of Construction Engineering and Management 132*(1), 3-13

Rubin, R. A., & Wordes, D. (1997). *Changing project delivery systems: Who's at risk*, Minneapolis, MN, USA.

The Construction Industry Institute Project Delivery and Contract Strategy Research Team (2001). *Owner's Tool for Project Delivery and Contract Strategy Selection* (No. Research Summary 165-1). Austin, TX: University of Texas.

Touran, A., Gransberg, D. D., Molenaar, K. R., Ghavamifar, K., Mason, D. J., & Fithian, L. A. (2009). *A Guidbook for the Evaluation of Project Delivery Methods.* Washington D.C.

Warne, T. R., & Beard, J. L. (2005). *Project delivery systems owner's manual*. Washington DC: American Council of Engineering Companies.