2009

The Influence Of Job-Order-Contracting As A Construction Project Delivery Method On Owner Satisfaction

Greg Ohrn
Indiana State University

NOTE TO USERS

Page(s) missing in number only; text follows. The manuscript was microfilmed as received.

132, 133

This reproduction is the best copy available.

UMI®

Vitae
Greg Ohrn

EDUCATION

Ph.D.	Indiana State University, Terre Haute, Indiana. May 2009. Major: Technology Management, Construction Management Specialization.
M.S.	Arizona State University, Tempe, Arizona. May 1997. Major: Construction.
B.S.	Northern Arizona University, Flagstaff, Arizona. December 1981. Major: Civil Engineering Technology.

TEACHING/INDUSTRIAL EXPERIENCE

1997-2009	Assistant Professor - Northern Arizona University. Teach construction management to undergraduates in the College of Engineering, Forestry, and Natural Sciences.
1991-1997	Consultant to the Office of Navajo and Hopi Indian Relocation. Managed construction contracts for the development of government buildings and infrastructure on the Navajo Nation.
1981-1989	Compliance Civil Engineer - Peabody Coal Company. Designed and managed the construction of OSM required structures and mining support facilities.

PAPERS/PRESENTATIONS

Ohrn G. & Rogers, T. (2008). *Defining Project Delivery Methods for Design, Construction, and Other Construction-Related Services in the United States* - Presented to the ASC Proceedings of the 44th Annual Conference, Auburn University, Auburn, Alabama. April 2008.

Ohrn, G. (2006). *Job-Order-Contracting for Facility Owners*: Presented to the ASC Proceedings of the 42nd Annual Conference, Colorado State University, Fort Collins, Colorado. April 2006.

Ohrn, G. & Schexnayder, C. & (1997). *Effect of Performance-Related Specifications on Highway Construction* – ASCE Practice Periodical on Structural Design and Construction (November 1997)

PROFESSIONAL MEMBERSHIPS

1985-2009	American Society of Civil Engineers

THE INFLUENCE OF JOB-ORDER-CONTRACTING AS A CONSTRUCTION PROJECT DELIVERY METHOD ON OWNER SATISFACTION

A Dissertation

Presented to

The School of Graduate Studies

College of Technology

Indiana State University

Terre Haute, Indiana

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

---

by

Greg Ohrn

May 2009

School of Graduate Studies
Indiana State University
Terre Haute, Indiana

CERTIFICATE OF APPROVAL

DOCTORAL DISSERTATION

This is to certify that the Doctoral Dissertation of

Greg Ohrn

entitled

The Influence of Job-Order-Contracting as a Construction Project Delivery Method on Owner Satisfaction

has been approved by the Examining Committee for the dissertation requirement for the

Doctor of Philosophy degree in

Technology Management (Construction Management)

May 2009

Lee A. Ellingson, Ph.D. 4/20/09 Date

Gordon Minty, Ph.D. 4/20/09 Date

Wilfred Roudebush, Ph.D. 4/17/09 Date

Charles Coddington, Ph.D. 2/29/09 Date

David L. Batie, Ph.D. 2/27/09 Date
Committee Chair

Jay D. Gatrell, Ph.D. 4/22/09 Date
Dean of the Graduate School

ABSTRACT

Large public and private facility owners are in constant need of small and routine construction projects. In the past, these facility owners have hired and maintained their own facility departments to do some of this work, but when projects become too large or too complex it becomes more cost effective to use an outside contractor. In addition, when facility owners take on these types of projects with their own staff, routine maintenance and other job duties must take a back seat. To deal with this problem, many facility owners are discovering the value of a project delivery method developed by the U. S. Army in the 1980s specifically designed to deal with these types of projects. While job-order-contracting has been around since the 1980s, there has been very little research into the issues of who is using this project delivery method and what their perceptions are with respect to the issues that affect owner satisfaction. This research found that owners using job-order-contracting are generally very satisfied with the results being produced, especially when compared to the traditional design-bid-build project delivery method. Owners generally cite the ability of this project delivery method to meet the owner's need for timely project delivery as the primary reason for selecting this method.

ACKNOWLEDGEMENTS

According to Ben Franklin, "Energy and persistence conquer all things." This quote, probably more than anything else, sums up what it has taken to complete this project. I hope others considering a similar task of their own will recognize the commitment required and put the full force of their energy and persistence into achieving their goals. It will be well worth the effort.

The successful completion of this project has not been achieved without the assistance and encouragement of many individuals including Dr. Jim Ernzen and Gary Aller at Arizona State University. Jim and Gary introduced me to the fine folks at the Center for Job Order Contracting Excellence who educated me and supported this effort.

I also have to thank my dissertation committee for their perseverance. This includes Dr. Ellingson, Dr. Minty, Dr. Roudebush, Dr. Coddington, and my Chair, Dr. Batie. I know there were times when everyone questioned whether or not this was going to be completed, so I cannot thank you enough for your patience.

Finally and probably most important, I have to thank my wife and family for tolerating and helping me with my obsession to complete this project. This includes my daughter and son-in-law, Wendy and John Gist for their expertise in reading and commenting on several early drafts, Brian White for his support and for being the best son a father could ever hope for, and my dear daughter Tori Ohrn for surviving life with her father. And of course a special thanks to my wife and best friend Toni.

I also have to acknowledge the people who put me on this planet and helped me grow into the person I am today. My father and mother, Russell and Alice Ohrn, have always been a great source of inspiration. It did not go unnoticed how hard they worked to provide for our family. Whether they knew it or not, they were always appreciated.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

The traditional design-bid-build project delivery system has been the dominate project delivery method for most of the 20th century (AGC, 2004). In recent years this dominance has been challenged by alternative project delivery methods such as design-build and construction-management-at-risk as owners demand that the construction industry to complete projects in less time. As a result of these market pressures, the construction industry has seen a large increase in use of alternative project delivery methods. For example, the Design Build Institute of America estimates that by the year 2010 the design-build project delivery method will replace the design-bid-build project delivery system as the most widely used project delivery system in the U. S. (Gransberg, Koch, & Molenaar, 2006).

To date, most research into the use of alternative project delivery methods has focused on multi-million dollar projects and the use of design-build and construction-management-at-risk. If multi-million dollar projects were the only types of construction completed by the construction industry, then it could be concluded that current research into design-build and construction-management-at-risk is on track. Unfortunately, the facts indicate there is a significant segment of the construction industry that is focused on small (under $1 million) and routine projects. For example, the Mohave Educational

Services Cooperative (MESC) of Kingman, Arizona offers a job-order contract to the members of its purchasing cooperative for small and routine construction projects. The members utilize this service at their facilities throughout the state of Arizona, including the metropolitan areas of Phoenix and Tucson. In 2005, MESC reported that its members had completed 324 job orders at a cost of $21.8 million, or about $67,000 per job-order (Peeler & Aller, 2005). Furthermore, in the first four years of the MESC job-order-contracting program, usage of the job-order-contracting services grew steadily from $2.3 million in 2002 to $21.8 million in 2005. In addition to the job-order-contracting experiences in Arizona, public agencies such as the Chicago School District in Illinois, the City of Miami, Florida, and the Spring Branch School District in Texas have recorded the successful implementation of job-order contracts within their jurisdictions.

While the utilization of job-order-contracting appears to be on the rise throughout the United States, there appears to be a noticeable lack of relevant research on this form of alternative project delivery. Some basic questions need to be addressed: Who is using job-order-contracting and why are they using it? What are the common characteristics, of the job-order-contracting users and what are their opinions on job-order-contracting with respect to its influence on the elements that contribute to owner satisfaction? The purpose of this research proposal is to begin answering these questions and to add to the body of knowledge associated with the use of job-order-contracting as a project delivery method.

Background

Job-order-contracting was originally conceived by the U. S. Army in the early 1980's in order to meet the ever-demanding need for small and routine maintenance/construction projects at their facilities in Europe (Williams, 1994). Senior engineering officers at the Strategic Headquarters Allied Powers Europe (SHAPE) were of the opinion that the conventional design-bid-build project delivery system was cumbersome, time consuming, and not keeping up with the demand for these types of projects. In addition, the existing project delivery system provided little or no incentive for contractors to contribute knowledge and expertise beyond what was minimally required by the contract. What the Army desired was a project delivery system that was responsive to the Army's need for quality construction services provided in a timely manner.

Recognizing this problem, Colonel Harry Mellon at SHAPE challenged his staff to develop a project delivery system that would meet the needs of the Army (Williams, 1994). This new system would need to satisfy the Army's requirements for a wide variety of small and routine projects. Furthermore, Colonel Melon and his staff desired a project delivery system that provided an incentive to contractors to provide quality work without expensive government oversight. The result of this challenge was a new project delivery system that tied contractors into long-term contracts with the government. These contractors became experts and specialists in small and routine projects that customers required. In addition, this new project delivery method provided incentives to contractors to provide higher levels of customer service, since their future work under the job-order contract was dependent on the owner's satisfaction with the previous work

completed by the contractor. This new project delivery system has evolved into what is now known as job-order-contracting (JOC).

Since the time of its inception in the early 1980's, JOC has spread to private enterprise and other branches of government, including state and local agencies. In general, almost any type of facility owner with extensive capital assets is likely to find JOC appealing. It is a project delivery system specifically designed to meet the needs of large facility owners, such as federal, state, and local agencies.

Description

Job-order-contracting is a type of indefinite delivery/indefinite quantity (IDIQ) project delivery system (Aller, 2005). Under this system, the owner contracts with a provider (the job-order contractor) for a broad scope of work over an extended period of time (typically 3 to 4 years), and there are generally provisions to extend the contract time if the owner continues to be satisfied with the contractor's performance.

Under this type of project delivery, when an individual project need is identified by the owner, the contractor is notified and requested to provide a job-order proposal (Aller, 2005). The contractor, following the receipt of the proposal, will typically meet separately with the owner and its own subcontractors to refine the scope of work. When a scope of work is agreed upon, the contractor will prepare and submit a cost proposal for the job-order. If the owner agrees with the contractor's proposal, the work can begin almost as soon as the owner can issue a purchase order. On the other hand, if the owner does not agree to the contractor's proposal, the owner and contractor can negotiate until an acceptable cost is reached. In the event that the owner and contractor are unable to

agree on scope and cost, the owner is generally free to procure the work through other means. Since contractor profit is tied to the volume of work completed, the contractor has a strong incentive to provide higher levels of customer service than would be expected in a traditional hard-bid environment.

The most notable features of JOC that distinguish it from other project delivery methods are: 1) It is an IDIQ type of contract; 2) It uses a unit price book for the pricing of work performed under the contract.

Indefinite delivery – indefinite quantity:

Job-order-contracting is a type of IDIQ contract. In general terms, this means that at the time when the contract is agreed upon between the owner and the contractor, there is no certainty with respect to what projects will be completed, and there is no certainty with respect to the volume of work that will be required. What the owner and contractor do know is that historically there has been a need for a certain volume of work within a general scope. Employing this information, the job-order contract is written for a very broad scope of small and routine types of project activities and an overall budget is established for the life of the contract. As the project needs become apparent, the owner will issue job-orders to the contractor within the general scope and budget of the contract. Other types of project delivery methods, including design-bid-build, design-build, and construction-management-at-risk, will have a well-defined scope of work and a budget for that scope at the time the contract is signed. The job-order contract on the other hand, allows owners and contractors to negotiate as the actual project needs begin to unfold.

Unit price book:

Under the original concept of JOC, the bulk of the pricing (90% or more) is based upon cost from a unit price book. The unit price book contains the unit costs for a wide variety of typical and routine construction activities that the owner may request within the general scope of the contract. While a typical unit price book may contain prices for 40,000 or more typical activities, there are situations where an owner may request work not specifically addressed by the unit price book. In these situations, the contractor may either use a price from a similar or related activity, or the contractor may go outside of the unit price book and use a bid from a subcontractor. In either case, a coefficient is applied to the costs developed for the proposed work. The majority of JOCs have a number of coefficients for a variety of situations such as one for unit price book activities completed during normal working hours and one for activities completed outside normal working hours. As such, a typical job-order contract will contain a separate coefficient for pricing developed as the result of a subcontractor bid (for activities not found in the unit price book). The coefficients will modify the unit price book and sub-bid totals to create the job-order proposal amount. This amount covers all of the contractor's costs to complete the work and to make a profit on the job-order.

In many respects, JOC is very similar to other project delivery methods. Source selection can be accomplished through a request for proposal (RFP) process or through an invitation for bids (IFB), where the unit price book coefficients serve as the cost components of the proposal or bid. With regard to actual construction, the activities are completed using conventional means and methods which are indistinguishable from the means and methods of other project delivery methods. Thus while there are significant

differences in the procurement and pricing of the work using JOC, the actual work is performed in the manner as found in other project delivery methods.

General Statement of the Problem

While the proponents of JOC are convinced of its benefits as a project delivery method, overall there is a general lack of comprehensive research to support their claims. As a consequence, an owner seeking to use job-order-contracting must either rely on the claims of the JOC proponents, or they must conduct their own study. A statistical study of the perceived benefits of JOC is clearly needed. For example, how does the use of job-order-contracting influence factors important to the owner, such as project costs, schedule, quality, safety, claims, and owner satisfaction? Currently, the answers to these questions are not available from unbiased sources.

Statement of Purpose

The purpose of this research is to collect and analyze data on the general characteristics of JOC users. In addition, the research will investigate the perceived influence of JOC on construction costs, timeliness of construction activities, quality, safety, claims and overall owner satisfaction.

Statement of Need

There is very little information on the general characteristics of the users of job-order-contracting. By collecting and analyzing this information, potential users of this project delivery method will have a better understanding of the relationship between the

general characteristics of job-order-contracting users and overall owner satisfaction. The information can be employed by potential users of job-order-contracting to determine if this project delivery method may be appropriate and applicable to their needs.

There are a multitude of project delivery methods available to the facility owner faced with the decision as to what project delivery method to use for a particular project. In the past, the decision as to what project delivery method to use for a particular project was guided primarily on the basis of past practices. In recent years, owners, contractors, and others have discovered that the project delivery method selected for a particular project has profound influence on owner satisfaction. Owners need and want more information on how the selection of the project delivery method will influence their satisfaction with the process. This study is designed to add to the body of knowledge that owners and contractors can utilize when making decisions as to what project delivery method is most appropriate for a specific type of project.

In 1976, Boyd Paulson first published the "level-of-influence" concept (Barrie & Paulson, 1992). In his study entitled "Designing to Reduce Construction Costs," Paulson concluded that it was much less expensive to make changes early rather than later in the project process (Figure 1). Paulson concluded that the ability to effectively influence a project was greatest at the beginning of a project rather than in the later stages of the project.

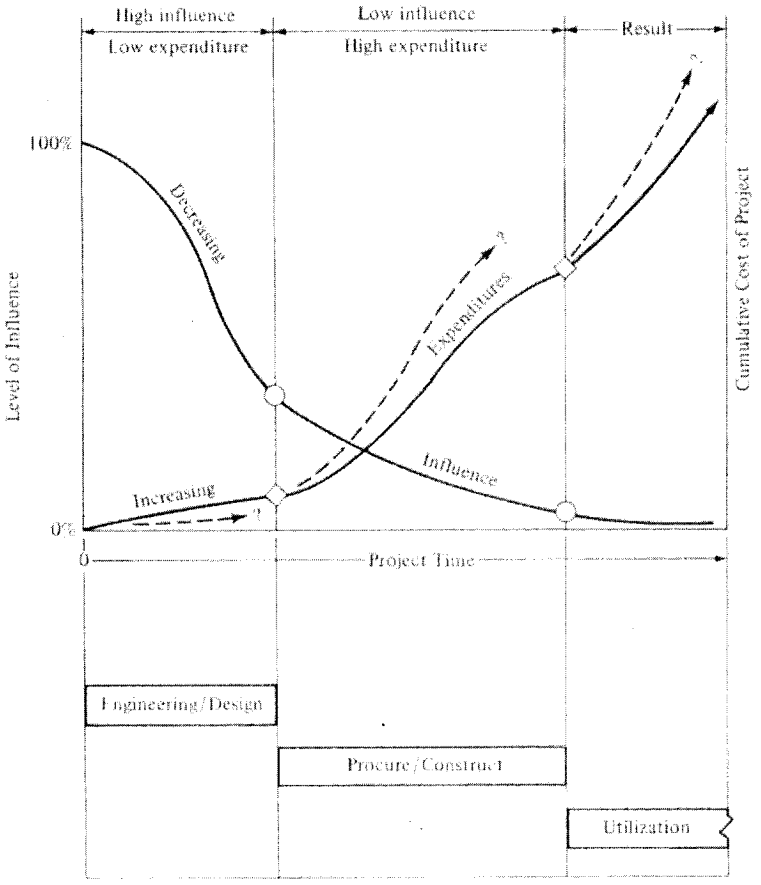

Figure 1. Cost versus level of influence (Barrie & Paulson, 1992)

According to Beard, Loulakis, and Wundram (2001), the steps that an owner will typically go through in acquiring a new facility are shown in Figure 2. If Paulson's level of influence concept is applied to the Beard, Loulakis, and Wundram acquisition process, it can be observed that the owner's greatest level of influence over this process occurs early in the project. Since the selection of a project delivery method is one of the earliest decisions in a project, this decision has a highly significant influence on the success of the project. Facility owners need the type of information this study will provide to assist in determining the most appropriate project delivery method available for a specific type of project.

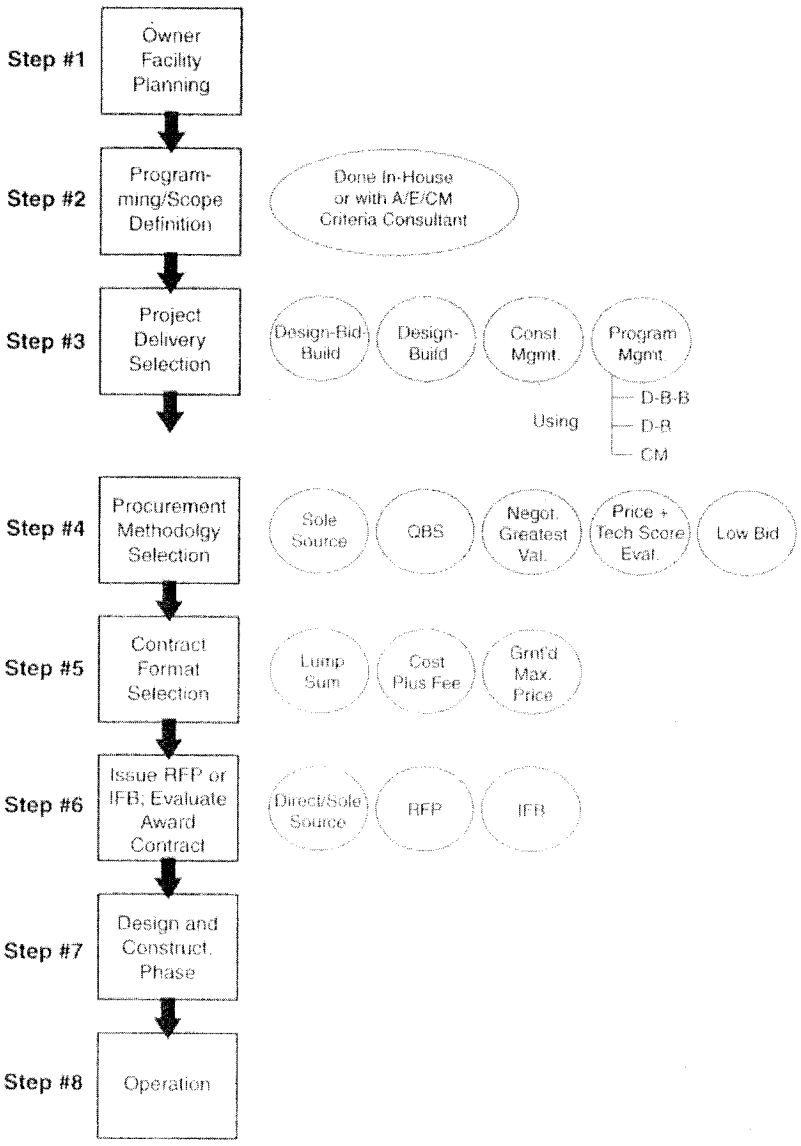

Figure 2. Owner decision tree (Beard, Loulakis, & Wundram, 2001)

Questions of the Study

Question 1

What are the characteristics of the typical JOC user with respect to experience, location, type of organization, pricing methodology, and reasons for using job-order-contracting?

Question 2

What is the most likely alternative to JOC as a project delivery method for the owner currently using job-order-contracting?

Question 3

Are owner perceptions with respect to construction costs, timeliness of construction, quality, safety, claims and owner satisfaction affected by the project delivery method selected for a project?

Limitations

This study may be limited by its ability to identify and inspire a response from a representative sample of JOC users. The study will be conducted through the delivery and collection of responses to an Internet survey instrument. An invitation to participate in this survey will be delivered to a list of clients provided by the Center for Job Order Contracting Excellence (CJE). The invitation will be delivered via e-mail and will contain a written request by the researcher to participate in the survey. A unique URL link embedded in the e-mail message will be implemented to take the potential respondent to the website where the questions will be delivered. With the high levels of spam e-mails that proliferate the Internet and the fear of e-mail delivered viruses, it is anticipated that many of the invitations will not be opened.

Another limitation of this study is the mailing list provided by CJE. While this list contains the e-mail addresses of owners, design professionals, and others most likely to be users of JOC, it is recognized that a membership in CJE is not a prerequisite for the

use of this type of project delivery method. Thus, there is a segment of the larger population that this survey will not reach. It is assumed that the list of users provided by the CJE is significant and representative of the population of all JOC users. A further discussion of the population and sample is provided in the Methodology section.

Delimitations

The ability of a public owner to utilize one type of project delivery method versus another may not always be a matter of preference, but in some instances will be a matter of legal mandate. This study does not address this issue. Only those respondents that indicate they are currently using or have used JOC will be included in this study.

Definition of Terms

Alternative project delivery method (APDM)

Any project delivery method other than the traditional design-bid-build method also known as low-bid or hard-bid. Design-bid, construction-management-at-risk, and job-order-contracting are all considered types of alternative project delivery methods.

Construction-management-at-risk (CMAR)

This is a project delivery method in which the owner has separate contracts with both a designer and a construction manager (CM). The CM will typically collaborate with the designer during the design process by providing value engineering and a review of constructability. During the construction phase of the project, the CM will manage the subcontractors and provide a guarantee to the owner on the project cost and schedule.

This project delivery method is also known as construction-manager-at-risk and referenced by the acronyms CM/GC, GC/CM, CMc.

Design-bid-build (DBB)

This is the traditional project delivery method which is the most commonly utilized in the United States. It is characterized by the owner contracting for the design prior to creating a separate contract for the construction. This method is sometimes referred to as low-bid or hard-bid.

Design-build (DB)

This is a project delivery method in which the owner contracts with one entity for both the design and construction of a project. Under this form of project delivery, the design is not required to be 100% complete prior to beginning construction. As such, the schedule is typically shorter than if the same project were completed as a design-bid-build project.

Job-order-contracting (JOC)

This is a project delivery method in which the owner contracts with a single entity for both design and construction of an undetermined amount of work over an extended period of time (typically three to four years). The design work is limited to a minimum level necessary to assure a basic understanding of the project requirements and what is required to meet code requirements. This project delivery method is a type of indefinite delivery/indefinite quantity contract and is often referred to as delivery-order-contracting

(DOC), work-order-contracting (WOC), and simplified-acquisition-of-base-engineering-requirements (SABER).

Most-likely-alternative (MLA)

The most likely alternative will be defined as the project delivery method that each owner would most likely utilize in the event that JOC was not being employed. For this study, the most-likely-alternatives will include design-bid-build, design-build, construction-management-at-risk, owner-managed-construction using in-house personnel, and other project delivery methods as indicated by the respondents.

Owner satisfaction

Owner satisfaction is a measure of the level of contentment with the finished product and the process used to deliver the finished product. In the construction industry, owner satisfaction is generally considered to be composed of, or closely related to, satisfaction with project cost, schedule, quality, safety, and freedom from disputes.

Project delivery method (PDM)

The process used to procure, organize, and complete a construction project. The project delivery method includes how the project will be organized, and how the responsibilities for design and construction will be allocated.

Assumptions

The primary analysis tools utilized for this study were non-parametric statistical techniques, primarily chi-square. The assumptions required for the use of these techniques are: 1) the sample is random, and 2) the observations are independent.

E-mail invitations were sent to approximately 7,600 users of job-order-contracting with the list of recipients coming from the members of the CJE. Each recipient was provided a unique URL address with which to participate in the survey. Once a participant used the URL to access the survey, the URL was disabled and blocked from further use. Thus each recipient was only allowed one opportunity to participate in the survey, generally assuring that the observations were independent.

Participation in this study was voluntary and there were no incentives other than an invitation e-mail to encourage participation in this survey. Thus, the participants were self-selected within the pool of the 7,600 users invited to participate. While this does not assure a random sample, for the purposes of this study the author is assuming a random sample.

Statement of Hypotheses

Null Hypothesis 1

The users of JOC will indicate there is a no one, or more, most likely alternative project delivery method to job-order-contracting. $H_0 1$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternate Hypothesis 1

The users of JOC will indicate there is one, or more, most likely alternative project delivery methods to job-order-contracting. $H_A 1$: Not $H_0 1$

Null Hypothesis 2

Opinions with respect to the cost of project design being higher, the same, or lower than the design cost for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 2$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 2

Opinions with respect to the cost of project design being higher, the same, or lower than the design cost for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. $H_A 2$: Not $H_0 2$

Null Hypothesis 3

Opinions with respect to the cost of contractor procurement being higher, the same, or lower than the procurement cost for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 3$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 3

Opinions with respect to the cost of contractor procurement being higher, the same, or lower than the procurement cost for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. $H_A 3$: Not $H_0 3$

Null Hypothesis 4

Opinions with respect to the cost of construction being higher, the same, or lower than the construction cost for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 4$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 4

Opinions with respect to the cost of construction being higher, the same, or lower than the construction cost for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. H_A4: Not $H_0 4$

Null Hypothesis 5

Opinions with respect to the cost of change orders being higher, the same, or lower than the change order cost for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 5$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 5

Opinions with respect to the cost of change orders being higher, the same, or lower than the change order cost for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. H_A5: Not $H_0 5$

Null Hypothesis 6

Opinions with respect to the cost of project administration being higher, the same, or lower than the project administration cost for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 6$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 6

Opinions with respect to the cost of project administration being higher, the same, or lower than the project administration cost for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. H_A6: Not $H_0 6$

Null Hypothesis 7

Opinions with respect to the cost of claims being higher, the same, or lower than the claims cost for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 7$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 7

Opinions with respect to the cost of claims being higher, the same, or lower than the claims cost for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. $H_A 7$: Not $H_0 7$

Null Hypothesis 8

Opinions with respect to the time required to initiate the work being longer, the same, or shorter than the time required for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 8$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 8

Opinions with respect to the time required to initiate the work being longer, the same, or shorter than the time required for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. $H_A 8$: Not $H_0 8$

Null Hypothesis 9

Opinions with respect to the time required to complete the design being longer, the same, or shorter than the time required for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 9$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 9

Opinions with respect to the time required to complete the design being longer, the same, or shorter than the time required for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. H_A9: Not H_09

Null Hypothesis 10

Opinions with respect to the time required to construct the project being longer, the same, or shorter than the time required for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. H_010: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 10

Opinions with respect to the time required to construct the project being longer, the same, or shorter than the time required for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. H_A10: Not H_010

Null Hypothesis 11

Opinions with respect to the time required to closeout the project being longer, the same, or shorter than the time required for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. H_011: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 11

Opinions with respect to the time required to closeout the project being longer, the same, or shorter than the time required for the most likely alternative project delivery method

are significantly influenced by the specific MLA used in the comparison. H_A11: Not H_011

Null Hypothesis 12

Opinions with respect to the ease of using JOC being easier, the same, or not as easy as using the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. H_012: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 12

Opinions with respect to the ease of using JOC being easier, the same, or not as easy as using the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. H_A12: Not H_012

Null Hypothesis 13

Opinions with respect to the quality of work being better, the same, or worse than the quality for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. H_013: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 13

Opinions with respect to the quality of work being better, the same, or worse than the quality for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. H_A13: Not H_013

Null Hypothesis 14

Opinions with respect to worker safety being better, the same, or worse than the safety for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. H_014: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 14

Opinions with respect to worker safety being better, the same, or worse than the safety for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. H_A14: Not H_014

Null Hypothesis 15

Opinions with respect to the number of warranty issues being higher, the same, or lower than the number for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. H_015: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 15

Opinions with respect to the number of warranty issues being higher, the same, or lower than the number for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. H_A15: Not H_015

Null Hypothesis 16

Opinions with respect to the number of accidents being higher, the same, or lower than the number for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. H_016: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 16

Opinions with respect to the number of accidents being higher, the same, or lower than the number for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. H_A16: Not H_016

Null Hypothesis 17

Opinions with respect to the number of claims being higher, the same, or lower than the number for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 17$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 17

Opinions with respect to the number of claims being higher, the same, or lower than the number for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. $H_A 17$: Not $H_0 17$

Null Hypothesis 18

Opinions with respect to the overall level of owner satisfaction being higher, the same, or lower than the level for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 18$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 18

Opinions with respect to the overall level of owner satisfaction being higher, the same, or lower than the level for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. $H_A 18$: Not $H_0 18$

CHAPTER 2

REVIEW OF LITERATURE

Project Delivery Methods in Construction

During the past two decades, there has been a marked increase in the number and variety of project delivery methods utilized to procure the design and construction services for facilities and infrastructure. Despite this increase in the number and variety of project delivery methods, the construction industry appears to have no clear definition and understanding of what a project delivery method entails. Prior to embarking on a study one project delivery method versus another, it is important to have a firm concept of what the term "project delivery method" means as applied to the construction industry. The initial purpose of this literature review is to explore what a project delivery method is and how the term is used within the construction industry.

Current Definitions

According to the Associated General Contractors of America (AGC), a project delivery method is "the comprehensive process of assigning the contractual responsibilities for designing and constructing a project" (AGC, 2004). Looking at the major components of this definition it can be seen that the AGC considers a project delivery method: 1) A comprehensive process; 2) Has the purpose of assigning

contractual responsibility; 3) Has a scope of work limited to the design and construction of a project.

In elaborating on this definition, the AGC acknowledges that the attempt with this definition to limit the number of project delivery methods to the three most common methods (AGC, 2004): 1) Design-Bid-Build (DBB); 2) CM-At-Risk (CMAR); 3) Design-Build (DB)

Following the AGC's definition, project delivery methods can be categorized in accordance with the characteristics (AGC, 2004): 1) what is the basis of contractor selection? (price, qualifications, or a combination of both); 2) are the design and construction under separate contracts? The result of this categorizing can be seen in Table 1.

Table 1.

AGC Matrix of Project Delivery Method Characteristics

Basis of Contractor Selection	Owner has separate contracts with both the designer and the builder	Owner one contract with an entity that provides both the design and construction
Low Bid selection	Design-bid-build	Design-build (low bid selection)
Best Value selection	CM-at-risk (best value selection)	Design-build (best value selection)
Qualifications based selection	CM-at-risk (qualifications selection)	Design-build (qualifications selection)

The AGC acknowledge the existence of other project delivery methods, but categorizes these other methods as "hybrids" of the three primary project delivery methods. The AGC makes no attempt to classify or expand on their definition of a hybrid project delivery method.

In contrast to this, Charles Thomsen, FAIA (2006), defines a project delivery process as "the sequence of defining responsibility, scope, and compensation." Thomsen states that owners should select a project delivery method on the basis of the following: 1) relationship with the contractor ranging from one, where the contractor acts in a fiduciary capacity (provider of a service) to one, where the contractor is acting as a vendor (provider of a product); 2) terms of payment that range from a cost-plus arrangement (time and materials) to a lump-sum arrangement (fixed price); 3) number of contracts held by the owner from one or a few contracts (i.e. design-build), to several contracts where the owner is doing direct procurement of the work; 4) selection criteria that range from purely qualifications based selection to price based selection (i.e. low bid).

Examining this definition, it can be seen that a project delivery method includes: 1) it is a sequence or a process; 2) it has a purpose of defining responsibility, scope, and compensation; 3) provides no limitation with respect to the scope of services such as only design or only construction.

Examining one additional definition, Sanvido and Konchar (1998) define a project delivery system as "the relationships, roles, and responsibilities of parties and the sequence of activities required to provide a facility." This definition of a project delivery system is predicated on: 1) the relationships, roles, and responsibilities and the sequence of activities; 2) has the purpose of establishing the relationships, roles and responsibilities of the parties; 3) limits the scope to the activities required to provide a facility.

In comparing these definitions it can be observed that all three definitions agree that a project delivery method is a process, or sequence. In addition, all three definitions

agree that one of the purposes of a project delivery method is to assign, or define responsibility. In contrast to their similarities, the most notable difference between these definitions is the scope of work. The AGC has the narrowest scope limiting their definition to only design and construction, while Sanvido and Konchar open up the scope to include all "activities" required to provide a facility. Presumably, the Sanvido and Konchar definition could be interpreted in a manner so as to include the procurement of property, financing, operation, and maintenance into the scope of services required to provide a facility.

To gain some perspective on how the construction industry arrived at this point in time where there are a variety of project delivery methods it might be helpful to look at a brief history of project delivery methods and their evolution.

Background

Prior to the twentieth century in the United States, design and construction (i.e. the design-build project delivery method) was a typical form of integrated services provided by construction contractors (Schexnayder & Mayo, 2004). Though there were firms that specialized exclusively in design, or exclusively in construction, prior to this period, many ordinary construction projects were completed by master builders who provided both the design and the construction. An example of this would be the accomplishments of John A. Roebling in the mid 1800's. Roebling was trained as a civil engineer in Prussia, but gained notoriety for his design and construction expertise with suspension bridges (Gibbon, 2006).

In the mid to late 1800's, the practices of design and construction began to

become more specialized as technological advances began to allow for more complicated constructed facilities/structures (Thomsen, 2006). This evolution resulted in the separation the two primary project delivery responsibilities; design and construction. Architects and engineers became the design professionals, while construction contractors became the constructors. As an indication of this separation, the American Society of Civil Engineers and Architects (which evolved into the American Society of Civil Engineers) was founded in 1852 to "promote the professional status of civil engineers and architects" (ASCE, 2002). Following this, in 1918 the Associated General Contractors of America (AGC) was founded to promote the interest of the construction industry (AGC, 2007). Thus, an era of specialization was ushered in with the incorporation of advocacy groups that represented the specialized interests of the designer professionals and of professional constructors.

This separation of the design and construction services continued to gain momentum in the early 1900's when one of the largest purchasers of construction services (the federal government) began requiring the use a qualification based selection for the procurement of architectural and engineering services (ASCE, 2002). In contrast to this, most government agencies were required to procure construction service on the basis of low bid. Thus, while design was viewed as a service where professional qualifications of the designers providing the service were more important than cost of the service, construction services were relegated to a type of commodity. In other words, the product of one contractor would be the same as the product of another provided they both follow the design precisely.

This evolutionary process had the affect of institutionalizing the design-bid-build

(DBB) project delivery method. DBB is a linear sequence during which the purchaser of construction service (often known as the owner) procures the A/E (architect/engineer) design services separate from the procurement of the construction services. One of the common frustrations with the use of the DBB method is that the design must be fully completed prior to the procurement of the construction services. This is due primarily to the fact that the procurement of construction services is typically based upon a hard bid price and a firm fixed price cannot be determined without a full and complete set of plans and specifications.

In the later twentieth century, owners began to recognize that the overall design and construction time could be reduced if there were some overlap of the design and construction. In other words, the selection of interior finishes had very little to do with the sitework and foundations once the configuration and layout of the facility were established. Thus market pressures came to bear on the design and construction professions to accelerate the process by integrating the activities of design and construction.

Another perceived problem with DBB is the owner's misconception that the bid price is the final price. A/E plans and specifications are rarely, if ever, perfect and the contractor's interpretation of the plans and specs rarely, if ever, match the intentions of the designer. As a result, it is typical in the construction process that there will be changes and change orders. This often has the untended consequence of placing a stress on the business relationships between the owner, design professional, and the contractor as unexpected costs are realized during the construction process.

To address the shortcomings of the DBB project delivery method, many owners

began to experiment with alternative project delivery methods. These methods were generally designed to accelerate the work by integrating the design and construction processes and to provide incentive to the construction professionals to contribute their expertise early in the design process. The result of these experiments are many of the alternative project delivery methods that are currently in use today including: design-build, construction management-at-risk, and job-order-contracting.

A Variety of Project Delivery Methods

As the twentieth century came to a close, a wide variety of project delivery methods had appeared. Many of these methods were developed to address the weaknesses of the DBB method and provided incentives to the contracting parties to meet and/or exceed the goals of completing the construction on-time, within budget, with the quality specified.

While there is any number of project delivery methods available to the owner, the following are the general characteristics of several of the more popular methods:

Design-Bid-Build also known as hard bid or the low bid method

This is still considered the traditional project delivery method for design and construction where the design precedes the construction and the contracts provides either a lump sum or unit price bid to obtain the work. Typically, the lowest responsible and responsive bidder wins the contract to perform the construction. Because the quality, price, and completion date of the contract are all established by the contract requirements, there is little incentive to the contractor to provide any expertise beyond what is

minimally required to obtain and complete the project within the minimal requirements of the contract.

Design-Build (DB)

The design-build method is a reintroduction of the master builder concept where the owner contracts with a single entity (i.e. the design-builder) to provide the integrated design and construction services for a project. This method has the advantage that the construction can actually begin prior to the completion of the design which typically shortens the overall project time. In addition, because the design-builder is providing integrated services, the owner can take advantage of the contractor's expertise during the design phase of the project and the design professional's expertise during the construction phase.

Construction-Management-at-Risk (CMAR)

Using this method the owner contracts separately with both a designer and a construction manager. The construction manager is brought into the design process early to provide cost and constructability input on the design. During the construction phase, the construction manager will assist the owner in finding and managing the activities of the subcontractors brought in to perform the work. The CMAR project delivery method typically uses an open book accounting process, so the owner can see how their money is being spent.

Design-Build-Operate (DBO), Design-Build-Operate-Maintain (DBOM), and Build-Operate-Transfer (BOT).

This is a family of project delivery methods that extends the owner-contractor relationship beyond just design and construction. In certain circumstances, the contractor can also provide operating services, maintenance services, and financing to assist the owner in meeting their needs. An example of this would be a municipality that needs a new waste water treatment facility to meet a growing demand, but does not have the financial capital and/or expertise to build and operate this type of facility. In this case a contractor with the right knowledge, financing, and expertise can assist the owner in meeting these extended needs.

Job-Order-Contracting (JOC)

This is a type of indefinite delivery, indefinite quantity contract (IDIQ) where the owner contracts with a contractor for an unspecified quantity of work within a specified scope of work. Typically, the work is relatively small and routine and may include some incidental design services. This project delivery method is primarily intended for facility owners who regularly have a need for these types of construction services. These services generally exceed the capabilities and/or the expertise of their internal maintenance staff to complete the work in a timely manner, but are not so large as to justify the relatively high cost of procurement in comparison to the cost of construction. An example of this might be the installation of one or two street lights to improve security at a facility. The cost and time required to procure this type of a project under a

DBB project delivery method would probably exceed or nearly exceed the cost and time required to complete the work. Under a JOC arrangement, a work order can be issued to perform this work once the pricing worked out, thus eliminating long and drawn out procurement process for a relatively small and routine type of project.

In addition to the basic project delivery methods previously outlined, there are variations in the procurement practices (selection criteria) that are utilized to obtain these services (Trauner, 2007). As an example, of this an A + B procurement method could be used with a traditional design-bid-build project delivery method. Here the contractor not only bids the cost of the work, but there is a cost factor (the "B" component) associated with the time required to complete the work. The winning bidders for these types of contracts are based upon a combination of price and time. Other procurement practices include (Trauner, 2007): 1) Lump sum bidding; 2) Reverse auction; 3) Bid averaging; 4) A + B; 5) A + B + C (cost + time + some other factor); 6) Alternate design; 7) Alternate bid; 8) Additive alternates; 9) Best value.

Common Threads

When the existing definitions of "project delivery method" are reviewed, the history of how these methods came to exist, and the characteristics of several of the more common project delivery methods in use today, it becomes apparent that definitions such as the AGC's definition do not accurately reflect the true meaning of the term "project delivery method." As Charles Thomson (2006) suggested, the defining characteristics of a project delivery method include:

Contractor selection criteria: 1) qualifications only, 2) a combination of qualifications and price; 3) price only.

Number of contracts: 1) Integrated services (i.e. design-build under one contract); 2) Separate design and construction contracts; 3) Multiple prime contractors; 4) Direct procurement.

Type of relationship with the owner: 1) A service provider; 2) A provider of product and service; 3) A product provider.

Terms of payment: 1) Time and materials; 2) Target price with incentives; 3) Cost plus with a guaranteed maximum price; 4) Unit price; 5) Fixed price.

Perhaps a better definition of "project delivery method" is: The process through which constructed projects are organized and completed including establishing how the contractor will be selected, the scope of services provided, the type of relationship with owner, and how the contractor will be compensated.

This is the definition that has been adopted for this study.

The Significance of Project Delivery Method Selection

The selection of a project delivery method for a design and construction of a project is one of the most important decisions an owner will make. In 1976 Boyd

Paulson (1992) published his findings on "Designing to Reduce Construction Costs" in the ASCE Journal of the Construction Division. In this paper, Paulson denoted what has become known as the cost-influence relationship. Essentially, as a construction project progresses through the "engineering/design", "procure/ construct", and "utilization" phases, the project expenditures increase while the ability to influence the project decreases. Following this concept back to the beginning of a project it is evident that the greatest chance to influence a project occurs in the earliest stages of a project. The selection of the project delivery method to be utilized in completing a project is one of the earliest decisions to be made on a project. Without a clear understanding of what is meant by project delivery method, owners and other users of construction services will not be able to make an informed decision as to what is the most appropriate project delivery method for their needs.

Two significant areas that could be influenced in the early stages of a project are risk and incentives. As stated above, one function of the project delivery method is the assignment of contractual responsibility. Owners, designers, and contractors all have a vested interest in the assignment of responsibilities under the contract since all responsibilities carry risk. Typically, owners are at risk for the financing, payments to the designer and contractor, and the site conditions. The design professionals are at risk to assure the design meets the aesthetic and functional requirements established by the owner, and that the design is code compliant. The contractor is at risk to assure the construction is completed on time, within budget and with the quality specified. The selection of a particular project delivery method for a particular project will establish how the risks on the project are to be shared and managed. This in turn will affect the cost of

the project. As Schexnayder and Mayo (2004) state: "Risks are best assumed by the party with the ability to control the risk."

As an example, one of the disadvantages of the design-bid-build project delivery method is that it "tends to create an adversarial relationship among the contracting parties, rather than foster a cooperative atmosphere in which issues can be resolved efficiently and effectively" (Trauner, 2007). Characterized in another way, what this states is that the design-bid-build project delivery method provides an incentive for the parties to the contract to not create a cooperative project atmosphere. While a cooperative project atmosphere may or may not be something that an owner would want on a project, the point here is that this is an incentive that can be influenced through the selection of the project delivery method for a particular project.

Two components of the project delivery method that provide the most incentive are the method of contractor selection and terms of payment. If a contractor is selected on the basis of low cost, only then is there incentive for that contractor to provide anything beyond the minimal to fulfill the requirements of the contract. On the other hand, a contractor selected on the basis of best value (qualifications and cost) has an incentive to maintain and enhance their value through performance that meets or exceeds the owner's expectations.

Comparative Studies of Project Delivery Methods

There have been a number of studies that have focused on the influence of project delivery method selection, specifically on those issues that matter most to owners - including project cost, schedule, and quality. Unfortunately, the majority of these studies

have focused exclusively on large projects at the exclusion of small and routine projects, including civil and infrastructure projects. As such, many of these studies have overlooked job-order-contracting. The purpose of this chapter is to provide an overview of the related research that has been completed, both in the area of project delivery method research and studies that have focused primarily on job-order-contracting.

Project Delivery Method Studies Excluding JOC

Bresnen and Haslam, 1991

One of the earliest studies in the comparison of project delivery methods was completed by Bresnen and Haslam in 1986. To put this date into context, the design-build project delivery method was still in its infancy in 1986 with the Design-Build Institute of America not being founded until 1993 (Beard, Loulakis, & Wundram, 2001).

In this study, researchers set out to collect and compare data on the characteristics of construction client organizations to project attributes such as preferred forms of contract, management structure, and project performance. Construction client characteristics surveyed included client type, project type, and levels of experience. Project data included monetary size of the projects, type of contract system used, time and cost outcomes of the project, and client satisfaction.

The methodology utilized for this study was a survey of the attributes and construction management practices of construction client organizations in the United Kingdom. The data were collected from September 1984 through February 1986, using a 40-page structured questionnaire. Survey participants were first telephoned to secure agreement to take part in the survey. The survey was then mailed to the participants for

completion. According to the researchers, this survey required between 1 and 1 ¾ hours to complete. From the 179 surveys distributed, 138 responses were received. In addition to the client characteristic data, opinion data for this study was collected using a Likert-type scale to measure satisfaction with various aspects of the project delivery method employed.

Results from this study indicated that the traditional contracting method (design-bid-build) was the prevalent form of contract preferred over other project delivery methods, including client project management and design-build (Figure 3). While the traditional project delivery method was the overall preference, there was a notable difference in the results when examined on the basis of public versus private owners. Private owners were more likely to utilize one of the alternative project delivery systems versus the traditional project delivery system.

	Public	Private	Miscellaneous	Total
Management	4	14		18 (13%)
Design-build	6	20		26 (19%)
Traditional JCT	33	55	6	94 (68%)
Total	43 (31%)	89 (64%)	6 (4%)	138 (100%)

Figure 3. Breakdown of project delivery method preferences by client type (Bresnen & Haslam, 1991)

With respect to client satisfaction, results indicated that clients were generally satisfied to very satisfied with their projects in the areas of meeting project objectives, contractor performance, quality of work, and client organization (Figure 4). The researchers noted that satisfaction levels with the design-build projects were much greater than with projects completed using the traditional project delivery methods.

Client satisfaction with:	Satisfied or very satisfied		Undecided		Dissatisfied or very dissatisfied	
	n	%	*n*	%	*n*	%
Project objectives						
Overall cost	104	79	13	10	15	11
Time taken	93	68	14	10	30	22
'Value for money'	107	78	18	13	12	9
Type of contract	109	80	11	8	17	12
Contractor performance						
Contractor performance	92	68	16	12	27	20
Commitment and involvement	93	69	15	11	27	20
Communications and co-ordination	104	77	16	12	15	11
Quality of work						
Suitability for user	130	96	3	2	3	2
Functional working	127	94	5	4	3	2
Overall quality	118	87	9	7	9	7
Client organization						
Communications and co-ordination	112	82	18	13	7	5
Involvement and teamwork	120	88	16	12	1	1
Others						
Physical disruption caused	97	81	8	7	15	13
Professional team performance	104	76	24	18	9	7

Figure 4. Client satisfaction levels (Brenen & Haslam, 1991)

Songer and Molenaar, 1996

In this study, the researchers examined the factors which influence the selection of design-build as the project delivery method of choice by owners. The factors considered included the establishment of cost, the reduction of cost, establishment of schedule, reduction of schedule, reduction of claims, large project size and complexity, and constructability/innovation (Figure 5).

Selection factor (1)	Definition (2)
Establish cost	Secure a project cost before the start of detailed design
Reduce cost	Decrease the overall project cost as compared to other procurement methods (design-bid-build, construction management, etc.)
Establish schedule	Secure a project schedule before the start of detailed design
Shorten duration	Decrease the overall project completion time as compared to other procurement methods (design-bid-build, construction management, etc.)
Reduce claims	Decrease ...igation due to separate design and construction entities
Large project size complexity	The project's shear magnitude is too complex to be managed through multiple contracts
Constructability/ innovation	Introduce construction knowledge into design early in the process

Figure 5. Design-build selection criteria and definitions (Songer & Molenaar, 1996)

Data for this study was collected through a survey instrument sent to 290 owner organizations. Of the 182 responses received, 108 of the responses were determined to be valid and included in the data analysis. The survey instrument prompted the participants to rate the factors considered on a Likert scale from 1 to 7, with 1 being the most important factor considered when making the decision to use the design-build project delivery method and 7 being the least important factor.

The researchers in this study found that owner attitudes toward the selection of design-build as the project delivery method of choice is influenced by the owner's desire for shorter project durations (Figure 6). Researchers also compared public versus private owner attitudes to determine if there were significant differences between the two in reference to the factors examined in the study. While there were differences between the two groups, the only area of noteworthy variation was the issue of claims reduction. Public owners were more inclined to cite the reduction of claims as a factor in their decision to use the design-build project delivery method (Songer & Molenaar, 1996).

Selection factor (1)	Mean (2)	Rank (3)	Standard deviation (4)	Median (5)	Rank (6)	Minimum (7)	Maximum (8)
Shorten duration	2.48	1	1.68	2	1	1	7
Establish cost	3.26	2	1.73	3	2	1	7
Reduce cost	3.82	3	1.60	4	3	1	7
Constructability/innovation	3.94	4	1.88	4	3	1	7
Establish schedule	3.99	5	1.80	4	3	1	7
Reduce claims	4.58	6	1.91	5	6	1	7
Large project size/complexity	5.92	7	1.58	7	7	1	7

Figure 6. Survey results (Songer & Molenaar, 1996)

Konchar and Sanvido, 1998

Researchers examined three of the most commonly utilized project delivery systems in use in the United States to determine how they compared on the basis of costs, schedule, and quality. The project delivery methods included in this study were design-bid-build, design-build, and construction-management-at-risk.

The researchers began with a literature review followed by the development of a survey instrument. Following testing of the instrument, it was sent to approximately 7,600 organizations and individuals for completion. Of this number, 378 surveys were returned to the researchers. In reviewing the returned surveys, 77 were found to contain data that was beyond the scope of the survey and were removed from the analysis. To strengthen the validity of the results, the researchers conducted a follow-up survey of 80 of the original recipients that did not respond. The purpose of this action was to determine if there were significant differences between those who initially responded to the survey and those who did not respond. The result of the follow-up analysis demonstrated that the results from the original respondents did not significantly differ from the results obtained from those of the original non-respondents.

The results from the 351 surveys returned and validated were grouped into categories on the basis of project delivery system used, facility type, owner type, size,

and unit costs. A comparison of the mean results from this study indicated that projects completed using the design-bid project delivery system had lower costs and higher schedule productivity when compared to similar projects using construction-management-at-risk or the design-bid-build project delivery system (Figure 7).

Metric (1)	Unit (2)	Construction management at risk (3)	Design/build (4)	Design/bid/build (5)	Maximum standard error (6)
Unit cost	Dollars/m³	1,140	861	1,291	197
Cost growth	%	3.37	2.17	4.83	2.2
Schedule growth	%	0	0	4.44	1.7
Construction speed	m³/month	761	845	477	220
Delivery speed	m³/month	438	636	302	191
Intensity	(dollars/m³)/month	50	62	40	13

Figure 7. Results comparing costs and schedule means (Konchar & Sanvido, 1998)

The researchers also compared project delivery methods on the basis of quality. For this area of the study, the participants were asked to rate the quality of their projects employing a Likert-type of scale with 10 being the highest quality rating. Construction-management-at-risk was rated highest in four of seven categories, followed by design-build being highest in two categories (Figure 8).

Quality metric (1)	Construction management at risk (2)	Design/build (3)	Design/bid/build (4)	Maximum standard error (5)
Start up	7.43	7.5	5.96	0.19
Call backs	8.07	7.94	7.04	0.19
Operation and maintenance	6.69	7.67	6.88	0.19
Envelope, roof, structure, and foundation	5.36	5.71	4.95	0.19
Interior space and layout	6.28	6.15	5.19	0.19
Environment	5.34	5.24	4.86	0.19
Process equipment and layout	5.63	5.61	5.07	0.19

Figure 8. Comparison of mean quality ratings (Konchar & Sanvido, 1998)

Project Delivery Method Studies Including JOC

Williams, 1994

The researcher conducted a comprehensive examination of job-order-contracting. The author studied the strengths and weaknesses of common forms of project delivery methods, including the use of fixed price contracts, unit price contracts, cost plus fee contracts, and negotiated contracts. The study also examined the development and history of job-order-contracting. The author then reviewed a number of job-order-contracting case studies in various locations across the U. S. The study concluded with a discussion of the advantages and disadvantages job-order-contracting as a project delivery method.

The primary research methodologies utilized for this study included a literature review, personal interviews, and the development of case studies. The personal interviews were with many of the originators/developers of this project delivery method and with the case study users of job-order-contracting. The case studies were developed from a number of sources including the City of Chicago, Texas A & M University, Spring Branch Independent School District in Texas, Dade County Florida, Atlanta Housing Authority, Palm Beach Florida, and private industry.

One of the most valuable findings of this research was the development of a chronology of the history of job-order-contracting from its early years with the U. S. Army to its widespread use as a project delivery method for state and local government agencies. Another important finding of this research was a listing of commonly perceived advantages and disadvantages of job-order-contracting (Table 2). While this was a good start at beginning to identify the common perceptions of job-order-contracting as a

project delivery method, the researcher did not provide quantitative data to support these perceptions. It is assumed that this list of advantages and disadvantages was developed through the interview process.

Table 2.

Advantages and Disadvantages of Job-Order-Contracting (Williams, 1994)

Advantages	Disadvantages
Reduced procurement burden costs	Competition restriction
Quicker response time	Reduction in owner's CM manning
Reduced risk and claims potential	Contractor mini-monopoly
Teamwork/design	A/E support loss
Value and quality	Being stuck with a bad contractor for a year
	Lack of planning by CE may drive the need
	Year-end spending limits

Kashiwagi, 2002

For this study, the researcher collected data over a five-year period (1994 through 1998) concerning the characteristics of JOC users and their contracts. This study was sponsored by the Center for Job Order Contracting Excellence and included a comparison of the characteristics being tracked on the basis of membership versus non-membership in the CJE. In addition to the tracking of the characteristics over this period of time, the researcher also included a discussion of the perceived advantages and disadvantages of using job-order-contracting.

The methodology used to conduct this study was not well-defined in the paper, but it does appear as if a survey instrument was utilized to collect data. The survey questions were primarily directed at the characteristics of the contracts being used and the

characteristics of owners using these contracts. Additional questions were focused on the effectiveness of JOC as a project delivery method. A Likert-type scale (1 to 10) was used to quantify subjective measures such as levels of owner satisfaction.

Results from this study generally indicate positive growth in performance trends from 1994 through 1998. Figure 9 compares results of the study on the basis of membership versus non-membership in the CJE. The results generally indicate better performance by CJE members when compared to non-CJE members, as illustrated with objective measures such as percentage of delivery orders completed on time (82% for CJE members versus 69% for non-members). This performance trend also appears to be true for subjective measures such as satisfaction with the job-order contractor (a mean of 8.21 out of 10 for the CJE member versus 7.17 out of 10 for the non-member).

	Performance Criteria	Unit	MEMBERS Group Average	NON MEMBERS Group Average
1	Number of surveys returned:	#	955	not provided
2	Percent of surveys returned:	%	56%	80%
3	Actual award amount to date:	$	5995335	not provided
4	Maximum duration (Base year & optional year):	Years	4.46	4.32
5	Total number of current JOC/SABER/DOC contracts on site:	#	5.71	4.50
6	Number of delivery (job) orders to date:	#	133.85	131.33
7	Number of contractor management personnel on site:	#	4.89	4.25
8	Approximate number of delivery orders being accomplished simultaneously by contractor:	#	12.96	11.40
9	Percentage of delivery orders completed on time:	%	82%	69%
10	What percentage of delivery orders on your JOC/SABER/DOC contract are you dissatisfied with?	%	5%	10%
11	Average response time for cost estimates and "basic" drawings on "routine" delivery orders:	Days	14	9.50
12	Average response time for cost estimates and "basic" drawings on "emergency / urgent" delivery orders:	Days	4.7	3.50
13	How satisfied are you with your JOC/SABER/DOC contractor?	1-10	8.21	7.17
14	Quality of drawings:	1-10	7.81	5.10
15	Quality of construction:	1-10	8.21	6.57
16	Professional level of the contractor:	1-10	8.45	7.43
17	Housekeeping level of contractor:	1-10	7.96	6.67
18	Contractor's management capability of on-site personnel:	1-10	7.93	7.00
19	Contractor's engineering support capability:	1-10	7.95	5.10
20	Contractor's public relations/customer service rating:	1-10	8.34	7.43
	How would you rate the efficiency of your JOC/SABER/DOC contract compared to other methods of project delivery?			
21	Performance level of subcontractors on contract:	1-10	8.15	6.75
22	Ability to manage multiple subcontractors:	1-10	7.78	6.03
23	Ability of contractor to manage multiple delivery orders simultaneously:	1-10	8.05	6.97
24	Contractor's safety performance:	1-10	8.74	8.03
25	Percent of JOC/SABER/DOC contracts that were rated as being better than other methods of project delivery:	%	88%	67%
26	Percent of JOC/SABER/DOC contracts that were rated as being the same as other methods of project delivery:	%	14%	25%
27	Percent of JOC/SABER/DOC contracts that were rated as being worse than other methods of project delivery:	%	0%	8%

Figure 9. CJE members versus non-members on basis of performance (Kashiwagi, 2002)

Figure 10 demonstrates the trends over the period from 1994 through 1998 for CJE members only. These results also indicate positive growth for JOC over this period

as illustrated by the increase in the maximum duration of the job-order-contracts from 3.7 years to 4.4 years in 1998.

		Years	94	95	96	97	98
		Units					
1	Percent of surveys returned:	%	72.98%	60%	67%	74%	78%
2	Maximum duration (Base year & optional year):	Years	3.7	3.6	4	4.3	4.4
3	Average percentage of delivery orders completed on time:	%	75.94%	78.35%	80.33%	82.00%	82.00%
4	What percentage of delivery orders on your JOC/SABER/IDOC contract are you dissatisfied with?	%	13.37%	13.80%	12.59%	8.52%	5.00%
5	Average response time for cost estimates and "basic" drawings on "routine" delivery orders:	Days	11.46	15.20	14.46	12.90	14.00
6	Average response time for cost estimates and "basic" drawings on "emergency / urgent" delivery orders:	Days	4.31	6.11	4.30	3.94	4.70
7	Customer rating of quality of drawings:	(1-10)	5.69	7.59	7.42	7.75	7.81
8	Average Customer rating of quality of construction:	(1-10)	7.32	7.75	8.08	8.48	8.21
9	Professional level of the contractor:	(1-10)	7.05	8.20	8.55	8.73	8.45
10	Housekeeping level of contractor:	(1-10)	7.00	7.90	8.16	8.16	7.96
11	Contractor's management capability of on-site personnel:	(1-10)	6.91	7.73	8.08	8.37	7.93
12	Contractor's engineering support capability:	(1-10)	5.54	7.32	7.44	7.85	7.95
13	Contractor's public relations/customer service rating:	(1-10)	6.92	8.55	8.38	8.24	8.54
14	Number of surveys returned:	#	85.00	55.00	83.00	93.00	62.00
15	Average number of delivery being accomplished simultaneously:	#	19.7	15.7	23	19.9	12.7

Figure 10. Performance trends on CJE member contracts (Kashiwagi, 2002)

Figure 11 illustrates the 1998 survey results grouped by the individual CJE member providing the job-order contract. It is noteworthy that this figure contains a table that compares JOC to other non-specific project delivery methods. In addition to the results shown in the previous figures, these findings indicate that the users of this project delivery method are of the opinion that JOC is superior to other project delivery methods (82% better than, 14% same as, and 2% worse than). While this might be a good indication of the results expected in similar research efforts, it would have been much more useful if the researcher had phrased this question in the context of a specific comparison such as job-order-contracting in comparison to design-bid-build.

	Performance Criteria	Unit	Group Average	A	B	C	D	E	F	H
		#	8.85	10.00	12.00	2.00	11.00	11.00	9.00	7.00
1	Number of surveys returned:	%	78%	91%	80%	67%	85%	65%	75%	78%
2	Percent of surveys returned:	$	5991535	1826284	5344756	600000	4016082	19860314	2502733	7933824
3	Actual award amount to date:	Years	4.43	3.89	6.50	5.00	4.50	4.30	2.56	4.29
4	Maximum duration: Base year & optional year):	#	3.71	4.56	4.42	1.00	1.30	8.55	4.44	1.71
5	Total number of current JOC/SABER/DOC contracts on site:	#	113.85	45.44	66.08	53.50	40.73	416.60	42.33	132.33
6	Number of delivery (job) orders to date:	#	4.89	4.56	3.33	3.50	4.82	12.55	2.11	3.42
7	Number of contractor management personnel on site:	#	12.66	8.90	10.92	13.50	9.50	24.50	7.89	13.50
8	Approximate number of delivery orders being accomplished simultaneously by contractor:	%	82.40%	82.38%	73.00%	92.00%	96.70%	85.27%	88.38%	90.40%
9	Percentage of delivery orders completed on time:	%	4.86%	3.67%	7.58%	3.50%	0.64%	1.90%	11.67%	3.14%
10	What percentage of delivery orders on your JOC/SABER/DOC contract are you dissatisfied with?	Days	13.98	14.45	15.29	14.00	12.82	19.86	12.00	9.42
11	Average response time for cost estimates and "basic" drawings on "routine" delivery orders:	Days	4.67	4.51	5.91	7.00	3.80	4.27	5.67	1.67
12	Average response time for cost estimates and "basic" drawings on "emergency / urgent" delivery orders:	(1-10)	8.21	8.20	7.58	8.50	8.91	8.55	7.06	8.71
13	How satisfied are you with your JOC/SABER/DOC contractor?	(1-10)	7.81	7.78	7.55	8.50	8.82	8.10	6.75	7.16
14	Quality of drawings:	(1-10)	8.21	7.78	8.17	8.50	8.91	8.36	6.67	9.14
15	Quality of construction:	(1-10)	8.45	8.20	8.08	9.50	9.23	8.82	6.56	9.00
16	Professional level of the contractor:	(1-10)	7.96	7.44	7.08	9.00	8.64	8.00	7.33	8.28
17	Housekeeping level of contractor:	(1-10)	7.93	8.20	7.33	8.50	8.73	8.00	6.56	8.71
18	Contractor's management capability of on-site personnel:	(1-10)	7.95	7.56	6.67	9.50	8.73	7.52	6.69	8.42
19	Contractor's engineering support capability:	(1-10)	8.54	8.90	8.18	9.50	9.09	8.55	6.56	9.00
20	Contractor's public relations/customer service rating:	(1-10)	7.69	7.90	7.92	7.00	8.64	7.55	6.25	9.00
21	Performance level of subcontractors on contract:	(1-10)	7.78	7.80	7.42	8.00	8.91	8.18	5.63	8.57
22	Ability to manage multiple subcontractors:	(1-10)	8.05	8.00	7.55	8.50	9.05	8.27	5.94	8.71
23	Ability of contractor to manage multiple delivery orders simultaneously:	(1-10)	8.74	8.80	8.25	8.50	9.36	9.45	8.00	8.85
24	Contractor's safety performance:									
	How would you rate the efficiency of your JOC/SABER/DOC contract compared to other methods of project delivery?	Better than:	85%	100%	67%	100%	90%	73%	78%	86%
25	Percent of JOC/SABER/DOC contracts that were rated as being better than other methods of project delivery:	Same as:	14%	0%	33%	0%	10%	27%	11%	14%
26	Percent of JOC/SABER/DOC contracts that were rated as being the same as other methods of project delivery:	Worse than:	2%	0%	0%	0%	0%	0%	11%	0%
27	Percent of JOC/SABER/DOC contracts that were rated as being worse than other methods of project delivery:									
		Number of Sites:	80	11	15	3	15	17	12	9
		Number of Surveys Returned:	62	10	12	2	11	11	9	7
		Percentage of Returned Surveys:	78%	91%	80%	67%	85%	65%	75%	78%

Figure 11. Summary of the 1998 survey results by CJE member (Kashiwagi, 2002)

Mulcahy, 2000

The researcher looked at different combinations of partnering and source selection factors that influence performance success on job-order contracts. The performance criteria established for this study included: 1) construction performance, 2) administrative support, 3) owner-contractor relationships, and 4) participant satisfaction.

Data for this study was collected through the development and delivery of survey instruments delivered to users and providers of job-order-contracting. While the user (owner) and provider (contractor) surveys were similar, the questions in each survey were targeted specifically toward the group being surveyed (owner or contractor). In total, 35 project sites were surveyed with one survey going to the owner and the other going to the contractor. The sites were organized into four groups as illustrated in Figure 12.

# of Sites	RFP Source Selection	Low bid
Partnered	17 (49%)	1 (3%)
Non-Partnered	10 (28%)	7 (20%)

Figure 12. Source selection/partnering combinations of sites surveyed (Mulcahy, 2000)

All together there were 21 questions directed at the owner and 9 questions for the contractor. The questions directed the respondents to rate each other in various categories and to rate the performance of the contract on the basis of a Likert-type scale (1 to 5). Following the receipt and evaluation of the responses, the data for each question were categorized into group combinations: 1) partnered with RFP source selection (P-RFP), 2) non-partnered with RFP source selection (NP-RFP), 3) partnered with low-bid source selection (P-LB), and 4) non-partnered with low-bid source selection

(NP-LB). Results were determined by comparing the group means to one another on the basis of each question.

Figure 13 illustrates the group combination of responses returned. Because no responses were received from the partnered with low-bid group, that combination was eliminated from further consideration.

Sample Population	Number of Sites	Owner Questionnaires Received	Contractor Questionnaires Received	Overall Response Rate
Partnered + RFP Source Selection	17	16	16	94%
Non-Partnered + RFP Source Selection	10	8	9	85%
Non-Partnered + Low Bid	7	6	6	86%
Totals	34	30	31	90%

Figure 13. Combination of responses to the survey (Mulcahy, 2000)

The results from this study were primarily a series of bar charts that compare group mean ratings as illustrated in Figure 13 for the quality of construction (1 = poor to 5 = outstanding). This particular result illustrates that the job-order-contracting users that issue a request for proposal selection in combination with partnering have a higher opinion of the quality of construction (mean response = 4.13 out of 5) when compared to the opinions of users that do not employ this combination of source selection and partnering.

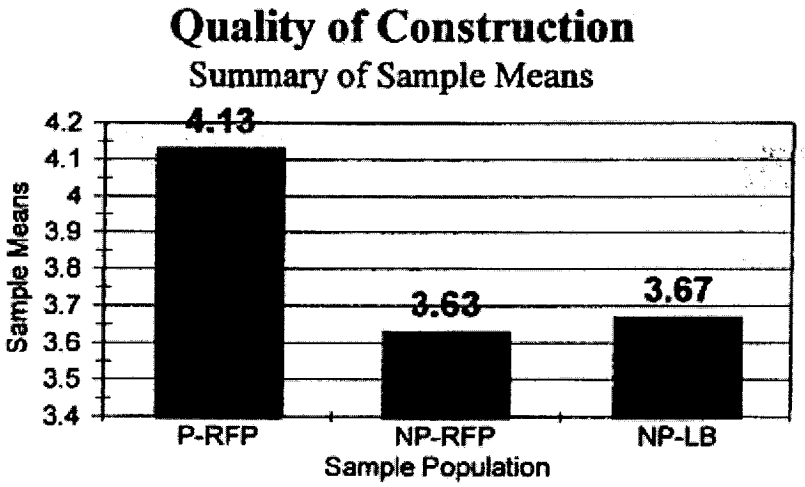

Figure 14. Comparison of construction quality of construction (Mulcahy, 2000)

In general, both owners and contractors indicated high levels of satisfaction with job-order contracts that were obtained through the use of an RFP source selection coupled with the use of a formal partnering arrangement. Lower levels of satisfaction were indicated when this combination of source selection and partnering was not engaged (Table 3).

Table 3.

Levels of Satisfaction (Mulcahy, 2000)

Characteristic	RFP source selection and partnering used	RFP source selection and partnering not used	Low bid source selection and partnering not used
Construction performance			
Quality of construction (1-5)	4.13	3.63	3.67
Contractor's safety performance (1-5)	4.44	4.00	4.17
On-time completion of job orders (1-5)	3.78	3.38	3.17
Subcontractor scheduling and performance (1-5)	3.72	3.13	3.17
Warranty service (1-5)	4.43	4.13	4.00
Administrative support			
Responsiveness and timeliness of administrative support: owner's perspective (1-5)	4.19	3.63	2.83
Responsiveness and timeliness of administrative support: contractor's perspective (1-5)	3.53	2.67	3.83
Innovation and value engineering: owner's perspective (1-5)	3.84	2.50	2.80
Innovation and value engineering: contractor's perspective (1-5)	3.73	2.89	3.33
Responsiveness to client needs (1-5)	4.56	3.13	3.67
Ability to prevent and solve scheduling and site coordination problems (1-5)	4.16	3.25	3.33
Contractor's management effectiveness (1-5)	4.00	3.38	3.33
Relationships			
Ease of job order negotiations: owner's perspective (1-5)	3.97	3.88	3.33
Ease of job order negotiations: contractor's perspective (1-5)	3.66	3.33	3.00
Participant satisfaction			
Customer (end user) satisfaction (1-5)	4.31	3.75	3.33

Henry & Brothers, 2001

In this study the researchers compared simplified-acquisition-of-base-engineering-requirements (SABER) to the design-bid-build project delivery method on the basis of construction cost and schedule (Note: SABER is the U.S. Air Force version of JOC). The research was performed on projects at two Air Force bases in the U. S. A unique feature of this research effort in comparison to other comparative studies is that the research is based upon actual cost and time data from projects completed for the U. S. Air Force. Other research used to compare project delivery methods is largely based upon opinion data.

The study began with a literature review and a review of case studies related to the use of SABER and JOC. The researchers noted that, as a general rule, job-order-contracts performed outside the U. S. Air Force were conducted in a less restrictive regulatory environment with respect to limitations placed on the maximum size of the project and the use of prices from outside of the unit price book. The Air Force required that the total cost of individual projects should be under $500,000 and that at least 90% of the prices used come from the unit price book.

The researchers screened over 400 projects at two Air Force bases that had used both SABER and the design-bid-build project delivery method. From this population, 31 SABER projects (also known as delivery orders) and 15 DBB projects were selected for inclusion in the study. Criteria for inclusion required that the projects contain a similar compliment of project activities such as structural components, architectural finishes, and mechanical/electrical/ plumbing components. Data collected included schedule data (i.e. start date, estimated completion date, actual completion date) and cost data (i.e. design

cost, construction award cost, cost of modifications, and final cost). The data were analyzed to determine the overall cost and schedule growth of the projects on the basis of the project delivery method utilized.

Figure 14 is a summary of the findings from the study. These findings indicate that the average SABER project demonstrated lower cost per square meter and lower time growth. In addition, the results indicate that the design-bid-build projects demonstrated lower cost growth. One of the concerns expressed by the researchers regarding the findings was the small sample size. The researchers acknowledged the fact that it would be difficult to reach sweeping conclusions on the basis of the 46 projects in the study.

Sample set	Cost/m² ($)	Time growth (%)	Cost growth (%)	No. of samples
Base 1 DBB	882.90	39.38	1.44	10
Base 2 DBB	824.90	18.00	1.80	5
Base 1 SABER	684.20	−6.67	6.45	19
Base 2 SABER	597.10	5.73	1.08	12
Average DBB	853.90	28.69	1.62	
Average SABER	640.70	−0.47	3.77	

Figure 15. Summary of cost and time findings (Henry & Brothers, 2001)

Summary

In summary, the research that has been completed to date has acknowledged the common belief that the selection of an appropriate project delivery method for a specific type of project will have a significant impact on the elements of owner satisfaction. As one researcher observed, it is not so much a question of finding the right project delivery method for the right project as it is the elimination of those project delivery methods which would be inappropriate (Garvin, 2003).

Unfortunately, the studies that have been completed thus far have generally either excluded job-order-contracting from the comparative studies, or they focus exclusively on job-order-contracting. There have been no comprehensive studies that compare JOC to other specific project delivery methods on the basis of the elements of owner satisfaction. The Kashiwagi (2002) study compares JOC to "other" project delivery methods, but does not identify what those other methods are.

Another noteworthy aspect of this literature review is that opinion surveys have been, and continue to be used as a method of determining attitudes with respect to the influence of project delivery methods on the elements of owner satisfaction. While most of these opinion surveys have contributed to a better understanding of the relationship between project delivery method and the elements of owner satisfaction, the sample sizes of these studies have been too small to be statistically significant. The one exception is the Konchar and Sanvido (1998) study. In this study, 7,700 organizations were contacted in an effort to determine the effects of project delivery method on construction costs, schedule, and quality. The researchers in this study managed to capture 5% of this number in responses, making this one of the more recognized studies in the area of project delivery comparisons.

CHAPTER 3

METHODOLOGY

Overview

The primary methodology utilized to conduct this study was be to conduct an Internet based survey of a sample of job-order-contracting users to determine their characteristics and opinions regarding the use of JOC as a project delivery method. Questions for inclusion in the survey were developed from the literature review and interviews with users and providers of JOC services, including Gary Aller of the Alliance for Construction Excellence; Charlie Bowers of the Center for Job-Order-Contracting Excellence; Tom Peeler and Craig McKee of Mohave Educational Services (Peeler & McKee, 2005); Ron Ecker, Phil Valardi, and Tom Bilecki of the 3D/I Corporation (Ecker, Valardi, & Bielecki, 2005); Rocky Gerber (Gerber, 2005); Quinn Dolan (Dolan, 2005); Mark Baier (Baier, 2005) of Centennial Construction, and Richard Morehouse of Northern Arizona University (Morehouse, 2005). The questions developed from this process related to: 1) What are the characteristics of the typical JOC user with respect to experience, location, type of organization, pricing methodology, and reasons for using job-order-contracting? 2) What is the most likely alternative to job-order-contracting as a project delivery method for the owner currently using JOC? 3) When compared to a

specific alternative, how satisfied are the users of job-order-contracting with respect to the performance of JOC in the areas of construction cost, timeliness, quality, safety, and claims?

Following the collection of the survey, the data were reviewed and analyzed in accordance with the objectives of this study. The following processes are an explanation of the review and analysis procedures utilized.

Conceptual Framework

In developing a conceptual framework for this study, a number of resources were consulted, including references on construction project delivery methods, customer satisfaction surveys, and the users of the JOC project delivery method. What was derived from this research is the conceptual framework for this study. These references most often identified owner satisfaction with the construction process as being related to having the project completed: 1) within budget (cost), 2) on-time (schedule), 3) with the quality specified (quality), 4) in a safe manner (safety), and 5) with no claims (claims). From this framework the following constructs were developed:

Cost

While cost is a major component in the owner's overall satisfaction with the construction process, it can be divided into a number of distinct categories. For this study the following propositions will be utilized:

P_1: The lower the cost of design for a JOC project in comparison to a specific alternative project delivery method (APDM), the higher the level of owner satisfaction.

P_2: The lower the cost of procuring the services of a JOC contractor in comparison to a specific APDM, the higher the level of owner satisfaction.

P_3: The lower the cost of JOC construction in comparison to a specific APDM, the higher the level of owner satisfaction.

P_4: The lower the cost of change orders on a JOC project in comparison to a specific APDM, the higher the level of owner satisfaction.

P_5: The lower the cost of administering a job-order-contract in comparison to a specific APDM, the higher the level of owner satisfaction.

P_6: The lower the cost of claims on a job-order-contracting project in comparison to a specific alternative project delivery method, the higher the level of owner satisfaction.

In summary, there is an inverse relationship between cost and owner satisfaction. Higher cost relates to lower levels of owner satisfaction and lower cost relate to higher levels of owner satisfaction.

Schedule

In a similar manner to that of cost of construction, the schedule could also be divided into distinct categories. The following are the schedule propositions used for this study:

P_7: The less time required to initiate a JOC project in comparison to a specific APDM, the higher the level of owner satisfaction.

P_8: The less time required to design a job-order-contracting project in comparison to a specific alternative project delivery method, the higher the level of owner satisfaction.

P_9: The less time required to construct a job-order-contracting project in comparison to a specific alternative project delivery method, the higher the level of owner satisfaction.

P_{10}: The less time required to closeout a job-order-contracting project in comparison to a specific alternative project delivery method, the higher the level of owner satisfaction.

In summary, an inverse relationship between project time required and owner satisfaction exists. More project time required relates to lower levels of owner satisfaction and lower project time required relates to higher levels of owner satisfaction.

Quality

Quality is a two-fold proposition of meeting the owner's expectations and the freedom from defects in the completed project. With this as the primary framework, the propositions for the quality component of this study include:

P_{11}: The better the quality of JOC work in comparison to a specific alternative project delivery method, the higher the level of owner satisfaction.

P_{12}: The less warranty issues encountered on a job-order-contracting project in comparison to a specific alternative project delivery method, the higher the level of owner satisfaction.

Safety

Safety is also a two-fold proposition of meeting the owner's expectations and the freedom from accidents during the construction. For this study the following propositions are being utilized:

P_{13}: The better the worker safety on a JOC project in comparison to worker safety on a specific alternative project delivery method, the higher the level of owner satisfaction.

P_{14}: The fewer accidents in a job-order-contracting project in comparison to the number of accidents on a specific alternative project delivery method, the higher the level of owner satisfaction.

Claims

The number of claims on a project is an indicator of unresolved disputes. For this study the following proposition is proposed:

P_{15}: The fewer the number of claims on a JOC project in comparison to the number of claims on a specific alternative project delivery method, the higher the level of owner satisfaction.

Validity

The validity of a survey instrument is a measure of how well the questions in the instrument measure the qualities being studied. In this study the propositions being utilized include: 1) the cost of a project, 2) the time required completing a project, 3) the quality of a project, 4) the safety on a project, and 5) the number of claims on a project, which are all related either directly or inversely to overall owner satisfaction. To validate these propositions each respondent was asked to rate overall owner satisfaction with job-order-contracting in comparison to a specific alternative project delivery method. Using a Likert-type scale of measurement (1 to 5), the levels of each element of owner satisfaction can be cross-tabulated with overall owner satisfaction. If the propositions are correct, then there will be a measurable correlation between overall owner satisfaction and each of the elements of owner satisfaction.

For this study each element of owner satisfaction was cross-tabulated with overall owner satisfaction. Using an alpha level of 0.05, which provides for a 95% confidence level, a Spearman Rank Order procedure was performed to determine if there is a significant relationship between overall owner satisfaction and the individual elements of owner satisfaction. Utilizing the SPSS software program for statistical analysis, those elements with a level of significance of less than 0.05 were judged to be valid elements of owner satisfaction.

Reliability

The reliability of a study is a measure of how reliable the results are. In other words, if someone else were to do this same study under the same or similar conditions, a study of good reliability should result in the same or similar conclusions.

In Kashiwagi's 1998 study (Kashiwagi, 2002), the question was asked if job-order-contracting is better than other methods of project delivery. In response to this question, 85% of respondents using a CJE contractor and 67% of those using a non-CJE contractor indicated JOC is better than other methods of project delivery. As an indication of the reliability of this study, 72% of the respondents to this study indicated they are more satisfied with job-order-contracting in comparison to the most likely alternative. There was no attempt in this study to segregate respondents on the basis of CJE contractor affiliation.

While the comparison of the results from these two questions in two independent studies provided similar results, true reliability of this study will not be validated until such time that this study can be independently reproduced.

Survey

The Institute for Social Science Research (ISSR) at Arizona State University was retained to develop the survey instrument in a format for delivery over the Internet. The survey questions were then converted into an HTTP format and posted to the ISSR Internet site. Following this, an e-mail invitation was sent to a mailing list compiled from the CJE membership.

It should be noted that each e-mail invitation contained a unique URL address that linked the recipient of the e-mail to the survey instrument. Once a specific URL was utilized, it would then be deactivated to assure that each respondent would only have one opportunity to contribute to the survey.

Between October 2005 and the end of February 2006, the survey was posted to the Internet and e-mail invitations sent to a list of 7,599 job-order-contracting users. From this, 247 responses (3.4% return rate) were received and reviewed. Of this amount, 57 of the respondents failed to significantly complete the owner satisfaction portion of the survey (failed to answer 20% or more of the questions) and were removed from further consideration. The remaining 190 responses were divided into two groups for further analysis: 1) those respondents that indicated they use a unit price book as part of their job-order contract (106 respondents), and 2) those that indicated they do not use a unit price book (84 respondents).

One of the issues currently being discussed among the providers and users of job-order-contracting is what makes job-order-contracting unique from other project delivery methods. As stated above, job-order-contracting was originally conceived as an

indefinite delivery indefinite quantity type of contract to be used with a unit price book. It was recognized early in this study that many users of job-order-contracting have moved away from the use of a unit price book and are using "cost plus" types of contracts to price their job-order work. While there is no intent with this study to redefine "what is" or "what is not" job-order-contracting, a conscientious decision was made to focus this study on the original definition of job-order-contracting: an IDIQ contract that utilizes a unit price book. Thus the findings of this study will be focused on that definition.

Restatement of Hypotheses

Null Hypothesis 1

The users of JOC will indicate there are no one, or more, most likely alternative project delivery methods to job-order-contracting. $H_0 1$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternate Hypothesis 1

The users of JOC will indicate there is one, or more, most likely alternative project delivery methods to job-order-contracting. $H_A 1$: Not $H_0 1$

Null Hypothesis 2

Opinions with respect to the cost of project design being higher, the same, or lower than the design cost for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 2$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 2

Opinions with respect to the cost of project design being higher, the same, or lower than the design cost for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. H_A2: Not $H_0 2$

Null Hypothesis 3

Opinions with respect to the cost of contractor procurement being higher, the same, or lower than the procurement cost for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 3$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 3

Opinions with respect to the cost of contractor procurement being higher, the same, or lower than the procurement cost for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. $H_A 3$: Not $H_0 3$

Null Hypothesis 4

Opinions with respect to the cost of construction being higher, the same, or lower than the construction cost for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 4$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 4

Opinions with respect to the cost of construction being higher, the same, or lower than the construction cost for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. $H_A 4$: Not $H_0 4$

Null Hypothesis 5

Opinions with respect to the cost of change orders being higher, the same, or lower than the change order cost for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 5$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 5

Opinions with respect to the cost of change orders being higher, the same, or lower than the change order cost for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. $H_A 5$: Not $H_0 5$

Null Hypothesis 6

Opinions with respect to the cost of project administration being higher, the same, or lower than the project administration cost for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 6$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 6

Opinions with respect to the cost of project administration being higher, the same, or lower than the project administration cost for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. $H_A 6$: Not $H_0 6$

Null Hypothesis 7

Opinions with respect to the cost of claims being higher, the same, or lower than the claims cost for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 7$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 7

Opinions with respect to the cost of claims being higher, the same, or lower than the claims cost for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. H_A7: Not H_07

Null Hypothesis 8

Opinions with respect to the time required to initiate the work being longer, the same, or shorter than the time required for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. H_08: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 8

Opinions with respect to the time required to initiate the work being longer, the same, or shorter than the time required for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. H_A8: Not H_08

Null Hypothesis 9

Opinions with respect to the time required to complete the design being longer, the same, or shorter than the time required for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. H_09: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 9

Opinions with respect to the time required to complete the design being longer, the same, or shorter than the time required for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. H_A9: Not H_09

Null Hypothesis 10

Opinions with respect to the time required to construct the project being longer, the same, or shorter than the time required for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 10$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 10

Opinions with respect to the time required to construct the project being longer, the same, or shorter than the time required for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. $H_A 10$: Not $H_0 10$

Null Hypothesis 11

Opinions with respect to the time required to closeout the project being longer, the same, or shorter than the time required for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 11$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 11

Opinions with respect to the time required to closeout the project being longer, the same, or shorter than the time required for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. $H_A 11$: Not $H_0 11$

Null Hypothesis 12

Opinions with respect to the ease of using JOC being easier, the same, or not as easy as using the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 12$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 12

Opinions with respect to the ease of using JOC being easier, the same, or not as easy as using the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. $H_A 12$: Not $H_0 12$

Null Hypothesis 13

Opinions with respect to the quality of work being better, the same, or worse than the quality for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 13$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 13

Opinions with respect to the quality of work being better, the same, or worse than the quality for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. $H_A 13$: Not $H_0 13$

Null Hypothesis 14

Opinions with respect to worker safety being better, the same, or worse than the safety for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 14$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 14

Opinions with respect to worker safety being better, the same, or worse than the safety for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. H_A14: Not $H_0 14$

Null Hypothesis 15

Opinions with respect to the number of warranty issues being higher, the same, or lower than the number for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 15$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 15

Opinions with respect to the number of warranty issues being higher, the same, or lower than the number for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. $H_A 15$: Not $H_0 15$

Null Hypothesis 16

Opinions with respect to the number of accidents being higher, the same, or lower than the number for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 16$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 16

Opinions with respect to the number of accidents being higher, the same, or lower than the number for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. $H_A 16$: Not $H_0 16$

Null Hypothesis 17

Opinions with respect to the number of claims being higher, the same, or lower than the number for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 17$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 17

Opinions with respect to the number of claims being higher, the same, or lower than the number for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. $H_A 17$: Not $H_0 17$

Null Hypothesis 18

Opinions with respect to the overall level of owner satisfaction being higher, the same, or lower than the level for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. $H_0 18$: $P_{DBB} = P_{DB} = P_{CMAR}$

Alternative Hypothesis 18

Opinions with respect to the overall level of owner satisfaction being higher, the same, or lower than the level for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. $H_A 18$: Not $H_0 18$

Alpha Discussion

Alpha represents the probability that the null hypothesis will be rejected when in fact it should be retained (Type I error). The alpha (α) for this study has been set at 0.05. At an alpha of 0.05 there is a 5% probability that the null hypothesis will be rejected when it should be retained.

The purpose of this study is to look for significant differences in attitudes and opinions regarding the use of job-order-contracting as a project delivery method in the construction industry. With an alpha for this study set at 0.05, there is a 95% possibility that these significant differences can be correctly identified. If alpha is set lower than 0.05, the probabilities of making a Type II error increases (the retention of the null hypothesis, when in fact it should be rejected).

Because this study proposes to seek out significant differences rather than provide assurances that the differences found are in fact significant, the alpha of 0.05 has been determined by this researcher to be at the appropriate level.

Statistical Technique

Analysis for the hypotheses of this study employed the Kruskal-Wallis test. This test is considered a non-parametric version of the analysis of variance test (ANOVA) used to determine if the observed differences between groups of data are the result of true differences in the populations or the result of random chance. For each of the hypotheses described above, the data were grouped by the specific project delivery method used in the comparison (i.e. design-bid-build, design-build, and construction-management-at-risk). A Kruskal-Wallis test statistic was calculated for each null hypothesis and compared to a chi square (χ^2) distribution. If significance was beyond what could be expected through chance sampling variation, then the null hypothesis was rejected in favor of the alternative hypothesis (Minium, Clark, & Coladarci, 1999). This would indicate that opinions regarding the influence of JOC on the elements of owner satisfaction are influenced by the project delivery method utilized in the comparison.

Statistical Assumptions

All assumptions regarding the use of the Kruskal-Wallis test and the chi square statistic apply to this study. These assumptions include: 1) the sample is random, and 2) all of the observations are independent.

Population

The individual member organizations from the Center for Job Order Contracting Excellence provided a list of clients and corresponding e-mail addresses to the ISSR at ASU for the population that will be sampled (approximately 7,600 addresses). While the CJE is probably the largest trade association involved in the use of JOC as a project delivery method, there are no assurances that the characteristics and opinions of this group of job-order-contracting users is representative of all job-order-contracting users. Thus the population for this study was limited to the clients of the CJE members that decided to participate.

Statistical Variables

Data for this study was be divided into three categories related to the questions of this study: 1) demographic information on the users of the JOC project delivery method, 2) the most likely alternative to JOC, and 3) opinions data on how JOC compares to the most likely alternative on the basis of cost, schedule, quality, safety, claims, and owner satisfaction.

Demographic Information

In order to gain greater insight into the users of job-order-contracting, the first portion of the survey was designed to collect information on the respondents such as employer type, zip code, years of experience with various project delivery methods, type of job-order-contract procurement, contracting environment, method of pricing JOC work, and primary reasons for using JOC. The answers to these questions were used to answer the question: What are the characteristics of the typical job-order-contracting user?

Employer type. A fundamental aspect of the construction process is understanding the roles of the participants in process. Each type of employer brings a different perspective to the process. The purpose of this question is to see what types of opinions will be represented in this study. The survey will provide for closed responses of 1) facility owner, 2) program manager, 3) general contractor, 4) subcontractor, and 5) do not know, and 6) not applicable. In addition, a seventh category will be provided for open-ended responses in the event the menu selections do not provide for a satisfactory option. The variable name for this response will be: EMPLYR.

Years of job-order-contracting experience. In addition to understanding the role that the respondent's employer plays regarding the use of job-order-contracting, it is anticipated that the respondent's level of JOC experience could play a significant role in these opinions. This is one of four questions that deal with levels of experience with job-order-contracting and the other three popular project delivery methods. The variable name for this response will be: JOCYRS.

Years of design-bid-build experience. This is the second of four questions that deal with levels of project delivery experience. The variable name for this response will be: DBBYRS.

Years of design-bid experience. This is the third of four questions that deal with levels of project delivery experience. The variable name for this response will be: DBYRS.

Years of construction-management-at-risk experience. This is the fourth of four questions that deal with levels of project delivery experience. The variable name for this response will be: CMARYRS.

Number of task orders. In addition to the years of experience with job-order-contracting, it is anticipated that the number of job orders that the respondent works with in a typical year could influence opinions regarding the use of JOC. This question is included to gain keener insight into the respondent's level of experience. The variable name for this response will be: NOTASK.

Type of Procurement. In the process of completing the literature review for this study, it became clear that there are two basic methods commonly utilized for the procurement of job-order-contracting services: owner procurement and a cooperative purchasing agreement. This question is designed to provide more insight into how users of JOC are procuring the services of a job-order contractor. The variable name for this response will be: PROCUR.

Contracting environment. Job-order-contracting was initially created by the U. S. Army and has been adopted by several other branches of the federal government. Since that time, it has been spreading into state and local governments in addition to private

companies. This question is designed to see where JOC is being used relative to contracting environment. The variable name for this response will be: ENVIRON.

Pricing method. While job-order-contracting was originally conceived to be utilized with a unit price book, many users of JOC indicate that pricing is being determined through a number of means including the use of sub-bids with predetermined mark-up and individual negotiation of each job-order proposal. This question is designed to look at how pricing for the work is determined. The variable name for this response will be: PRICING.

Zip code. One of the basic questions with respect to the use of job-order-contracting is: where is it being used? This question is designed to collect the zip codes of the locals where JOC is being used. The variable name for this response will be: ZIP.

Why use JOC? In trying to determine the characteristics of the respondents using job-order-contracting, one of the most important tasks is trying to understand why an organization would use one project delivery method over another. This question asks the respondents to identify their primary motivation for using JOC, and whether it is related to costs, quality, expediency, or something else. The variable name for this response will be: WHY01.

Most-likely-alternative to job-order-contracting

In order to provide a basis of comparison between job-order-contracting and other project delivery methods, each respondent has been asked to identify what they believe to be the most likely alternative to job-order-contracting. This not only provides for the basis of comparison for all of the subsequent questions in the survey, but it also provides

insight into what project delivery methods would use in lieu of JOC. The variable name for this response will be: MLA.

Opinions comparing job-order-contracting to the most likely alternative

The remaining questions in this survey ask the respondents to provide their opinions on job-order-contracting to the project delivery method that they have identified as the most likely alternative to JOC. These opinions will relate to the elements of owner satisfaction including cost, schedule, quality, safety, claims, and overall owner satisfaction. The respondents will be asked how the individual elements of owner satisfaction for job-order-contracting compare to the most likely alternative to JOC. Menu responses were provided in the form of a Likert scale that allows varying degrees of response (i.e. less to more, worse to better, and fewer to more).

Design costs. This question asks the respondents to compare the cost of project design using job-order-contracting to the cost of project design using the most likely alternative. Responses for this question will range from job-order-contract being much lower in cost to job-order-contracting being much higher in cost. The variable name for this response will be: DESIGN$.

Job order procurement costs. This question asks the respondents to compare the cost of obtaining the services of a contractor using job-order-contracting to the cost of obtaining the services of a contractor using the most likely alternative. Responses for this question will range from job-order-contract being much lower in cost to job-order-contracting being much higher in cost. The variable name for this response will be: PROC$.

Construction costs. This question asks the respondents to compare the cost of construction using job-order-contracting to the cost of construction using the most likely alternative. Responses for this question will range from job-order-contract being much lower in cost to job-order-contracting being much higher in cost. The variable name for this response will be: CONST$.

Change order costs. This question asks the respondents to compare the cost of change orders using job-order-contracting to the cost of change orders using the most likely alternative. Responses for this question will range from job-order-contract being much lower in cost to job-order-contracting being much higher in cost. The variable name for this response will be: CHANGE$.

Administration costs. This question asks the respondents to compare the cost of project administration using job-order-contracting to the cost of project administration using the most likely alternative. Responses for this question will range from job-order-contract being much lower in cost to job-order-contracting being much higher in cost. The variable name for this response will be: ADMIN$.

Claims costs. This question asks the respondents to compare the cost of claims using job-order-contracting to the cost of claims using the most likely alternative. Responses for this question will range from job-order-contract being much lower in cost to job-order-contracting being much higher in cost. The variable name for this response will be: CLAIM$)

Time to initiate work. This question asks the respondents to compare the time required to initiate the work using job-order-contracting to the time required to initiate the work using the most likely alternative. Responses for this question will range from

job-order-contracting using a lot less time to job-order-contracting using a lot more time. The variable name for this response will be: STARTIME.

Time to design the project. This question asks the respondents to compare the time required to design the project using job-order-contracting to the time required to design the project using the most likely alternative. Responses for this question will range from job-order-contracting using much less time to job-order-contracting using much more time. The variable name for this response will be: DSGNTIME

Time to construct. This question asks the respondents to compare the time required to construct the work using job-order-contracting to the time required to construct the work using the most likely alternative. Responses for this question will range from job-order-contracting using much less time to job-order-contracting using much more time. The variable name for this response will be: CONSTIME.

Time to close out the project. This question asks the respondents to compare the time required to close out the project using job-order-contracting to the time required to close out the project using the most likely alternative. Responses for this question will range from job-order-contracting using a lot less time to job-order-contracting using a lot more time. The variable name for this response will be: CLOSTIME

Ease of use. This question asks the respondents to compare the ease of using job-order-contracting to the ease of using the most likely alternative. Responses for this question will range from job-order-contracting using much easier to use to job-order-contracting using much more difficult to use. The variable name for this response will be: EASYUSE.

Quality. This question asks the respondents to compare the quality of work using job-order-contracting to the quality of work using the most likely alternative. Responses for this question will range from job-order-contracting using much better quality to job-order-contracting using much worse quality. The variable name for this response will be: QUALITY.

Safety. This question asks the respondents to compare worker safety using job-order-contracting to worker safety using the most likely alternative. Responses for this question will range from job-order-contracting using much better safety to job-order-contracting using much worse safety. The variable name for this response will be: SAFETY.

Warranty issues. This question asks the respondents to compare the frequency of warranty issues using job-order-contracting to the frequency of warranty issues using the most likely alternative. Responses for this question will range from job-order-contracting using much fewer warranty issues to job-order-contracting using much more warranty issues. The variable name for this response will be: WARRANT.

Accidents. This question asks the respondents to compare the frequency of accidents using job-order-contracting to the frequency of accidents using the most likely alternative. Responses for this question will range from job-order-contracting using much fewer accidents to job-order-contracting using much more accidents. The variable name for this response will be: ACCIDENT.

Claims. This question asks the respondents to compare the frequency of claims using job-order-contracting to the frequency of claims using the most likely alternative. Responses for this question will range from job-order-contracting using much fewer

claims to job-order-contracting using much more claims. The variable name for this response will be: CLAIMS.

Owner Satisfaction. This question asks the respondents to compare owner satisfaction using job-order-contracting to owner satisfaction using the most likely alternative. Responses for this question will range from job-order-contracting providing much more satisfaction to job-order-contracting providing much less satisfaction. The variable name for this response will be: SATISFY.

Collection and Coding of Data

Data for this study was collected through the Institute for Social Science Research at Arizona State University. An e-mail message containing a unique URL address was sent to each individual on the mailing list. The message advised the recipient that they are being invited to participate in an academic survey related to the use of job-order-contracting and that their participation would be appreciated. If the recipient decided to participate in the survey, they clicked on the URL link that took their web-browser to the survey website. The survey questions were then provided to the participant in groups of three questions per page. Depending on the answer to the question regarding the most likely alternative that the owner would use in lieu of job-order-contracting, the remaining questions will ask the respondent to compare their opinions regarding the use of JOC to the most likely alternative identified. The participant could opt out of the survey at anytime and the survey would then be terminated.

The unique URL allows the survey to be limited to only those who receive an invitation to participate, and it limits participation in the survey to only one response per

invitation. Once the unique URL has been utilized it will be closed, and no further responses will be allowed using the unique URL.

While there were a few open-ended inquiries allowing almost any type of response, most of the participant characteristic questions are provided with a menu of possible answers. In addition, those questions with a menu of possible responses there was also an option called "other" which would allow the participant to enter a response not provided on the menu.

The final portion of the survey asked the respondent to compare job-order-contracting to a most likely alternative using a Likert-type scale to measure the respondent's opinions with respect to the elements of owner satisfaction. These inquiries asked the respondent to compare their opinions regarding their experiences with JOC in comparison to the most likely alternative on the basis of cost (higher or lower), time (more or less), quality (better or worse), safety (better or worse), claims (more or less), and owner satisfaction (better or worse). The questions differ with the element of owner satisfaction being measured, but in essence each of these questions allows for five possible answers such as: 1) much more costly, 2) more costly, 3) about the same cost, 4) less costly, and 5) much less costly. The respondent only needs to indicate which one of these five responses best represents his or her opinion. Following collection of the responses, the data were then coded on an ordinal scale of 1 to 5.

Test Statistic

The test statistic for this study was the Kruskal-Wallis test statistic and the chi square (χ^2) distribution. For each hypothesis the Kruskal-Wallis test statistic was

calculated and compared to the chi square statistic based upon the selected alpha and appropriate degree of freedom.

Critical Value Analysis

If the calculated Kruskal-Wallis statistic exceeds the predicted χ^2 value, the null hypothesis was rejected and the alternate hypothesis accepted. If the calculated Kruskal-Wallis statistic is smaller than the predicted χ^2 distribution for the selected alpha and degree of freedom, then the null hypothesis was retained as a viable possibility.

Summary

The basic methodology proposed for this study was to conduct a survey of job-order-contracting users to determine their demographic characteristics and their opinions regarding the use of JOC in comparison to a specific most likely alternative. This data were collected by the Institute of Social Science Research at Arizona State University where it was coded and provided to this researcher. The data were then be analyzed to determine if the statistical assumptions regarding the use of the chi square statistic are valid. The data were then be examined to determine if the hypotheses are acceptable or not in accordance with the criteria established for this study.

CHAPTER 4

FINDINGS AND DATA ANALYSIS

Introduction

As stated in the previous chapter, data for this study was divided into three categories related to the questions of this study: 1) demographic information on the users of the JOC project delivery method, 2) the most likely alternative to JOC, and 3) opinions data on how JOC compares to the most likely alternative on the basis of cost, schedule, quality, safety, claims, and owner satisfaction.

Demographic Findings

Question 1 of this study restated is: What are the characteristics of the typical JOC user with respect to experience, location, type of organization, pricing methodology, and reasons for using job-order-contracting? The findings for this portion of the study are all tabulated using descriptive statistics.

Employer type. The purpose of this question was to see what types of opinions will be represented in this study on the basis of employer type: 1) facility owner, 2) program manager, 3) general contractor, 4) subcontractor, and 5) do not know, and 6) not applicable. Table 4 is a cross-tabulation of employer type (EMPLYR) and use of unit price book (UPB).

Table 4.

Employer Type * Use of Unit Price Book Cross-Tabulation

Employer Type		Use of Unit Price Book		Total
		Yes	No	
Facility Owner	Count	84	67	151
	% within Use of Unit Price Book	79.2%	79.8%	79.5%
Program Manager	Count	14	6	20
	% within Use of Unit Price Book	13.2%	7.1%	10.5%
General Contractor	Count	5	2	7
	% within Use of Unit Price Book	4.7%	2.4%	3.7%
Subcontractor	Count	2	3	5
	% within Use of Unit Price Book	1.9%	3.6%	2.6%
Don't Know	Count	0	1	1
	% within Use of Unit Price Book	.0%	1.2%	.5%
Not Applicable	Count	1	2	3
	% within Use of Unit Price Book	.9%	2.4%	1.6%
Other	Count	0	3	3
	% within Use of Unit Price Book	.0%	3.6%	1.6%
Total	Count	106	84	190
	% within Use of Unit Price Book	100.0%	100.0%	100.0%

Years of experience. To gain insight into the levels of experience with each type of project delivery method the respondents were asked to indicate the number of years of experience they have with DBB (DBBYRS), DB (DBYRS), CMAR (CMARYRS), and JOC (JOCYRS). Table 5 is a side-by-side comparison of the frequency findings for each of these four questions. In addition, Figures 16 through 19 are histograms that depict the

responses to the years of experience question in regard to each of the four project delivery methods in question.

Table 5.

Years of Experience Frequency Table Comparison

		Years of DBB Experience	Years of DB Experience	Years of CMAR Experience	Years of JOC Experience
N	Valid	172	163	153	182
	Missing	18	27	37	8
Mean		17.05	9.53	6.20	8.73
Median		16.50	5.00	3.00	5.50
Mode		25	5	0	5

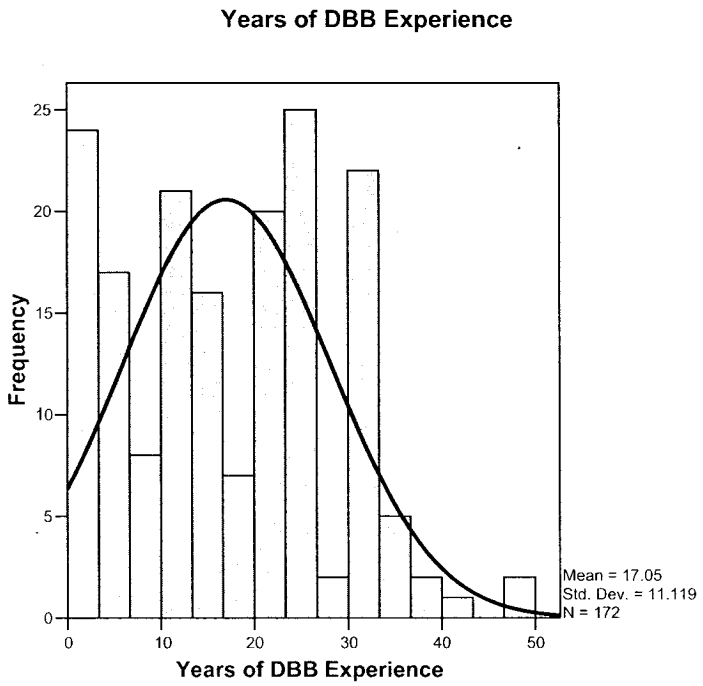

Figure 16. Years of experience histogram for design-bid-build

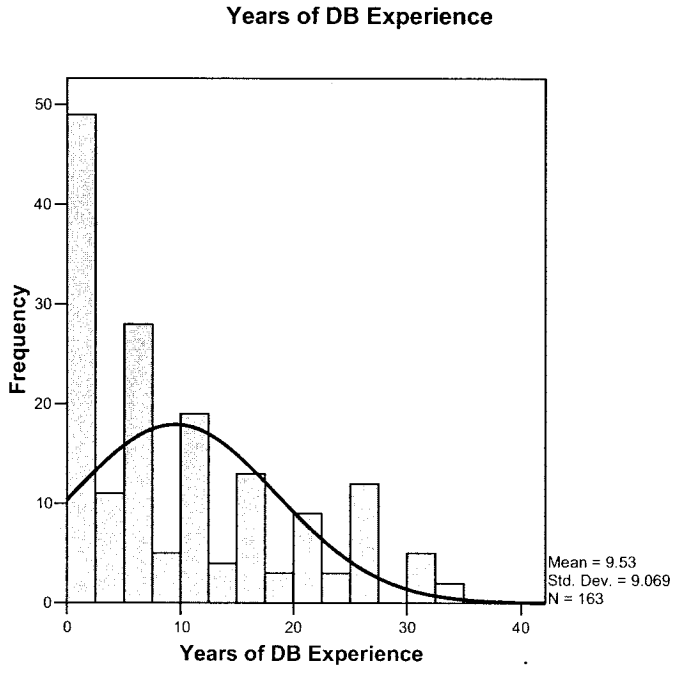

Figure 17. Years of experience histogram for design-build

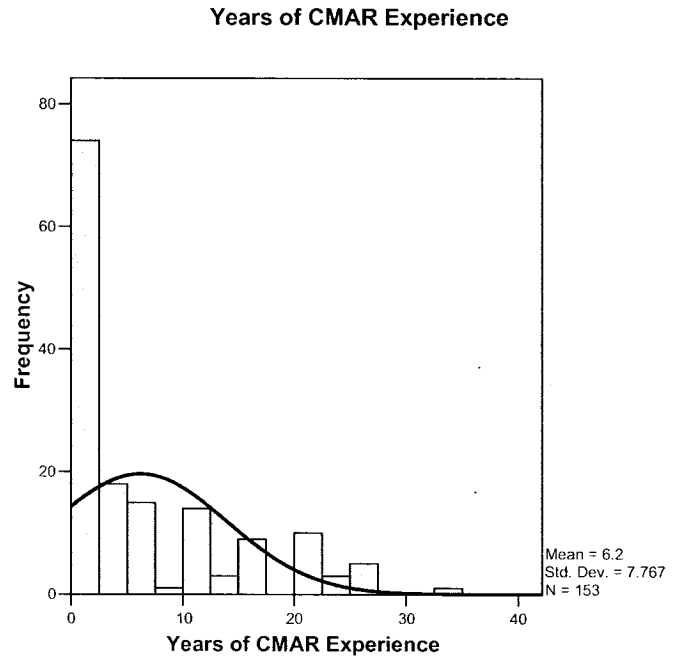

Figure 18. Years of experience histogram for construction-management-at-risk

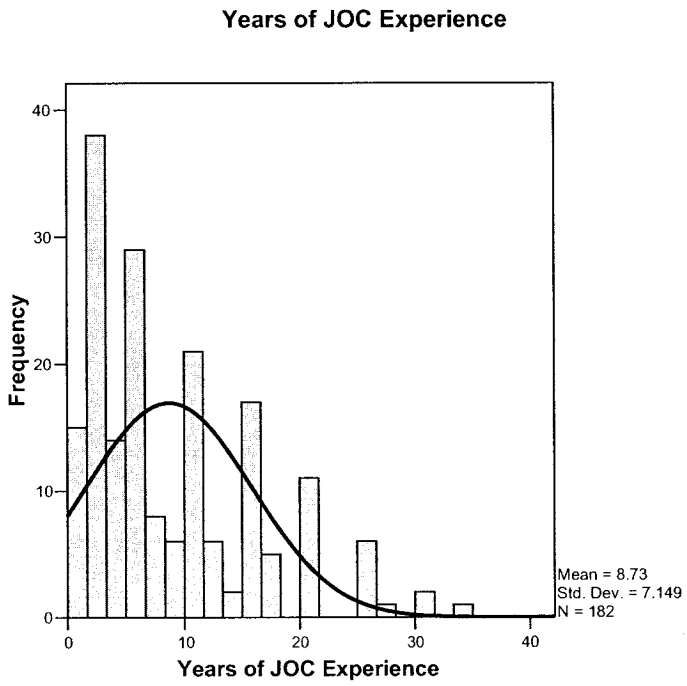

Figure 19. Years of experience histogram for job-order-contracting

Number of task orders. Along with the years of experience that an individual has with job-order-contracting, it is anticipated that the number of job orders that an individual works with in a typical year could influence opinions (NOTASK). The purpose of this question was to gain greater insight into the respondent's level of experience. Figure 20 is a histogram that depicts the response levels to the question of the number of job orders last year.

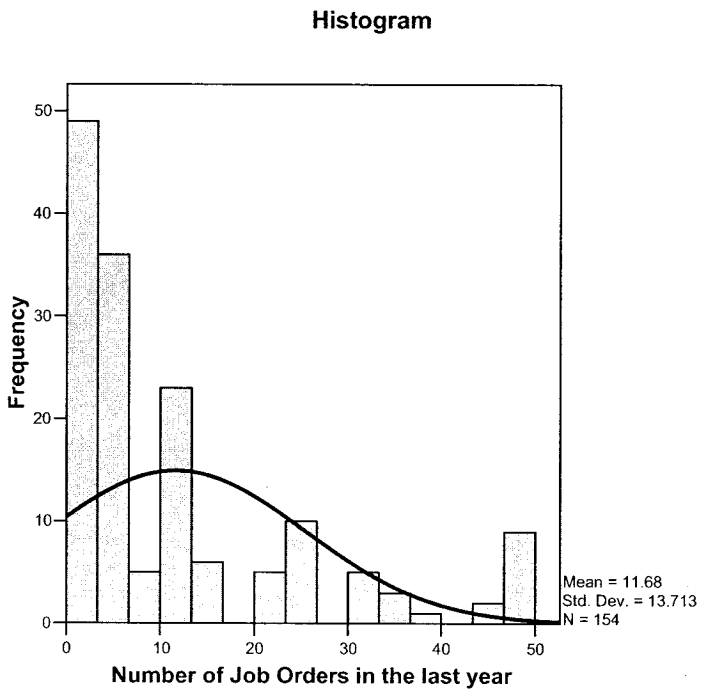

Figure 20. Number of job orders last year histogram

Type of Procurement. The purpose of this question is to provide more insight into how users of JOC are procuring the services of a job-order contractor. Table 6 is a cross-tabulation of procurement method (PROCUR) and use of unit price book (UPB).

Table 6.

JOC Procurement Method * Use of Unit Price Book Cross-Tabulation

JOC procurement method		Use of Unit Price Book		Total
		Yes	No	
Facility Owner	Count	74	61	135
	% within Use of Unit Price Book	69.8%	72.6%	71.1%

Table 6. (Continued)

JOC procurement method		Use of Unit Price Book		Total
		Yes	No	
Cooperative Purchasing Agency	Count	27	18	45
	% within Use of Unit Price Book	25.5%	21.4%	23.7%
Don't Know	Count	2	1	3
	% within Use of Unit Price Book	1.9%	1.2%	1.6%
Not Applicable	Count	1	3	4
	% within Use of Unit Price Book	.9%	3.6%	2.1%
Other	Count	2	1	3
	% within Use of Unit Price Book	1.9%	1.2%	1.6%
Total	Count	106	84	190
	% within Use of Unit Price Book	100.0%	100.0%	100.0%

Contracting environment. The purpose of this question is to see where JOC is being used relative to contracting environment. Table 7 is a cross-tabulation of contracting environment (ENVIRON) and use of unit price book (UPB).

Table 7.

Type of Owner Organization * Use of Unit Price Book Cross-Tabulation

Type of Owner Organization		Use of Unit Price Book		Total
		Yes	No	
Private Companies	Count	8	17	25
	% within Use of Unit Price Book	7.5%	20.2%	13.2%
Federal Agencies [non-military]	Count	11	8	19
	% within Use of Unit Price Book	10.4%	9.5%	10.0%
Federal Agencies [military]	Count	32	16	48
	% within Use of Unit Price Book	30.2%	19.0%	25.3%
Semi-Private Federal Agencies	Count	1	1	2
	% within Use of Unit Price Book	.9%	1.2%	1.1%
State/Commonwealth Agencies	Count	12	3	15
	% within Use of Unit Price Book	11.3%	3.6%	7.9%
County or Parish Departments	Count	9	3	12
	% within Use of Unit Price Book	8.5%	3.6%	6.3%
City, Town or other type of Municipalities	Count	7	13	20
	% within Use of Unit Price Book	6.6%	15.5%	10.5%
Higher Education [university or community college]	Count	11	12	23
	% within Use of Unit Price Book	10.4%	14.3%	12.1%
Primary education [K-12]	Count	11	8	19
	% within Use of Unit Price Book	10.4%	9.5%	10.0%

Table 7. (continued)

Type of Owner Organization		Use of Unit Price Book		Total
		Yes	No	
Don't Know	Count	1	1	2
	% within Use of Unit Price Book	.9%	1.2%	1.1%
Other	Count	3	2	5
	% within Use of Unit Price Book	2.8%	2.4%	2.6%
Total	Count	106	84	190
	% within Use of Unit Price Book	100.0%	100.0%	100.0%

Pricing method. The purpose of this question is to look at how pricing for the work is determined. Table 8 is a summary of the responses to the question is the work priced using a unit price book (PRICING).

Table 8.

Use of Unit Price Book

Use of Unit Price Book	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	106	55.8	55.8	55.8
No	84	44.2	44.2	100.0
Total	190	100.0	100.0	

Zip code (Location). The purpose of this question was to see where JOC is being used. In order to make the results to this question more intuitive, all of the zip codes were recoded into city (CITY) and state (STATE) locations. Table 9 is a cross-tabulation of state (STATE) and use of unit price book (UPB).

Table 9.

State * Use of Unit Price Book Cross-Tabulation

State		Use of Unit Price Book		Total
		Yes	No	
	Count	3	0	3
	% within Use of Unit Price Book	2.8%	.0%	1.6%
AE	Count	1	0	1
	% within Use of Unit Price Book	.9%	.0%	.5%
AK	Count	2	0	2
	% within Use of Unit Price Book	1.9%	.0%	1.1%
AR	Count	1	1	2
	% within Use of Unit Price Book	.9%	1.2%	1.1%
AZ	Count	15	11	26
	% within Use of Unit Price Book	14.2%	13.1%	13.7%
CA	Count	6	7	13
	% within Use of Unit Price Book	5.7%	8.3%	6.8%
CO	Count	0	1	1
	% within Use of Unit Price Book	.0%	1.2%	.5%
CT	Count	1	2	3
	% within Use of Unit Price Book	.9%	2.4%	1.6%
DC	Count	2	3	5
	% within Use of Unit Price Book	1.9%	3.6%	2.6%
FL	Count	7	3	10
	% within Use of Unit Price Book	6.6%	3.6%	5.3%
GA	Count	6	0	6
	% within Use of Unit Price Book	5.7%	.0%	3.2%
IA	Count	1	0	1
	% within Use of Unit Price Book	.9%	.0%	.5%
ID	Count	1	2	3
	% within Use of Unit Price Book	.9%	2.4%	1.6%
IL	Count	1	1	2
	% within Use of Unit Price Book	.9%	1.2%	1.1%

Table 9. (Continued)

State		Use of Unit Price Book		Total
		Yes	No	
IN	Count	1	1	2
	% within Use of Unit Price Book	.9%	1.2%	1.1%
KS	Count	1	1	2
	% within Use of Unit Price Book	.9%	1.2%	1.1%
KY	Count	0	2	2
	% within Use of Unit Price Book	.0%	2.4%	1.1%
MA	Count	1	0	1
	% within Use of Unit Price Book	.9%	.0%	.5%
MD	Count	6	1	7
	% within Use of Unit Price Book	5.7%	1.2%	3.7%
ME	Count	1	0	1
	% within Use of Unit Price Book	.9%	.0%	.5%
MI	Count	0	4	4
	% within Use of Unit Price Book	.0%	4.8%	2.1%
MN	Count	0	2	2
	% within Use of Unit Price Book	.0%	2.4%	1.1%
MO	Count	2	3	5
	% within Use of Unit Price Book	1.9%	3.6%	2.6%
NC	Count	1	1	2
	% within Use of Unit Price Book	.9%	1.2%	1.1%
ND	Count	0	1	1
	% within Use of Unit Price Book	.0%	1.2%	.5%
NE	Count	1	0	1
	% within Use of Unit Price Book	.9%	.0%	.5%
NH	Count	0	1	1
	% within Use of Unit Price Book	.0%	1.2%	.5%
NJ	Count	1	1	2
	% within Use of Unit Price Book	.9%	1.2%	1.1%
NM	Count	1	2	3
	% within Use of Unit Price Book	.9%	2.4%	1.6%

Table 9. (Continued)

State		Use of Unit Price Book		Total
		Yes	No	
NY	Count	3	6	9
	% within Use of Unit Price Book	2.8%	7.1%	4.7%
OH	Count	3	2	5
	% within Use of Unit Price Book	2.8%	2.4%	2.6%
OK	Count	2	0	2
	% within Use of Unit Price Book	1.9%	.0%	1.1%
OR	Count	0	2	2
	% within Use of Unit Price Book	.0%	2.4%	1.1%
PA	Count	0	3	3
	% within Use of Unit Price Book	.0%	3.6%	1.6%
SC	Count	2	1	3
	% within Use of Unit Price Book	1.9%	1.2%	1.6%
TX	Count	11	5	16
	% within Use of Unit Price Book	10.4%	6.0%	8.4%
UT	Count	0	1	1
	% within Use of Unit Price Book	.0%	1.2%	.5%
VA	Count	8	6	14
	% within Use of Unit Price Book	7.5%	7.1%	7.4%
WA	Count	13	7	20
	% within Use of Unit Price Book	12.3%	8.3%	10.5%
WI	Count	1	0	1
	% within Use of Unit Price Book	.9%	.0%	.5%
Total	Count	106	84	190
	% within Use of Unit Price Book	100.0%	100.0%	100.0%

Why use JOC? The purpose of this question is to learn the respondent's primary motivation for using JOC with respect to 1) costs, 2) quality, 3) expediency, or 4) something else. Table 10 is a cross-tabulation of primary reason for using JOC (WHY01) and use of unit price book (UPB).

Table 10.

Reason #1 for Using JOC * Use of Unit Price Book Cross-Tabulation

Reason #1 for using JOC		Use of Unit Price Book		Total
		Yes	No	
Lower cost compared to the most likely alternative	Count	7	7	14
	% within Use of Unit Price Book	6.6%	8.3%	7.4%
Urgency or need to complete the work	Count	45	37	82
	% within Use of Unit Price Book	42.5%	44.0%	43.2%
Contractor's reputation for quality work	Count	1	6	7
	% within Use of Unit Price Book	.9%	7.1%	3.7%
Contractor's reputation for not filing claims	Count	0	1	1
	% within Use of Unit Price Book	.0%	1.2%	.5%
Owner's previous experience with the contractor	Count	14	8	22
	% within Use of Unit Price Book	13.2%	9.5%	11.6%
Simplicity of the job-order-contracting process	Count	21	11	32
	% within Use of Unit Price Book	19.8%	13.1%	16.8%
Predictability of the process to meet the owner's needs	Count	13	11	24
	% within Use of Unit Price Book	12.3%	13.1%	12.6%
Don't Know	Count	1	1	2
	% within Use of Unit Price Book	.9%	1.2%	1.1%
Other	Count	4	2	6
	% within Use of Unit Price Book	3.8%	2.4%	3.2%

Table 10. (Continued)

Reason #1 for using JOC		Use of Unit Price Book		Total
		Yes	No	
Total	Count	106	84	190
	% within Use of Unit Price Book	100.0%	100.0%	100.0%

Most Likely Alternative to JOC

Question 2 of this study restated is: What is the most likely alternative to JOC as a project delivery method for the owner currently using job-order-contracting? The findings for this portion of the study are tabulated using descriptive statistics and analyzed using the chi square statistic.

Most-likely-alternative to job-order-contracting. The purpose of this question was twofold: 1) determine overall what the most likely alternative is to JOC, and 2) to provide a basis of comparison between job-order-contracting and the project delivery methods identified by each respondent. Table 11 is a cross-tabulation of the most likely alternative (MLA) and use of unit price book (UPB).

Table 11.

Most Likely Alternative to Using JOC * Use of Unit Price Book Cross-Tabulation

Most likely alternative to using JOC		Use of Unit Price Book		Total
		Yes	No	
Design-bid-build contract	Count	59	41	100
	% within Use of Unit Price Book	55.7%	48.8%	52.6%

Table 11. (Continued)

Most likely alternative to using JOC		Use of Unit Price Book		Total
		Yes	No	
Design-build contract	Count	21	16	37
	% within Use of Unit Price Book	19.8%	19.0%	19.5%
Construction-manager-at-risk contract	Count	16	13	29
	% within Use of Unit Price Book	15.1%	15.5%	15.3%
The owner's employees would complete the work	Count	4	7	11
	% within Use of Unit Price Book	3.8%	8.3%	5.8%
Don't Know	Count	0	1	1
	% within Use of Unit Price Book	.0%	1.2%	.5%
Other	Count	6	6	12
	% within Use of Unit Price Book	5.7%	7.1%	6.3%
Total	Count	106	84	190
	% within Use of Unit Price Book	100.0%	100.0%	100.0%

In addition to the descriptive aspects of this question, Hypothesis 1 states that there is no difference with respect to the MLA that the respondents would indicate. In essence, there is an equal chance that any one of the three alternatives might be indicated as the MLA. If this were true then it could be anticipated that the respondents would have indicated near equal frequencies for each of the three alternatives provided. To analyze the validity of this hypothesis, a χ^2 procedure was run on this data using a distribution of 2 degrees of freedom ($\alpha = 0.05$). The chi-square statistic for this

distribution yields $\chi^2 = 54.66$ as compared to a $\chi^2 = 5.99$ for a distribution of 2 degrees of freedom using $\alpha = 0.05$. Table 12 contains the observed and expected frequencies for this distribution.

Table 12.

Frequencies of Most Likely Alternative to Using JOC

	Most likely alternative to using JOC			
	Category	Observed N	Expected N	Residual
1	Design-bid-build contract	100	55.3	44.7
2	Design-build contract	37	55.3	-18.3
3	Construction-manager-at-risk contract	29	55.3	-26.3
Total		166		

Comparison of JOC to the MLA

Question 3 of this study restated is: Are owner perceptions with respect to construction costs, timeliness of construction, quality, safety, claims and owner satisfaction affected by the project delivery method selected for a project? The findings for this portion of the study are tabulated using descriptive statistics and analyzed using the chi square statistic.

Design costs. This question asked the respondents to compare the cost of project design using job-order-contracting to the cost of project design using the most likely alternative (DESIGN$). Table 13 contains the cross tabulation findings for this question.

Table 13.

Most Likely Alternative to Using JOC * Comparison of Design Costs Cross-Tabulation

			Comparison of Design Costs							Total
			A lot more than the MLA	A little more than the MLA	About the same as the MLA	A little less than the MLA	A lot less than the MLA	Don't Know	Not Applicable	
Most likely alternative to using JOC	Design-bid-build contract	Count	4	20	25	21	23	7	0	100
		% within Comparison of Design Costs	21.1%	48.8%	58.1%	56.8%	62.2%	70.0%	.0%	52.6%
	Design-build contract	Count	9	12	4	6	6	0	0	37
		% within Comparison of Design Costs	47.4%	29.3%	9.3%	16.2%	16.2%	.0%	.0%	19.5%
	Construction-manager-at-risk contract	Count	3	7	7	6	5	0	1	29
		% within Comparison of Design Costs	15.8%	17.1%	16.3%	16.2%	13.5%	.0%	33.3%	15.3%
	Other	Count	3	2	7	4	3	3	2	24
		% within Comparison of Design Costs	15.8%	4.9%	16.3%	10.8%	8.1%	30.0%	66.7%	12.6%
Total		Count	19	41	43	37	37	10	3	190
		% within Comparison of Design Costs	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Hypothesis 2 states that opinions with respect to the cost of project design being higher, the same, or lower than the design cost for the MLA are not significantly influenced by the specific MLA used in the comparison. To address this, a Kruskal-Wallis test was performed to determine if the data supports the hypothesis that the observed differences in responses are the result of random variation, or are the result of the MLA used in the comparison. The Kruskal-Wallis test statistic for this analysis yielded $H = 11.43$. The critical chi-square value for a distribution using 2 degrees of freedom and $\alpha = 0.05$ would be 5.99. The asymptotic significance of this Kruskal-Wallis test statistic is 0.003, or 3 chances in 1000 that this distribution is the result of random variation.

Job order procurement costs. This question asks the respondents to compare the cost of obtaining the services of a contractor using job-order-contracting to the cost of obtaining the services of a contractor using the most likely alternative (PROC$). Table 14 contains the cross tabulation findings for this question.

Table 14.

Most Likely Alternative to Using JOC * Comparison of Procurement Costs Cross-Tabulation

			Comparison of Procurement Costs							Total
			A lot more than the MLA	A little more than the MLA	About the same as the MLA	A little less than the MLA	A lot less than the MLA	Don't Know	Not Applicable	
Most likely alternative to using JOC	Design-bid-build contract	Count	5	18	30	26	14	5	2	100
		% within Comparison of Procurement Costs	27.8%	46.2%	58.8%	55.3%	56.0%	83.3%	50.0%	52.6%
	Design-build contract	Count	6	10	6	9	6	0	0	37
		% within Comparison of Procurement Costs	33.3%	25.6%	11.8%	19.1%	24.0%	.0%	.0%	19.5%
	Construction-manager-at-risk contract	Count	2	7	8	8	3	0	1	29
		% within Comparison of Procurement Costs	11.1%	17.9%	15.7%	17.0%	12.0%	.0%	25.0%	15.3%
	Other	Count	5	4	7	4	2	1	1	24
		% within Comparison of Procurement Costs	27.8%	10.3%	13.7%	8.5%	8.0%	16.7%	25.0%	12.6%
Total		Count	18	39	51	47	25	6	4	190
		% within Comparison of Procurement Costs	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Hypothesis 3 states that opinions with respect to the cost of contractor procurement being higher, the same, or lower than the design cost for the MLA are not significantly influenced by the specific MLA used in the comparison. To address this, a Kruskal-Wallis test was performed to determine if the data supports the hypothesis that the observed differences in responses are the result of random variation, or are the result of the MLA used in the comparison. The Kruskal-Wallis test statistic for this analysis yielded H = 3.42. The critical chi-square value for a distribution using 2 degrees of freedom and $\alpha = 0.05$ would be 5.99. The asymptotic significance of this Kruskal-Wallis test statistic is 0.181, or 181 chances in 1000 that this distribution is the result of random variation.

Construction costs. This question asks the respondents to compare the cost of construction using job-order-contracting to the cost of construction using the most likely alternative (CONST$). Table 15 contains the cross tabulation findings for this question.

Table 15.

Most Likely Alternative to Using JOC * Comparison of Construction Costs Cross-Tabulation

			Comparison of Construction Costs						Total
			A lot more than the MLA	A little more than the MLA	About the same as the MLA	A little less than the MLA	A lot less than the MLA	Don't Know	
Most likely alternative to using JOC	Design-bid-build contract	Count	14	36	19	22	3	6	100
		% within Comparison of Construction Costs	58.3%	49.3%	46.3%	64.7%	27.3%	85.7%	52.6%
	Design-build contract	Count	5	14	10	6	2	0	37
		% within Comparison of Construction Costs	20.8%	19.2%	24.4%	17.6%	18.2%	.0%	19.5%
	Construction-manager-at-risk contract	Count	3	11	7	4	4	0	29
		% within Comparison of Construction Costs	12.5%	15.1%	17.1%	11.8%	36.4%	.0%	15.3%
	Other	Count	2	12	5	2	2	1	24
		% within Comparison of Construction Costs	8.3%	16.4%	12.2%	5.9%	18.2%	14.3%	12.6%
Total		Count	24	73	41	34	11	7	190
		% within Comparison of Construction Costs	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Hypothesis 4 states that opinions with respect to the cost of construction being higher, the same, or lower than the design cost for the MLA are not significantly influenced by the specific MLA used in the comparison. To address this, a Kruskal-Wallis test was performed to determine if the data supports the hypothesis that the observed differences in responses are the result of random variation, or are the result of the MLA used in the comparison. The Kruskal-Wallis test statistic for this analysis yielded $H = 0.395$. The critical chi-square value for a distribution using 2 degrees of freedom and $\alpha = 0.05$ would be 5.99. The asymptotic significance of this Kruskal-Wallis test statistic is 0.821, or 821 chances in 1000 that this distribution is the result of random variation.

Change order costs. This question asks the respondents to compare the cost of change orders using job-order-contracting to the cost of change orders using the most likely alternative (CHANGE$). Table 16 contains the cross tabulation findings for this question.

Table 16.

Most likely Alternative to Using JOC * Comparison of Change Order Costs Cross-Tabulation

			Comparison of Change Order Costs							
			A lot more than the MLA	A little more than the MLA	About the same as the MLA	A little less than the MLA	A lot less than the MLA	Don't Know	Not Applicable	Total
Most likely alternative to using JOC	Design-bid-build contract	Count	7	19	23	24	23	4	0	100
		% within Comparison of C. O. Costs	35.0%	59.4%	47.9%	54.5%	62.2%	57.1%	.0%	52.6%
	Design-build contract	Count	4	5	13	7	6	1	1	37
		% within Comparison of C. O. Costs	20.0%	15.6%	27.1%	15.9%	16.2%	14.3%	50.0%	19.5%
	Construction-manager-at-risk contract	Count	5	3	8	10	3	0	0	29
		% within Comparison of C. O. Costs	25.0%	9.4%	16.7%	22.7%	8.1%	.0%	.0%	15.3%
	Other	Count	4	5	4	3	5	2	1	24
		% within Comparison of C. O. Costs	20.0%	15.6%	8.3%	6.8%	13.5%	28.6%	50.0%	12.6%
Total		Count	20	32	48	44	37	7	2	190
		% within Comparison of C. O. Costs	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Hypothesis 5 states that opinions with respect to the cost of change orders being higher, the same, or lower than the design cost for the MLA are not significantly influenced by the specific MLA used in the comparison. To address this, a Kruskal-Wallis test was performed to determine if the data supports the hypothesis that the observed differences in responses are the result of random variation, or are the result of the MLA used in the comparison. The Kruskal-Wallis test statistic for this analysis yielded $H = 1.68$. The critical chi-square value for a distribution using 2 degrees of freedom and $\alpha = 0.05$ would be 5.99. The asymptotic significance of this Kruskal-Wallis test statistic is 0.431, or 431 chances in 1000 that this distribution is the result of random variation.

Administration costs. This question asks the respondents to compare the cost of project administration using job-order-contracting to the cost of project administration using the most likely alternative (ADMIN$). Table 17 contains the cross tabulation findings for this question.

Table 17.

Most Likely Alternative to Using JOC * Comparison of Project Admin Costs Cross-Tabulation

			Comparison of Project Admin Costs							
			A lot more than the MLA	A little more than the MLA	About the same as the MLA	A little less than the MLA	A lot less than the MLA	Don't Know	Not Applicable	Total
Most likely alternative to using JOC	Design-bid-build contract	Count	3	17	29	25	21	4	0	99
		% within Comparison of P. A. Costs	30.0%	53.1%	53.7%	48.1%	61.8%	66.7%	.0%	52.4%
	Design-build contract	Count	3	5	12	13	4	0	0	37
		% within Comparison of P. A. Costs	30.0%	15.6%	22.2%	25.0%	11.8%	.0%	.0%	19.6%
	Construction-manager-at-risk contract	Count	1	7	7	8	6	0	0	29
		% within Comparison of P. A. Costs	10.0%	21.9%	13.0%	15.4%	17.6%	.0%	.0%	15.3%
	Other	Count	3	3	6	6	3	2	1	24
		% within Comparison of P. A. Costs	30.0%	9.4%	11.1%	11.5%	8.8%	33.3%	100.0%	12.7%
Total		Count	10	32	54	52	34	6	1	189
		% within Comparison of P. A. Costs	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Hypothesis 6 states that opinions with respect to the cost of project administration being higher, the same, or lower than the design cost for the MLA are not significantly influenced by the specific MLA used in the comparison. To address this, a Kruskal-Wallis test was performed to determine if the data supports the hypothesis that the observed differences in responses are the result of random variation, or are the result of the MLA used in the comparison. The Kruskal-Wallis test statistic for this analysis yielded H = 1.38. The critical chi-square value for a distribution using 2 degrees of freedom and $\alpha = 0.05$ would be 5.99. The asymptotic significance of this Kruskal-Wallis test statistic is 0.502, or 502 chances in 1000 that this distribution is the result of random variation.

Claims costs. This question asks the respondents to compare the cost of claims using job-order-contracting to the cost of claims using the most likely alternative (CLAIM$). Table 18 contains the cross tabulation findings for this question.

Table 18.

Most Likely Alternative to Using JOC * Comparison of Claims Costs Cross-Tabulation

			Comparison of Claims Costs							
			A lot more than the MLA	A little more than the MLA	About the same as the MLA	A little less than the MLA	A lot less than the MLA	Don't Know	Not Applicable	Total
Most likely alternative to using JOC	Design-bid-build contract	Count	2	10	20	12	30	22	4	100
		% within Comparison of Claims Costs	28.6%	52.6%	47.6%	57.1%	57.7%	56.4%	40.0%	52.6%
	Design-build contract	Count	2	4	10	2	13	6	0	37
		% within Comparison of Claims Costs	28.6%	21.1%	23.8%	9.5%	25.0%	15.4%	.0%	19.5%
	Construction-manager-at-risk contract	Count	1	4	7	3	6	5	3	29
		% within Comparison of Claims Costs	14.3%	21.1%	16.7%	14.3%	11.5%	12.8%	30.0%	15.3%
	Other	Count	2	1	5	4	3	6	3	24
		% within Comparison of Claims Costs	28.6%	5.3%	11.9%	19.0%	5.8%	15.4%	30.0%	12.6%
Total		Count	7	19	42	21	52	39	10	190
		% within Comparison of Claims Costs	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Hypothesis 7 states that opinions with respect to the cost of claims being higher, the same, or lower than the design cost for the MLA are not significantly influenced by the specific MLA used in the comparison. To address this, a Kruskal-Wallis test was performed to determine if the data supports the hypothesis that the observed differences in responses are the result of random variation, or are the result of the MLA used in the comparison. The Kruskal-Wallis test statistic for this analysis yielded $H = 1.50$. The critical chi-square value for a distribution using 2 degrees of freedom and $\alpha = 0.05$ would be 5.99. The asymptotic significance of this Kruskal-Wallis test statistic is 0.472, or 472 chances in 1000 that this distribution is the result of random variation.

Time to initiate work. This question asks the respondents to compare the time required to initiate the work using job-order-contracting to the time required to initiate the work using the most likely alternative (STARTIME). Table 19 contains the cross tabulation findings for this question.

Table 19.

Most Likely Alternative to Using JOC * Comparison of Start-up Time Cross-Tabulation

			Comparison of Start-up Time						
			A lot more than the MLA	A little more than the MLA	About the same as the MLA	A little less than the MLA	A lot less than the MLA	Don't Know	Total
Most likely alternative to using JOC	Design-bid-build contract	Count	7	10	9	19	54	1	100
		% within Comparison of Start-up Time	58.3%	62.5%	40.9%	45.2%	55.7%	100.0%	52.6%
	Design-build contract	Count	3	0	5	6	23	0	37
		% within Comparison of Start-up Time	25.0%	.0%	22.7%	14.3%	23.7%	.0%	19.5%
	Construction-manager-at-risk contract	Count	1	1	2	11	14	0	29
		% within Comparison of Start-up Time	8.3%	6.3%	9.1%	26.2%	14.4%	.0%	15.3%
	Other	Count	1	5	6	6	6	0	24
		% within Comparison of Start-up Time	8.3%	31.3%	27.3%	14.3%	6.2%	.0%	12.6%
Total		Count	12	16	22	42	97	1	190
		% within Comparison of Start-up Time	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Hypothesis 8 states that opinions with respect to the time required to initiate the work being longer, the same, or shorter than the time required for the MLA are not significantly influenced by the specific MLA used in the comparison. To address this, a Kruskal-Wallis test was performed to determine if the data supports the hypothesis that the observed differences in responses are the result of random variation, or are the result of the MLA used in the comparison. The Kruskal-Wallis test statistic for this analysis yielded $H = 0.593$. The critical chi-square value for a distribution using 2 degrees of freedom and $\alpha = 0.05$ would be 5.99. The asymptotic significance of this Kruskal-Wallis test statistic is 0.744, or 744 chances in 1000 that this distribution is the result of random variation.

Time to design the project. This question asks the respondents to compare the time required to design the project using job-order-contracting to the time required to design the project using the most likely alternative (DSGNTIME). Table 20 contains the cross tabulation findings for this question.

Table 20.

Most Likely Alternative to Using JOC * Comparison of Design Time Cross-Tabulation

			Comparison of Design Time							
			A lot more than the MLA	A little more than the MLA	About the same as the MLA	A little less than the MLA	A lot less than the MLA	Don't Know	Not Applicable	Total
Most likely alternative to using JOC	Design-bid-build contract	Count	4	7	27	36	23	3	0	100
		% within Comparison of Design Time	50.0%	38.9%	54.0%	57.1%	57.5%	37.5%	.0%	52.6%
	Design-build contract	Count	2	7	5	13	9	0	1	37
		% within Comparison of Design Time	25.0%	38.9%	10.0%	20.6%	22.5%	.0%	33.3%	19.5%
	Construction-manager-at-risk contract	Count	1	2	9	10	3	3	1	29
		% within Comparison of Design Time	12.5%	11.1%	18.0%	15.9%	7.5%	37.5%	33.3%	15.3%
	Other	Count	1	2	9	4	5	2	1	24
		% within Comparison of Design Time	12.5%	11.1%	18.0%	6.3%	12.5%	25.0%	33.3%	12.6%
Total		Count	8	18	50	63	40	8	3	190
		% within Comparison of Design Time	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Hypothesis 9 states that opinions with respect to the time required to initiate the work being longer, the same, or shorter than the time required for the MLA are not significantly influenced by the specific MLA used in the comparison. To address this, a Kruskal-Wallis test was performed to determine if the data supports the hypothesis that the observed differences in responses are the result of random variation, or are the result of the MLA used in the comparison. The Kruskal-Wallis test statistic for this analysis yielded $H = 0.151$. The critical chi-square value for a distribution using 2 degrees of freedom and $\alpha = 0.05$ would be 5.99. The asymptotic significance of this Kruskal-Wallis test statistic is 0.927, or 927 chances in 1000 that this distribution is the result of random variation.

Time to construct. This question asks the respondents to compare the time required to construct the work using job-order-contracting to the time required to construct the work using the most likely alternative (CONSTIME). Table 22 contains the cross tabulation findings for this question.

Table 21.

Most Likely Alternative to Using JOC * Comparison of Construction Time Cross-Tabulation

			Comparison of Construction Time							
			A lot more than the MLA	A little more than the MLA	About the same as the MLA	A little less than the MLA	A lot less than the MLA	Don't Know	Not Applicable	Total
Most likely alternative to using JOC	Design-bid-build contract	Count	2	6	33	38	20	1	0	100
		% within Comparison of Const. Time	33.3%	42.9%	49.3%	59.4%	55.6%	50.0%	.0%	52.6%
	Design-build contract	Count	3	3	15	8	8	0	0	37
		% within Comparison of Const. Time	50.0%	21.4%	22.4%	12.5%	22.2%	.0%	.0%	19.5%
	Construction-manager-at-risk contract	Count	1	1	14	8	3	1	1	29
		% within Comparison of Const. Time	16.7%	7.1%	20.9%	12.5%	8.3%	50.0%	100.0%	15.3%
	Other	Count	0	4	5	10	5	0	0	24
		% within Comparison of Const. Time	.0%	28.6%	7.5%	15.6%	13.9%	.0%	.0%	12.6%
Total		Count	6	14	67	64	36	2	1	190
		% within Comparison of Const. Time	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Hypothesis 10 states that opinions with respect to the time required to construct the project being longer, the same, or shorter than the time required for the MLA are not significantly influenced by the specific MLA used in the comparison. To address this, a Kruskal-Wallis test was performed to determine if the data supports the hypothesis that the observed differences in responses are the result of random variation, or are the result of the MLA used in the comparison. The Kruskal-Wallis test statistic for this analysis yielded $H = 2.31$. The critical chi-square value for a distribution using 2 degrees of freedom and $\alpha = 0.05$ would be 5.99. The asymptotic significance of this Kruskal-Wallis test statistic is 0.315, or 315 chances in 1000 that this distribution is the result of random variation.

Time to close out the project. This question asks the respondents to compare the time required to close out the project using job-order-contracting to the time required to close out the project using the most likely alternative (CLOSTIME). Table 22 contains the cross tabulation findings for this question.

Table 22.

Most Likely Alternative to Using JOC * Comparison of Closeout Time Cross-Tabulation

			Comparison of Closeout Time							
			A lot more than the MLA	A little more than the MLA	About the same as the MLA	A little less than the MLA	A lot less than the MLA	Don't Know	Not Applicable	Total
Most likely alternative to using JOC	Design-bid-build contract	Count	2	5	23	45	23	2	0	100
		% within Comparison of Closeout Time	28.6%	45.5%	46.0%	60.8%	53.5%	50.0%	.0%	52.6%
	Design-build contract	Count	3	0	11	12	10	1	0	37
		% within Comparison of Closeout Time	42.9%	.0%	22.0%	16.2%	23.3%	25.0%	.0%	19.5%
	Construction-manager-at-risk contract	Count	1	2	8	12	5	0	1	29
		% within Comparison of Closeout Time	14.3%	18.2%	16.0%	16.2%	11.6%	.0%	100.0%	15.3%
	Other	Count	1	4	8	5	5	1	0	24
		% within Comparison of Closeout Time	14.3%	36.4%	16.0%	6.8%	11.6%	25.0%	.0%	12.6%
Total		Count	7	11	50	74	43	4	1	190
		% within Comparison of Closeout Time	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Hypothesis 11 states that opinions with respect to the time required to closeout the project being longer, the same, or shorter than the time required for the MLA are not significantly influenced by the specific MLA used in the comparison. To address this, a Kruskal-Wallis test was performed to determine if the data supports the hypothesis that the observed differences in responses are the result of random variation, or are the result of the MLA used in the comparison. The Kruskal-Wallis test statistic for this analysis yielded $H = 0.576$. The critical chi-square value for a distribution using 2 degrees of freedom and $\alpha = 0.05$ would be 5.99. The asymptotic significance of this Kruskal-Wallis test statistic is 0.750, or 750 chances in 1000 that this distribution is the result of random variation.

Ease of use. This question asks the respondents to compare the ease of using job-order-contracting to the ease of using the most likely alternative (EASYUSE). Table 23 contains the cross tabulation findings for this question.

Table 23.

Most Likely Alternative to Using JOC * Comparison of Ease of Using JOC Cross-Tabulation

			Comparison of Ease of Using JOC							
			A lot easier than the MLA	A little easier than the MLA	About the same as the MLA	A little less easier than the MLA	A lot less easier than the MLA	Don't Know	Not Applicable	Total
Most likely alternative to using JOC	Design-bid-build contract	Count	36	36	8	12	4	0	4	100
		% within Comparison of Ease of Use	54.5%	51.4%	47.1%	57.1%	44.4%	.0%	80.0%	52.6%
	Design-build contract	Count	12	15	5	1	3	1	0	37
		% within Comparison of Ease of Use	18.2%	21.4%	29.4%	4.8%	33.3%	50.0%	.0%	19.5%
	Construction-manager-at-risk contract	Count	11	15	0	3	0	0	0	29
		% within Comparison of Ease of Use	16.7%	21.4%	.0%	14.3%	.0%	.0%	.0%	15.3%
	Other	Count	7	4	4	5	2	1	1	24
		% within Comparison of Ease of Use	10.6%	5.7%	23.5%	23.8%	22.2%	50.0%	20.0%	12.6%
Total		Count	66	70	17	21	9	2	5	190
		% within Comparison of Ease of Use	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Hypothesis 12 states that opinions with respect to the ease of using JOC being easier, the same, or not as easy as using the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. To address this, a Kruskal-Wallis test was performed to determine if the data supports the hypothesis that the observed differences in responses are the result of random variation, or are the result of the MLA used in the comparison. The Kruskal-Wallis test statistic for this analysis yielded $H = 1.44$. The critical chi-square value for a distribution using 2 degrees of freedom and $\alpha = 0.05$ would be 5.99. The asymptotic significance of this Kruskal-Wallis test statistic is 0.488, or 488 chances in 1000 that this distribution is the result of random variation.

Quality. This question asks the respondents to compare the quality of work using job-order-contracting to the quality of work using the most likely alternative (QUALITY). Table 24 contains the cross tabulation findings for this question.

Table 24.

Most Likely Alternative to Using JOC * Comparison of Quality Cross-Tabulation

			Comparison of Quality						
			A lot better than the MLA	A little better than the MLA	About the same as the MLA	A little worse than the MLA	A lot worse than the MLA	Don't Know	Total
Most likely alternative to using JOC	Design-bid-build contract	Count	10	26	54	6	2	1	99
		% within Comparison of Quality	50.0%	61.9%	52.4%	40.0%	28.6%	50.0%	52.4%
	Design-build contract	Count	3	3	25	2	3	1	37
		% within Comparison of Quality	15.0%	7.1%	24.3%	13.3%	42.9%	50.0%	19.6%
	Construction-manager-at-risk contract	Count	3	9	13	3	1	0	29
		% within Comparison of Quality	15.0%	21.4%	12.6%	20.0%	14.3%	.0%	15.3%
	Other	Count	4	4	11	4	1	0	24
		% within Comparison of Quality	20.0%	9.5%	10.7%	26.7%	14.3%	.0%	12.7%
Total		Count	20	42	103	15	7	2	189
		% within Comparison of Quality	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Hypothesis 13 states that opinions with respect to the quality of work being better, the same, or worse than the quality for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. To address this, a Kruskal-Wallis test was performed to determine if the data supports the hypothesis that the observed differences in responses are the result of random variation, or are the result of the MLA used in the comparison. The Kruskal-Wallis test statistic for this analysis yielded $H = 5.15$. The critical chi-square value for a distribution using 2 degrees of freedom and $\alpha = 0.05$ would be 5.99. The asymptotic significance of this Kruskal-Wallis test statistic is 0.076, or 76 chances in 1000 that this distribution is the result of random variation.

Safety. This question asks the respondents to compare worker safety using job-order-contracting to worker safety using the most likely alternative (SAFETY). Table 25 contains the cross tabulation findings for this question.

Table 25.

Most Likely Alternative to Using JOC * Comparison of Safety Cross-Tabulation

			Comparison of Safety						
			A lot better than the MLA	A little better than the MLA	About the same as the MLA	A little worse than the MLA	A lot worse than the MLA	Don't Know	Total
Most likely alternative to using JOC	Design-bid-build contract	Count	11	14	64	5	1	3	98
		% within Comparison of Safety	78.6%	58.3%	50.0%	38.5%	25.0%	60.0%	52.1%
	Design-build contract	Count	2	2	26	3	2	2	37
		% within Comparison of Safety	14.3%	8.3%	20.3%	23.1%	50.0%	40.0%	19.7%
	Construction-manager-at-risk contract	Count	0	5	22	2	0	0	29
		% within Comparison of Safety	.0%	20.8%	17.2%	15.4%	.0%	.0%	15.4%
	Other	Count	1	3	16	3	1	0	24
		% within Comparison of Safety	7.1%	12.5%	12.5%	23.1%	25.0%	.0%	12.8%
Total		Count	14	24	128	13	4	5	188
		% within Comparison of Safety	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Hypothesis 14 states that opinions with respect to the quality of work being better, the same, or worse than the quality for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. To address this, a Kruskal-Wallis test was performed to determine if the data supports the hypothesis that the observed differences in responses are the result of random variation, or are the result of the MLA used in the comparison. The Kruskal-Wallis test statistic for this analysis yielded $H = 5.22$. The critical chi-square value for a distribution using 2 degrees of freedom and $\alpha = 0.05$ would be 5.99. The asymptotic significance of this Kruskal-Wallis test statistic is 0.073, or 73 chances in 1000 that this distribution is the result of random variation.

Warranty issues. This question asks the respondents to compare the frequency of warranty issues using job-order-contracting to the frequency of warranty issues using the most likely alternative (WARRANT). Table 26 contains the cross tabulation findings for this question.

Table 26.

Most Likely Alternative to Using JOC * Comparison of Warranty Issues Cross-Tabulation

			Comparison of Warranty Issues						
			A lot fewer than the MLA	A little fewer than the MLA	About the same as the MLA	A little more than the MLA	A lot more than the MLA	Don't Know	Total
Most likely alternative to using JOC	Design-bid-build contract	Count	9	27	51	8	2	1	98
		% within Comparison of Warranty Issues	52.9%	62.8%	48.6%	53.3%	66.7%	20.0%	52.1%
	Design-build contract	Count	4	3	27	2	1	0	37
		% within Comparison of Warranty Issues	23.5%	7.0%	25.7%	13.3%	33.3%	.0%	19.7%
	Construction-manager-at-risk contract	Count	3	5	19	0	0	2	29
		% within Comparison of Warranty Issues	17.6%	11.6%	18.1%	.0%	.0%	40.0%	15.4%
	Other	Count	1	8	8	5	0	2	24
		% within Comparison of Warranty Issues	5.9%	18.6%	7.6%	33.3%	.0%	40.0%	12.8%
Total		Count	17	43	105	15	3	5	188
		% within Comparison of Warranty Issues	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Hypothesis 15 states that opinions with respect to the number of warranty issues being higher, the same, or lower than the number for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison. To address this, a Kruskal-Wallis test was performed to determine if the data supports the hypothesis that the observed differences in responses are the result of random variation, or are the result of the MLA used in the comparison. The Kruskal-Wallis test statistic for this analysis yielded $H = 1.43$. The critical chi-square value for a distribution using 2 degrees of freedom and $\alpha = 0.05$ would be 5.99. The asymptotic significance of this Kruskal-Wallis test statistic is 0.489, or 489 chances in 1000 that this distribution is the result of random variation.

Accidents. This question asks the respondents to compare the frequency of accidents using job-order-contracting to the frequency of accidents using the most likely alternative (ACCIDENT). Table 27 contains the cross tabulation findings for this question.

Table 27.

Most Likely Alternative to Using JOC * Comparison of Accidents Cross-Tabulation

			Comparison of Accidents							
			A lot fewer than the MLA	A little fewer than the MLA	About the same as the MLA	A little more than the MLA	A lot more than the MLA	Don't Know	Not Applicable	Total
Most likely alternative to using JOC	Design-bid-build contract	Count	8	12	66	5	1	4	1	97
		% within Comparison of Accidents	57.1%	57.1%	51.2%	62.5%	50.0%	33.3%	100.0%	51.9%
	Design-build contract	Count	1	5	28	2	1	0	0	37
		% within Comparison of Accidents	7.1%	23.8%	21.7%	25.0%	50.0%	.0%	.0%	19.8%
	Construction-manager-at-risk contract	Count	2	3	20	1	0	3	0	29
		% within Comparison of Accidents	14.3%	14.3%	15.5%	12.5%	.0%	25.0%	.0%	15.5%
	Other	Count	3	1	15	0	0	5	0	24
		% within Comparison of Accidents	21.4%	4.8%	11.6%	.0%	.0%	41.7%	.0%	12.8%
Total		Count	14	21	129	8	2	12	1	187
		% within Comparison of Accidents	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Hypothesis 16 states that opinions with respect to the number of accidents being higher, the same, or lower than the number for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. To address this, a Kruskal-Wallis test was performed to determine if the data supports the hypothesis that the observed differences in responses are the result of random variation, or are the result of the MLA used in the comparison. The Kruskal-Wallis test statistic for this analysis yielded $H = 0.295$. The critical chi-square value for a distribution using 2 degrees of freedom and $\alpha = 0.05$ would be 5.99. The asymptotic significance of this Kruskal-Wallis test statistic is 0.863, or 863 chances in 1000 that this distribution is the result of random variation.

Claims. This question asks the respondents to compare the frequency of claims using job-order-contracting to the frequency of claims using the most likely alternative (CLAIMS). Table 28 contains the cross tabulation findings for this question.

Table 28.

Most Likely Alternative to Using JOC * Comparison of Claims Cross-Tabulation

			Comparison of Claims							
			A lot fewer than the MLA	A little fewer than the MLA	About the same as the MLA	A little more than the MLA	A lot more than the MLA	Don't Know	Not Applicable	Total
Most likely alternative to using JOC	Design-bid-build contract	Count	28	22	33	3	3	6	3	98
		% within Comparison of Claims	71.8%	51.2%	44.6%	30.0%	50.0%	46.2%	100.0%	52.1%
	Design-build contract	Count	4	7	22	2	2	0	0	37
		% within Comparison of Claims	10.3%	16.3%	29.7%	20.0%	33.3%	.0%	.0%	19.7%
	Construction-manager-at-risk contract	Count	5	10	12	1	0	1	0	29
		% within Comparison of Claims	12.8%	23.3%	16.2%	10.0%	.0%	7.7%	.0%	15.4%
	Other	Count	2	4	7	4	1	6	0	24
		% within Comparison of Claims	5.1%	9.3%	9.5%	40.0%	16.7%	46.2%	.0%	12.8%
Total		Count	39	43	74	10	6	13	3	188
		% within Comparison of Claims	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Hypothesis 17 states that opinions with respect to the number of claims being higher, the same, or lower than the number for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. To address this, a Kruskal-Wallis test was performed to determine if the data supports the hypothesis that the observed differences in responses are the result of random variation, or are the result of the MLA used in the comparison. The Kruskal-Wallis test statistic for this analysis yielded $H = 3.30$. The critical chi-square value for a distribution using 2 degrees of freedom and $\alpha = 0.05$ would be 5.99. The asymptotic significance of this Kruskal-Wallis test statistic is 0.192, or 192 chances in 1000 that this distribution is the result of random variation.

Owner Satisfaction. This question asks the respondents to compare owner satisfaction using job-order-contracting to owner satisfaction using the most likely alternative (SATISFY). Table 29 contains the cross tabulation findings for this question.

Table 29.

Most Likely Alternative to Using JOC * Comparison of Overall Satisfaction Cross-Tabulation

			Comparison of Overall Satisfaction							
			Much more satisfied than the MLA	A little more satisfied than the MLA	About the same as the MLA	A little less satisfied than the MLA	A lot less satisfied than the MLA	Don't Know	Not Applicable	Total
Most likely alternative to using JOC	Design-bid-build contract	Count	23	35	27	5	4	3	1	98
		% within Comparison of O. Satisfaction	62.2%	53.8%	50.0%	38.5%	36.4%	60.0%	50.0%	52.4%
	Design-build contract	Count	6	15	10	3	2	1	0	37
		% within Comparison of O. Satisfaction	16.2%	23.1%	18.5%	23.1%	18.2%	20.0%	.0%	19.8%
	Construction-manager-at-risk contract	Count	6	7	9	2	3	1	0	28
		% within Comparison of O. Satisfaction	16.2%	10.8%	16.7%	15.4%	27.3%	20.0%	.0%	15.0%
	Other	Count	2	8	8	3	2	0	1	24
		% within Comparison of O. Satisfaction	5.4%	12.3%	14.8%	23.1%	18.2%	.0%	50.0%	12.8%
Total		Count	37	65	54	13	11	5	2	187
		% within Comparison of O. Satisfaction	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Hypothesis 18 states that opinions with respect to the overall level of owner satisfaction being higher, the same, or lower than the level for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison. To address this, a Kruskal-Wallis test was performed to determine if the data supports the hypothesis that the observed differences in responses are the result of random variation, or are the result of the MLA used in the comparison. The Kruskal-Wallis test statistic for this analysis yielded $H = 1.25$. The critical chi-square value for a distribution using 2 degrees of freedom and $\alpha = 0.05$ would be 5.99. The asymptotic significance of this Kruskal-Wallis test statistic is 0.536, or 536 chances in 1000 that this distribution is the result of random variation.

Summary

This study began with three questions: 1) what are the characteristics of the typical JOC user with respect to experience, location, type of organization, pricing methodology, and reasons for using job-order-contracting?; 2) what is the most likely alternative to JOC as a project delivery method for the owner currently using job-order-contracting?; and 3) are owner perceptions with respect to construction costs, timeliness of construction, quality, safety, claims and owner satisfaction affected by the project delivery method selected for a project? The following is a summary of the findings with respect to these questions:

Question 1 - What are the characteristics of the typical JOC user with respect to experience, location, type of organization, pricing methodology, and reasons for using job-order-contracting? Table 30 is a summary of the most prevalent responses received.

Table 30.

Characteristics of JOC Users: Most Prevalent Responses

Characteristic	Most Prevalent Responses	Quantity	Unit
Employer type	Facility Owner	79.5	% of Response
	Program Manager	10.5	% of Response
	General Contractor	3.7	% of Response
Years of MLA experience	DBB	17.0	Years (mean)
	DB	9.5	Years (mean)
	JOC	8.7	Years (mean)
	CMAR	6.2	Years (mean)
Number of task orders	Last year	11.7	Count (mean)
Type of procurement	Facility Owner	71.1	% of Response
	Coop. Purchasing Agency	23.7	% of Response
Contracting environment	Federal Agency [military]	25.3	% of Response
	Private Companies	13.2	% of Response
	Higher Education	12.1	% of Response
Pricing method	Use a UPB	55.8	% of Response
	Do not use a UPB	44.2	% of Response
Zip code (State)	Arizona	13.7	% of Response
	Washington	10.5	% of Response
	Texas	8.4	% of Response
Why use JOC?	Urgency or need to complete the work	43.2	% of Response
	Simplicity of the job-order-contracting process	16.8	% of Response
	Predictability of the process to meet the owner's needs	12.6	% of Response

Question 2 - What is the most likely alternative to JOC as a project delivery method for the owner currently using job-order-contracting? Table 31 is a summary of the most prevalent responses received.

Table 31.

Most Likely Alternative to Use of JOC: Most Prevalent Responses

Most Likely Alternative	Percent of Total
Design-bid-build	52.6%
Design-build	19.5%
Construction-management-at-risk	15.3%
Self perform the work	5.8%

Question 3 - Are owner perceptions with respect to construction costs, timeliness of construction, quality, safety, claims and owner satisfaction affected by the project delivery method selected for a project? Table 32 is a summary of the Kruskal-Wallis test statistics from the analysis performed.

Table 32.

Kruskal-Wallis Test Statistic Findings

Are opinions regarding _____ using JOC significantly influenced by the MLA used in the comparison?	Kruskal-Wallis H	Chi-square (2 degrees of freedom)	Asymptotic Significance
Design costs	11.43	5.99	0.003
Job order procurement costs	3.42	5.99	0.181
Construction costs	0.395	5.99	0.821
Change order costs	1.68	5.99	0.431
Administration costs	1.38	5.99	0.502
Claims costs	1.50	5.99	0.472
Time to initiate work	0.593	5.99	0.744
Time to design the project	0.151	5.99	0.927
Time to construct	2.31	5.99	0.315
Time to close out the project	0.576	5.99	0.750

Table 32. (Continued)

Are opinions regarding _____ using JOC significantly influenced by the MLA used in the comparison?	Kruskal-Wallis H	Chi-square (2 degrees of freedom)	Asymptotic Significance
Ease of use	1.44	5.99	0.488
Quality	5.15	5.99	0.076
Safety	5.22	5.99	0.073
Warranty issues	1.43	5.99	0.489
Accidents	0.295	5.99	0.863
Claims	3.30	5.99	0.192
Owner Satisfaction	1.25	5.99	0.536

CHAPTER 5

CONCLUSIONS

Questions of the Study

Question 1

What are the characteristics of the typical JOC user with respect to experience, location, type of organization, pricing methodology, and reasons for using job-order-contracting? This question has been addressed through the use of descriptive statistics.

The respondents to this study primarily indicated that they were employed by facility owners (79.5%) and that they had on average 17 years of design-bid-build experience in addition to 8.7 years of job-order-contracting experience. Also, on an average, the respondents indicated that they had worked on 11.7 work orders in the previous year. In regard to the type of procurement used to obtain the services of a JOC contractor, the respondents indicated that the majority of them have their own owner procured JOC (71.1%) while another significant portion of them use the JOC services of a cooperative purchasing agency (23.7%). With respect to the contracting environment where JOC is being used, about 50% of the responses were from federal agencies – military (25.3%), private companies (13.2%), and higher education – universities and colleges (12.1%). The unit price book is still the primary method of pricing JOC work

with 55.8% of the responses indicating they use a UPB and 44.2% indicating they price their JOC work in some other manner. Converting the zip codes of the respondents into state names, it can be seen that the respondents came from 38 states with most of the respondents coming from the states of Arizona (13.7%), Washington (10.5%), and Texas (8.4%). Finally, just under three-quarters of the respondents indicated their primary motivation for using JOC is 1) the urgency or need to complete the work (43.2%), 2) the simplicity of the job-order-contracting process (16.8%), and 3) the predictability of the process to meet the owner's needs (12.6%).

Question 2

What is the most likely alternative to JOC as a project delivery method for the owner currently using job-order-contracting? This question was analyzed using the following hypotheses:

$H_0 1$: $P_{DBB} = P_{DB} = P_{CMAR}$: The users of JOC will indicate there is no one, or more, most likely alternative project delivery method to job-order-contracting.

$H_A 1$: Not $H_0 1$: The users of JOC will indicate there is one, or more, most likely alternative project delivery methods to job-order-contracting.

Assuming there is no one, or more, most likely alternative to JOC there would be an expected 55.3 frequency (using 166 responses) that each of the alternatives would be selected. In contrast to this, respondents to this study indicated 100 times that the DBB project delivery method would be the MLA for JOC. In addition, DB was identified as the MLA 37 times, and CMAR was selected 29 times (see Table 11). Using the chi-square statistic for this distribution yields $\chi^2 = 54.66$ as compared to a $\chi^2 = 5.99$ for a

distribution of 2 degrees of freedom using $\alpha = 0.05$. The asymptotic significance of this as calculated using SPSS is 0.000, or there is a less than 1 chance in 1000 there is a Type 2 error (acceptance of a hypothesis when in fact it should be rejected). Based upon this, $H_0 1$ is rejected and the alternative hypothesis ($H_A 1$) accepted, there is one, or more, most likely alternatives to JOC.

Question 3

Are owner perceptions with respect to construction costs, timeliness of construction, quality, safety, claims and owner satisfaction affected by the project delivery method selected for a project?

Using the Kruskal-Wallis test statistic, each of the following seventeen hypotheses were examined by comparing this test statistic to a corresponding chi-square distribution at 2 degrees of freedom using an $\alpha = 0.05$ ($\chi^2 = 5.99$).

$H_0 2$: $P_{DBB} = P_{DB} = P_{CMAR}$: Opinions with respect to the cost of project design being higher, the same, or lower than the design cost for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

$H_A 2$: Not $H_0 2$: Opinions with respect to the cost of project design being higher, the same, or lower than the design cost for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison.

The calculated Kruskal-Wallis test statistic using SPSS is 11.43 which is greater than 5.99 (χ^2 for 2 degrees of freedom at $\alpha = 0.05$) with a significance of $0.0038 < 0.05$ (α for this study). This null hypothesis is rejected. It is possible that opinions with respect

to the cost of project design being higher, the same, or lower than the design cost for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison.

$H_0$3: $P_{DBB} = P_{DB} = P_{CMAR}$: Opinions with respect to the cost of contractor procurement being higher, the same, or lower than the procurement cost for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

H_A3: Not $H_0$3: Opinions with respect to the cost of contractor procurement being higher, the same, or lower than the procurement cost for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison.

The calculated Kruskal-Wallis test statistic using SPSS is 3.42 which is less than 5.99 (χ^2 for 2 degrees of freedom at $\alpha = 0.05$) with a significance of $0.181 > 0.05$ (α for this study). This hypothesis is retained. It is possible that opinions with respect to the cost of contractor procurement being higher, the same, or lower than the procurement cost for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

$H_0$4: $P_{DBB} = P_{DB} = P_{CMAR}$: Opinions with respect to the cost of construction being higher, the same, or lower than the construction cost for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

H_A4: Not $H_0$4: Opinions with respect to the cost of construction being higher, the same, or lower than the construction cost for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison.

The calculated Kruskal-Wallis test statistic using SPSS is 0.395 which is less than 5.99 (χ^2 for 2 degrees of freedom at $\alpha = 0.05$) with a significance of 0.821 > 0.05 (α for this study). This hypothesis is retained. It is possible that opinions with respect to the cost of construction being higher, the same, or lower than the construction cost for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

$H_0$5: $P_{DBB} = P_{DB} = P_{CMAR}$: Opinions with respect to the cost of change orders being higher, the same, or lower than the change order cost for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

H_A5: Not $H_0$5: Opinions with respect to the cost of change orders being higher, the same, or lower than the change order cost for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison.

The calculated Kruskal-Wallis test statistic using SPSS is 1.68 which is less than 5.99 (χ^2 for 2 degrees of freedom at $\alpha = 0.05$) with a significance of 0.431 > 0.05 (α for this study). This hypothesis is retained. It is possible that opinions with respect to the cost of change orders being higher, the same, or lower than the change order cost for the

most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

$H_0$6: $P_{DBB} = P_{DB} = P_{CMAR}$: Opinions with respect to the cost of project administration being higher, the same, or lower than the project administration cost for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

H_A6: Not $H_0$6: Opinions with respect to the cost of project administration being higher, the same, or lower than the project administration cost for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison.

The calculated Kruskal-Wallis test statistic using SPSS is 1.38 which is less than 5.99 (χ^2 for 2 degrees of freedom at $\alpha = 0.05$) with a significance of $0.502 > 0.05$ (α for this study). This hypothesis is retained. It is possible that opinions with respect to the cost of project administration being higher, the same, or lower than the project administration cost for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

$H_0$7: $P_{DBB} = P_{DB} = P_{CMAR}$: Opinions with respect to the cost of claims being higher, the same, or lower than the claims cost for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

H_A7: Not $H_0 7$: Opinions with respect to the cost of claims being higher, the same, or lower than the claims cost for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison.

The calculated Kruskal-Wallis test statistic using SPSS is 1.50 which is less than 5.99 (χ^2 for 2 degrees of freedom at $\alpha = 0.05$) with a significance of $0.472 > 0.05$ (α for this study). This hypothesis is retained. It is possible that opinions with respect to the cost of claims being higher, the same, or lower than the claims cost for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

$H_0 8$: $P_{DBB} = P_{DB} = P_{CMAR}$: Opinions with respect to the time required to initiate the work being longer, the same, or shorter than the time required for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

H_A8: Not $H_0 8$: Opinions with respect to the time required to initiate the work being longer, the same, or shorter than the time required for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison.

The calculated Kruskal-Wallis test statistic using SPSS is 0.593 which is less than 5.99 (χ^2 for 2 degrees of freedom at $\alpha = 0.05$) with a significance of $0.744 > 0.05$ (α for this study). This hypothesis is retained. It is possible that opinions with respect to the time required to initiate the work being longer, the same, or shorter than the time required

for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

$H_0$9: $P_{DBB} = P_{DB} = P_{CMAR}$: Opinions with respect to the time required to complete the design being longer, the same, or shorter than the time required for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

H_A9: Not $H_0$9: Opinions with respect to the time required to complete the design being longer, the same, or shorter than the time required for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison.

The calculated Kruskal-Wallis test statistic using SPSS is 0.151 which is less than 5.99 (χ^2 for 2 degrees of freedom at $\alpha = 0.05$) with a significance of $0.927 > 0.05$ (α for this study). This hypothesis is retained. It is possible that opinions with respect to the time required to complete the design being longer, the same, or shorter than the time required for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

$H_0$10: $P_{DBB} = P_{DB} = P_{CMAR}$: Opinions with respect to the time required to construct the project being longer, the same, or shorter than the time required for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

H_A10: Not H_010: Opinions with respect to the time required to construct the project being longer, the same, or shorter than the time required for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison.

The calculated Kruskal-Wallis test statistic using SPSS is 2.31 which is less than 5.99 (χ^2 for 2 degrees of freedom at $\alpha = 0.05$) with a significance of $0.315 > 0.05$ (α for this study). This hypothesis is retained. It is possible that opinions with respect to the time required to construct the project being longer, the same, or shorter than the time required for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

H_011: $P_{DBB} = P_{DB} = P_{CMAR}$: Opinions with respect to the time required to closeout the project being longer, the same, or shorter than the time required for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

H_A11: Not H_011: Opinions with respect to the time required to closeout the project being longer, the same, or shorter than the time required for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison.

The calculated Kruskal-Wallis test statistic using SPSS is 0.576 which is less than 5.99 (χ^2 for 2 degrees of freedom at $\alpha = 0.05$) with a significance of $0.750 > 0.05$ (α for this study). This hypothesis is retained. It is possible that opinions with respect to the time required to closeout the project being longer, the same, or shorter than the time

required for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

$H_0$12: $P_{DBB} = P_{DB} = P_{CMAR}$: Opinions with respect to the ease of using JOC being easier, the same, or not as easy as using the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

H_A12: Not $H_0$12: Opinions with respect to the ease of using JOC being easier, the same, or not as easy as using the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison.

The calculated Kruskal-Wallis test statistic using SPSS is 1.44 which is less than 5.99 (χ^2 for 2 degrees of freedom at $\alpha = 0.05$) with a significance of $0.488 > 0.05$ (α for this study). This hypothesis is retained. It is possible that opinions with respect to the ease of using JOC being easier, the same, or not as easy as using the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

$H_0$13: $P_{DBB} = P_{DB} = P_{CMAR}$: Opinions with respect to the quality of work being better, the same, or worse than the quality for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

H_A13: Not $H_0$13: Opinions with respect to the quality of work being better, the same, or worse than the quality for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison.

The calculated Kruskal-Wallis test statistic using SPSS is 5.15 which is less than 5.99 (χ^2 for 2 degrees of freedom at $\alpha = 0.05$) with a significance of $0.076 > 0.05$ (α for this study). This hypothesis is retained. It is possible that opinions with respect to the quality of work being better, the same, or worse than the quality for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

$H_0$14: $P_{DBB} = P_{DB} = P_{CMAR}$: Opinions with respect to worker safety being better, the same, or worse than the safety for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

H_A14: Not $H_0$14: Opinions with respect to worker safety being better, the same, or worse than the safety for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison.

The calculated Kruskal-Wallis test statistic using SPSS is 5.22 which is less than 5.99 (χ^2 for 2 degrees of freedom at $\alpha = 0.05$) with a significance of $0.073 > 0.05$ (α for this study). This hypothesis is retained. It is possible that opinions with respect to worker safety being better, the same, or worse than the safety for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

$H_0$15: $P_{DBB} = P_{DB} = P_{CMAR}$: Opinions with respect to the number of warranty issues being higher, the same, or lower than the number for the most likely alternative

project delivery method are not significantly influenced by the specific MLA used in the comparison.

H_A15: Not $H_0$15: Opinions with respect to the number of warranty issues being higher, the same, or lower than the number for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison.

The calculated Kruskal-Wallis test statistic using SPSS is 1.43 which is less than 5.99 (χ^2 for 2 degrees of freedom at $\alpha = 0.05$) with a significance of $0.489 > 0.05$ (α for this study). This hypothesis is retained. It is possible that opinions with respect to the number of warranty issues being higher, the same, or lower than the number for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

$H_0$16: $P_{DBB} = P_{DB} = P_{CMAR}$: Opinions with respect to the number of accidents being higher, the same, or lower than the number for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

H_A16: Not $H_0$16: Opinions with respect to the number of accidents being higher, the same, or lower than the number for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison.

The calculated Kruskal-Wallis test statistic using SPSS is 0.295 which is less than 5.99 (χ^2 for 2 degrees of freedom at $\alpha = 0.05$) with a significance of $0.863 > 0.05$ (α for this study). This hypothesis is retained. It is possible that opinions with respect to the number of accidents being higher, the same, or lower than the number for the most likely

alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

$H_0$17: $P_{DBB} = P_{DB} = P_{CMAR}$: Opinions with respect to the number of claims being higher, the same, or lower than the number for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

H_A17: Not $H_0$17: Opinions with respect to the number of claims being higher, the same, or lower than the number for the most likely alternative project delivery method are significantly influenced by the specific MLA used in the comparison.

The calculated Kruskal-Wallis test statistic using SPSS is 3.30 which is less than 5.99 (χ^2 for 2 degrees of freedom at $\alpha = 0.05$) with a significance of $0.192 > 0.05$ (α for this study). This hypothesis is retained. It is possible that opinions with respect to the number of claims being higher, the same, or lower than the number for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

$H_0$18: $P_{DBB} = P_{DB} = P_{CMAR}$: Opinions with respect to the overall level of owner satisfaction being higher, the same, or lower than the level for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

H_A18: Not $H_0$18: Opinions with respect to the overall level of owner satisfaction being higher, the same, or lower than the level for the most likely alternative project

delivery method are significantly influenced by the specific MLA used in the comparison.

The calculated Kruskal-Wallis test statistic using SPSS is 1.25 which is less than 5.99 (χ^2 for 2 degrees of freedom at $\alpha = 0.05$) with a significance of $0.536 < 0.05$ (α for this study). This hypothesis is retained. It is possible that opinions with respect to the overall level of owner satisfaction being higher, the same, or lower than the level for the most likely alternative project delivery method are not significantly influenced by the specific MLA used in the comparison.

To summarize the seventeen hypotheses related to the question: Are owner perceptions with respect to construction costs, timeliness of construction, quality, safety, claims and owner satisfaction affected by the project delivery method selected for a project?; only one null hypotheses was rejected. Owner opinions with respect to the cost of design using JOC appear to be influenced by the specific most likely alternative project delivery method used in the comparison. All of the other 16 null hypotheses related to this question were retained. It does appear from the results of this study that owner opinions with respect to the use of JOC in comparison to the most likely alternative project delivery method are not influenced by the specific alternative used in the comparison.

Suggestions for Future Studies

With the construction industry transitioning from an industry dominated by the DBB project delivery method, to one where the project delivery method will be selected on the basis of what best fits the owner and the situation, the issue of owner satisfaction is

going to become a major factor in source selection (selection of a contractor to do the work). With this as the general direction of the industry, construction contractors need to recognize that the overall owner satisfaction is not solely built around the cost of construction. Contractors are going to need to understand what owners want and how they can position themselves to provide their services in a manner that enhances their ability to meet the owner's needs.

The results of this study are largely based upon non-parametric data (opinion data). Since opinions can often be influenced by factors other than the facts, one of the best areas for future research will be in validating (or disputing) the findings of this study using parametric data. This would mean utilizing project data (most likely supplied by owners) to determine if job-order-contracting is in fact better or worse than other project delivery methods in the areas of cost, schedule, quality, safety, claims, and overall owner satisfaction. Facility owners such as government agencies and educational institutions that regularly contract for small and routine construction work using both JOC and other project delivery methods would be the best sources of this type of data.

Using project data from a representative sample of relatively small and routine construction projects, future studies could begin to answer questions such as: 1) Is the cost to procure work under JOC less expensive than using other project delivery methods?, 2) Is the time required to initiate construction using JOC less than what it would be if another project delivery method were used?, and 3) Are there less change orders and claims using JOC in comparison to other project delivery methods? The findings of this study indicate that popular opinion amongst the users of JOC suggests that job-order-contracting performs well in comparison to other project delivery methods,

but the best way to answer these types of questions is with hard project data (parametric data).

It was recognized from the outset that this study was a starting place for research into the issues that surround the use of job-order-contracting. With a framework now established for this type of research, future studies can focus on collecting and analyzing the parametric data that the construction industry needs to take JOC and the other project delivery methods in the 21st century.

REFERENCES

Aller, G. (2005). (Personal communication March 31, 2005)

American Society of Civil Engineers (2002). 150 years of civil engineering. Retrieved December 24, 2007 from http://www.asce.org/150/150years.html.

American Society of Civil Engineers (2002). Brooks A/E Act turns 30. Retrieved December 24, 2007 from http://www.asce.org/pressroom/news/grwk/event_release.cfm?uid=1777.

Associated General Contractors of America (2007). About AGC. Retrieved December 24, 2007 from http://www.agc.org/page.ww?section=About+AGC&name=About+AGC.

Associated General Contractors of America (2004). Project delivery systems for construction. Arlington, VA: Associated General Contractors of America.

Baier, M. (2005). Personal communication, June 16 2005. Tucson, AZ.

Barrie, D. S., & Paulson, B. C. (1992). Professional construction management including CM, design-construct, and general contracting. New York, NY: McGraw-Hill.

Beard, J. L., Loulakis, M. C., & Wundram, E. C. (2001). Design-build: planning through development. New York, NY: McGraw-Hill.

Bresnen, M. J., & Haslam, C. O. (1991). Construction industry clients: a survey of their attributes and project management practices. Construction Management and Economics, 9, 327-342.

Dolan, Q. (2005). Personal communication, June 15, 2005. Fort Lewis, WA.

Ecker, R., Valardi, P., & Bielecki, T. (2005). Personal communication, May 27 2005. Flagstaff, AZ.

Garvin, M. J. (2003). Role of project delivery systems in infrastructure improvement. In Construction Research 2003. Winds of Change: Integration and Innovation of Construction, Construction Research Congress 2003, March 19–21, 2003, Honolulu, Hawaii, USA. Keith R. Molenaar, Paul S. Chinowsky, Editors.

Gerber, R. (2005). Personal communication, June 15, 2005. Fort Lewis, WA.

Gibbon, D. (2006). How Roebling did it: Building the world's first wire-rope suspension aqueduct in 1840s Pittsburgh Journal of Minerals v 58, n 5, May, 2006, p 20-29.

Gransberg, D. D., Koch, J. E., & Molenaar, K. R. (2006). Preparing for design-build projects: a primer for owners, engineers, and contractors. Reston, VA: ASCE Press.

Henry, E., & Brothers, H. S. (2001). Cost analysis between SABER and design bid build contracting methods. Journal of Construction Engineering and Management, Vol. 127, No. 5, 359-366.

Institute for Social Science Research (n.d.). Our mission. Retrieved January 21, 2006 from http://www.asu.edu/clas/issr/mission.htm

Kashiwagi, D. (2002). Documented performance of the JOC construction delivery system (1994 – 1998). Cost Engineering, Vol. 44, No. 6, 14-20.

Konchar, M., & Sanvido, V. (1998). Comparison of U. S. project delivery systems. Journal of Construction Engineering and Management, Nov/Dec 1998 pg 435-444.

Minium, E. W., Clark, R. B., and Coladarci, T. (1999). Elements of statistical reasoning, 2nd ed. Hoboken, NJ: John Wiley and Sons.

Morehouse, R. (2005). Personal communication May 25, 2005. Flagstaff, AZ

Mulcahy, F. S. (2000). The effectiveness of partnering and source selection in job order contracting – masters thesis. Washington, DC: National Technical Information Service.

Peeler, T., & Aller, G. (2005). Job order contracting through educational cooperatives. *School Business Affairs*, Vol. 71, No 8, 22-25.

Peeler, T., & McKee, C. (2005). Personal communication June 7, 2005. Kingman, AZ.

Songer, A. D., & Molenaar, K. R. (1996). Selecting design-build: public and private sector attitudes. Journal of Management in Engineering, Nov/Dec 1996 pg 47-53.

Thomsen, C. (2006). Project delivery processes. Retrieved December 23, 2007 from http://www.3di.com/rnd/Files/Essays/Project%20Delivery%20Strategy.pdf.

Trauner Consulting Services (2007). Construction project delivery systems and procurement practices: considerations, alternative, advantages, disadvantages. Retrieved December 23, 2007 from http://www.fefpa.org/pdf/summer2007/Pros-Cons-handout.pdf.

Williams, J. (1994). Exploring and implementing job order contracting. Unpublished master's thesis. University of Alaska, Fairbanks, Alaska.

APPENDIX A: SURVEY E-MAIL INVITATION

The following is an example of an invitation that will be sent via e-mail to participate in this study.

RE: Shining a Light on JOC

Help Us Help You! Be an industry leader and help improve the understanding of the applications and benefits of job-order-contracting (JOC) by completing this national survey developed by the students and faculty at Arizona State University, Northern Arizona University, Indiana State University, and East Carolina University. Your insights on JOC are very important to us and we have constructed a short, concise survey to accommodate your busy schedule.

Your survey responses are confidential and will be reported only in the aggregate. Survey results will be available to you and others in the industry. A web address where results will be posted is provided at the end of the survey.

To ensure that we have a common understanding of the terms mentioned in this survey, please use the following definitions:

- Job-order-contracting – A form of project delivery where the owner has a long term, indefinite-delivery, indefinite quantity, type of contract for construction services delivered on an on-call basis through firm fixed price job orders based on pre-established unit prices. Job-order-contracting is sometimes referred to as DOC, TOC, MATOC, SABER and WOC.
- Design-bid-build (DBB) – The traditional low bid or hard bid contract where the owner contracts separately for design to be provided by an architect/engineer and for construction to be provided by a construction contractor.
- Design-build (DB) – A form of project delivery where the owner has one single contract for both the design and construction. The Design Builder takes all the responsibility of both the design and for the construction of the project.
- Construction-management-at-risk (CMAR) – A form of project delivery where the owner has a separate contract with the CM at Risk and another directly with the designer. The CM at Risk provides preconstruction services, holds the trade contracts, takes responsibility for the performance of the work, and guarantees the construction cost and schedule. Sometimes referred to as CM/GC, GC/CM, CMc and, in the private sector, negotiated contract.
- Owner – This is the entity (agency, firm or individual) that contracts for the services of a contractor. The term refers to the owners of all types of facilities including buildings, infrastructure and transportation facilities.

Thank you for your time and consideration.

Sincerely,

Greg Ohrn

Greg Ohrn, P.E.

APPENDIX B: SURVEY QUESTIONNAIRE

The following is an example of the survey as it is proposed for delivery over the Internet. While the content will be consistent with the following, the appearance will be somewhat different due to differences in the word processing software utilized by the Internet based survey software.

Page 1:

First, have you ever used job-order-contracting?

- ❑ Yes
- ❑ No

Note: a response of "No" to the question above will result in termination of the survey

Page 2:

About how many years of experience do you personally have with job-order-contracting? If less than one year, please indicate the number of months in the appropriate space below.

Years: _____ years

or

Months: ____months

Page 3:

In the past year, about how many job orders or delivery orders did you personally participate in?

Number of job orders: _____

Page 4:

Which of the following best describes your employer? [Select one]

- ❑ Facility owner (including transportation and infrastructure facilities)
- ❑ Program manager
- ❑ General contractor
- ❑ Subcontractor
- ❑ Don't know
- ❑ Not applicable
- ❑ Other. Please describe: _____

Page 5:

What is the zip code of your work place? If more than one, please indicate the zip code of your primary local work place.

_____ [Please enter 5-digit zip code]

- ❑ Don't know

Page 6:

About how many years of experience do you personally have with the following project delivery methods? If less than one year, please indicate the number of months.

a. Design-bid-build: ____ years or ____ mos.

b. Design-build: ____ years or ____ mos.

c. Construction-manager-at-risk: ____ years or ____ mos.

Page 7

Are your job-order-contracts primarily procured through the facility owner or are they procured through a cooperative purchasing agency?

- ❑ Facility owner
- ❑ Cooperative purchasing agency
- ❑ Don't know
- ❑ Not applicable
- ❑ Other. Please describe: _____

Page 8

Which of the following entities best describes the owner organization that is utilizing job-order-contracting? [Select one]

- ❑ Private companies or corporations
- ❑ Federal agencies [non-military]
- ❑ Federal agencies [military]
- ❑ Semi-private federal agencies such as USPS
- ❑ State/commonwealth agencies
- ❑ County or parish departments
- ❑ City, town or other type of municipalities
- ❑ Higher education [university or community college]
- ❑ Primary education [K-12]
- ❑ Don't know
- ❑ Not applicable
- ❑ Other. Please describe: _____

Page 9

Which of the following items or methods do you most typically use to determine pricing for job-order-contracts? [Select one]

- ❑ A national unit price book [UPB] with city cost indexing
- ❑ A customized unit price book [UPB] unique to the owner or region
- ❑ Sub-bids obtained by the general contractor and then a pre-established mark-up is applied
- ❑ Each job order is individually negotiated
- ❑ Other. Please describe: _____
- ❑ Don't know
- ❑ Not applicable

Page 10

If the facility owner were required to use a project delivery method other than job-order-contracting, which of the following alternatives would the owner use? [Select one.]

- ❑ Design-bid-build contract [also known as low bid/hard bid]
- ❑ Design-build contract
- ❑ Construction-manager-at-risk contract
- ❑ The owner's employees would complete the work
- ❑ Don't know
- ❑ Not applicable
- ❑ Other. Please describe: _____

Page 11

What would you say is the most important factor that the facility owner considers when determining whether to use job-order-contracting as the project delivery method? [Select one]

- ❑ A lower cost compared to the most likely alternative
- ❑ The urgency or need to complete the work within a certain time frame
- ❑ The contractor's reputation for quality work
- ❑ The contractor's safety record
- ❑ The contractor's reputation for not filing claims
- ❑ The owner's previous experience and satisfaction with the contractor
- ❑ The simplicity of the job-order-contracting process
- ❑ The overall predictability of the process to meet the owner's needs
- ❑ Don't know
- ❑ Not applicable
- ❑ Other. Please describe: _____

Page 12

For each of the following items, would the facility owner's costs generally be a lot more, a little more, a little less, a lot less, or about the same if job-order-contracting is used instead of _____ contracting?

	A lot more	A little more	Same	A little less	A lot less	Don't know	NA
a. Design costs	❑	❑	❑	❑	❑	❑	❑
b. Cost of obtaining the services of a contractor	❑	❑	❑	❑	❑	❑	❑
c. Construction costs	❑	❑	❑	❑	❑	❑	❑
d. Costs of change orders	❑	❑	❑	❑	❑	❑	❑
e. Project administration costs	❑	❑	❑	❑	❑	❑	❑
f. Cost of claims	❑	❑	❑	❑	❑	❑	❑

Note: the _____ will be replaced by the project delivery method indicated in the response to question #10

Page 13

Would each of the following tasks generally take a lot more, a little more, a little less, a lot less, or about the same amount of time if job-order-contracting is used instead of _____ contracting?

	A lot more	A little more	Same	A little less	A lot less	Don't know	NA
a. The time to initiate the work	☐	☐	☐	☐	☐	☐	☐
b. The time to complete the design	☐	☐	☐	☐	☐	☐	☐
c. The time to construct the job order	☐	☐	☐	☐	☐	☐	☐
d. The time to close out the job order	☐	☐	☐	☐	☐	☐	☐

Note: the _____ will be replaced by the project delivery method indicated in the response to question #10

Page 14

Would it generally be a lot easier, a little easier, a little more difficult, or a lot more difficult for the facility owner to use job-order-contracting instead of _____ contracting, or would it be about the same?

- ❑ A lot easier
- ❑ A little easier
- ❑ Same
- ❑ A little more difficult
- ❑ A lot more difficult
- ❑ Don't know
- ❑ Not applicable

Note: the _____ will be replaced by the project delivery method indicated in the response to question #10

Page 15

Would each of the following items generally be a lot better, a little better, a little worse, a lot worse, or about the same if you used job-order-contracting instead of _____ contracting?

	A lot better	A little better	Same	A little worse	A lot worse	Don't know	NA
a. The quality of work	☐	☐	☐	☐	☐	☐	☐
b. Workers' safety	☐	☐	☐	☐	☐	☐	☐

Note: the _____ will be replaced by the project delivery method indicated in the response to question #10

Page 16

For each of the following items, would you say there would generally be a lot fewer, a little fewer, a little more, a lot more, or about the same number if you used job-order-contracting instead of _____ contracting?

	A lot fewer	A little fewer	Same	A little more	A lot more	Don't know	NA
a. Warranty issues	☐	☐	☐	☐	☐	☐	☐
b. Accidents	☐	☐	☐	☐	☐	☐	☐
c. Claims	☐	☐	☐	☐	☐	☐	☐

Note: the _____ will be replaced by the project delivery method indicated in the response to question #10