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EVALUATING DESIGN-BUILD PROCUREMENT METHODS

M.S. Thesis Proposal

by

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ABSTRACT

Several research studies have addressed the design-build project delivery method, illustrating that it has been preferred by owners due to the numerous advantages it offers. Another important issue associated with the design-build delivery method is the procurement approach of the design-build team. To benefit from the successful performance this delivery method can offer, the appropriate design-build team has to be selected. Therefore, the procurement of the design-build team is a critical decision that should be carefully considered by owners. Moreover, the procurement approach should consider several evaluation criteria to ensure that the appropriate design-build team has been selected.

Due to the increased use of the design-build as a project delivery method, together with the importance of the procurement method, the aim of this study is to quantitatively research the potential correlation that may exist between the procurement method and the performance of the design-build project with regard to time, cost and quality. After identifying the definitions for the different procurement methods and performing a literature review, data collection and analysis, in addition to the use of various statistical methods such as univariate and multivariate analysis will be used to help identify if such correlation exists. Since the study is not expected to identify the best procurement method, the results will possibly include an owner's recommendations section, which may assist owners in selecting the most appropriate design-build team.

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1. Introduction

Procurement is the approach an owner follows to recruit a team that provides services under the chosen project delivery system. A project can be procured using different procurement methods ranging from sole source to open competition procurement (Beard et al. 2001). Numerous factors should be considered when selecting the appropriate procurement method. Procurement of the design-build team is a critical decision because it defines the method to select the key player of the project team, which is the design-build entity that is expected to deliver the project. This decision greatly impacts the performance because if the design-build team is not qualified to achieve the project goals, serious problems may arise during and after construction. Therefore, it can be assumed that the adoption of a comprehensive procurement method can minimize certain risks associated with this process.

In a previous study conducted at Penn State, in coordination with the Construction Industry Institute (CII), the design-build delivery system has been identified as offering the best project performance (Konchar et al. 1998). A design-build team can be procured using several procurement approaches that will be discussed later. However, the selection of a particular procurement method should take into consideration the type of the design-build contract, the level of design achieved prior to selection, and other factors related to the design-build team. It follows that many owners face difficulty in determining the appropriate method to select the design-build team and often selection is solely based on cost, which may endanger the successful project performance. Although numerous studies have identified selection models and evaluation criteria systems for contractor procurement, limited research has addressed the relation between the use of a particular procurement method for the design-build team and the project performance. Also, of the studies that were directed towards design-build projects, few have attempted to empirically research the impact of the selection method on the various project attributes. Accordingly, this study will aim to quantitatively investigate this potential relationship between the procurement methods of design-build teams and project performance.

1.1 Design-Build Market

This study mainly emphasizes on design-build projects. Another main reason besides being identified as a delivery methods offering the best performance regarding several project

performance measures, design-build has been experiencing extraordinary growth in recent years in terms of previous volume and as a percentage of total construction (Konchar and Sanvido 1998). The Design-Build Institute of America (DBIA) indicates that compared to the design-bid-build and construction management at risk delivery methods, the trend for adopting the design-build approach is increasing since 1985, where 5% of the projects were delivered via design-build (Beard et al. 2001). In 2001, the number of design-build projects accounted for more than 30 percent of the construction in the U.S. Although the economy is experiencing a slower growth, which was reflected in decreased revenues for the ENR Top 100 design-build firms in 2001, it is expected that this percentage will continue to increase in 2002 (Tulacz 2002). By 2010, the U.S. Department of Commerce projects that half of the nonresidential construction projects will be delivered through the design-build approach (Songer et al. 1996).

Different market sectors are increasingly resorting to the design-build approach. In healthcare, design-build accounted for 15% of the medical institutions in 1997 and currently is accounting for 46% (Tulacz 2002). Educational institutions sector is providing more opportunities for design-build delivery method. In addition, the design-build delivery system is not restricted to use by one owner type. Currently, both public and private owners are considering the design-build delivery approach due to the numerous advantages it can offer. Governmental agencies are also shifting towards the use of the design-build delivery system. This shift was promoted by changes in regulations on the states level that facilitated the procurement for design-build projects (Tulacz 2002).

One main advantage of the design-build delivery method is the possibility for the owner to contract with a single entity. The design-build team is responsible for providing the owner with all aspects required to deliver the facility, starting from design services till construction, and including equipment selection and procurement. In this way, the risks associated with design management and control are transferred to the design-build entity. Moreover, the owner totally relies on the design-build team for coordination, quality and cost control, in addition to schedule monitoring (Beard et al. 2001).

1.2 Description of the Research

1.2.1 Goal

The main goal of this research is to study the correlation between the performance of a design-build project and the method for procuring the design-build team. Comparing the different project attributes, of cost, time and quality, to the corresponding procurement approach followed to select the design-build team may help in identifying this correlation.

1.2.2 Objectives

The research study possesses several objectives that are necessary to illustrate the possible correlation and guide the different project participants through the procurement process. These objectives can be identified as follows:

1. *To collect data on design-build projects*. Through the initial CII study, data regarding the several design-build projects performance metrics is already available. However, to complete the research it is necessary to gather more information on the procurement method the owners followed to select and evaluate the design-build team, in addition to other project information required to complete the research.

2. *To determine the impact of the procurement method on the project matrix*. It is important to determine if there is a correlation between the owner's selected procurement method for the design-build team and the project performance measures, cost, schedule and quality. Through data analysis, it can be illustrated whether those parameters are related or not and consequently, a possible correlation is existent.

3. *To provide recommendations to the owners.* Based on the results of the study, it would be beneficial for owners to review a set of recommendations that could be used to guide them through the design-builder procurement process.

1.2.3 Relevance

As previously indicated, minimal research studies have addressed the relation between the procurement method of the design-build team and the project performance. The conclusions and

guidelines developed based on the outcome of the study can benefit several parties. The guidelines will be specifically directed to the owners' organizations. The aim of these guidelines is to provide owners with a basis they can rely upon to decide how to procure the right design-build team. Supplying owners with such recommendations will enable them to clearly identify their requirements and follow a systematic process to select the appropriate design-build team. Otherwise, contractors and different organizations within the construction industry may benefit from this study by considering the results of the research while they are pursuing projects.

1.2.4 Research Approach

The research approach mainly relies on first identifying the different procurement methods for design-build projects through the literature review. This is necessary to enable categorization of the data after it is collected. The review of the literature also enables to identify the current practices for contractor selection, especially for the design-build team. Following, a data collection tool, a survey, was developed to gather the required information regarding the procurement of the design-build projects existing in the CII projects database. After the data is collected, it will be analyzed statistically using univariate and multivariate analysis to determine the potential correlation between the cost, time and quality metrics and the procurement method used to select the design-build team. The research steps are detailed in the section below.

1.2.5 Research Steps

The following steps will be used to fulfill the purpose of the study. These are defined in greater detail in Chapter 2:

1. *Review Literature:* Because limited research has addressed how the procurement method can impact the project performance of design-build projects, it was necessary to review the practices used by owners to procure contractors in all project delivery methods. The growing trend of design-build projects and the importance of the contractor evaluation as a project success factor were also deemed necessary to address in the literature review.

2. *Develop definitions for the different procurement methods:* Definitions of the three main procurement approaches were developed to serve as a basis for data categorization during the initial data collection phase.

3. *Collect the Data:* Data regarding the evaluation criteria for design-builders, in addition to the structure of the design-build entity undertaking the project will be collected and added to the previously collected performance metrics database.

4. *Perform Data analysis: D*ata will be categorized and analyzed to identify the different correlations and impacts that the procurement methods had on the projects.

5. *Develop conclusions and recommendations:* Based on the analysis of the data, the deduced relationships will be formulated into conclusions and guidelines for the selection of the most appropriate design-build team.

1.2.6 Results

Rather than identifying the best procurement method for a design-build team, the research aims at determining the appropriate selection approach taking into consideration several project-specific factors, such as the facility type, the level of project complexity and the degree of design completion at the time of procurement. The conclusions of the study will illustrate the extent that implementation of the proper procurement method is related to successful project performance. Cost, time and quality will serve as the basis of comparison between the three main procurement methods.

Contractor selection is a major project success factor. Because analysis of the data does not ensure the presence of a relation between the different variables tested, which the main focus of the study, the conclusions of the study may be used to develop a set of guidelines. Guidelines particularly directed to project owners will be developed. Owners, assisted by those guidelines, will be able to clearly identify their requirements and select according the design-builder that is qualified to complete the project. This is an issue of extreme importance to the construction industry because a qualified design-build team can ensure delivery on time, within budget and

meeting the owner's expectations. On the other hand, an inefficient procurement method can result in numerous problems during and subsequent to construction. Consequently, in order for the construction industry to guarantee an optimized use of the design-build delivery systems advantages, it is necessary to ensure that the proper procurement method is used to select the right deign-build team.

2. Research Methodology

2.1 Research Techniques

This study focuses on the identification of quantifiable relationships between design-build procurement methods and project performance. To achieve this purpose, a survey was developed to gather the data regarding the procurement method of the design-build team for each project. The survey data collection method was selected because it possesses numerous advantages. Several questions can be asked about the topic of the study simultaneously, which adds flexibility to the analysis. The majority of the projects targeted in the research are located in different states. This condition favors the use of the survey collection method because it is relatively inexpensive and easier to administer from remote locations. Surveys will be sent using mail or e-mail and followed up using phone calls (The Writing Center at Colorado State University@1997). Because statistical analysis will be used for data evaluation, it is important to obtain a considerably large sample to make the results statistically significant, an objective that can be easily achieved with the help of surveys. Moreover, the survey method relies on a set of standardized questions that ensure precise measurement through enforcing uniform definitions upon the respondents and guarantees that similar data would be collected then interpreted comparatively. Finally, presenting all participants with an identical set of questions results in high reliability and eliminates any possible subjectivity (Simon 1969).

The designed survey includes several questions that aim to identify the basis of the selection process of the design-build team and the level of design completion at the time of procurement. Also, the structure of the design-build entity and the operational variations within the design-build approach are issues addressed in the survey. Specific contract clauses that may be included in the contract between the owner and the design-build organization may provide additional insight on the project performance and relate to the project procurement method. Finally, other data pertinent to the analysis process such as the use of wrap-up insurance, specialty subcontractors project requirements and the nature of the specifications represent some of the survey questions the participants are required to respond to.

2.2 Research Process

2.2.1 Literature Review

A review of the existing literature represents an integral part of the study. The literature review identified how authors defined the various methods of contractor procurement, and specifically the procurement methods for design-build teams. Numerous research studies have confirmed the fact that cost, time and quality are the three main criteria used to measure the successful project delivery. Finally, the different models and criteria evaluation systems illustrate the fact that it became necessary within the construction industry to shift from the lowest cost criterion to a more comprehensive and systematic approach for contractor selection.

2.2.2 Procurement Methods Definition

Since the research mainly relies on studying the relation between the selected procurement method and the project performance, it was necessary to establish the definitions of the three main procurement methods. According to those definitions and based on the data collected through the surveys, the procurement method for each project will be identified.

2.2.3 Data Collection

To perform the research, it is required to collect data regarding the design-build projects and how their teams were procured. As outlined before, a survey instrument will be used to achieve this purpose (see Appendix A). The survey places emphasis on identifying the nature of the selection process, the weight assigned to each selection criteria, the level of design completion and the structure of the design-build organization. Other survey inquiries are supporting the main emphasis of the research and may be useful in generating possible correlations.

Relying on the projects already existing in the previous CII study database, the survey is to be mailed to owners' organizations since they are responsible of the procurement process of the design-build team. Approximately, 150 design-build projects, performed for either public or private owner's organizations, will form the database for this research. All projects are located in the United States, with exception of one that is located in the United Kingdom. Data gathered through the survey will be recorded and arranged in a format that facilitates its analysis.

2.2.4 Data Analysis

Following the data collection phase, responses gathered from the surveys will be analyzed to determine the potential correlations that exist between the different parameters. Since the research mainly aims at identifying the correlation between the project performance and the design-build team selection method, several metrics will be used to measure the project performance. Cost performance metrics include cost growth, unit cost and intensity. Time performance will be measured using the schedule growth and the construction speed metrics. Finally, quality performance is indicated through turnover and system quality measures. The same performance metrics were previously used in the CII study "Comparison of U.S. Project Delivery Systems" (Konchar and Sanvido 1998).

Following, various statistical methods will be utilized to determine the effect of the selected procurement method on the previously defined metrics. Univariate analysis will be used to study the effect of the selection methods of each performance factor at a time. It will also be used to determine if there exists a correlation between the presence of a liquidated damages clauses and the different project attributes. The facility type and how it relates to the structure of the design-build entity will also be studied through a univariate analysis also. Multivariate regression analysis may be used to deduce the effect of the interaction between each one of the performance metrics and the three selection methods, taking into consideration other project specific factors that may affect the analysis. Multivariate analysis is preferred over the univariate analysis because it can provide a matrix that shows how variables interact with each other.

The implementation of the previously described statistical analysis is guided by the CII study, "Comparison of U.S. Delivery Methods". The later study has also used univariate and multivariate analysis to study the relation between the performance factors and the project delivery methods. Univariate results have also identified the relation between the facility types and how the different project delivery methods performed (Sanvido et al.1998). On the other hand, in their study of the performance of design-build public projects, Molenaar et al. resorted to a different methodology approach. Based on data gathered through 104 public design-build projects, charts were used to illustrate the percentage of projects over or under budget and schedule, projects conforming to expectations and satisfying owner's requirements and finally

projects with high or low administrative burden (Molenaar et al. 1999). Frequency histograms were also as a means to show how public and private design-build projects perform with regard to cost, time and quality (Songer et al. 1996). These studies are described in more detail in the literature review (Chapter 3).

2.2.5 Formulation of a Set of Recommendations

Conclusions drawn from the statistical analysis of the data will be used to determine whether there exist a correlation between project performance and the selection process of the design-build team. Based on those deductions, a set of recommendations regarding the most appropriate approach to procure a design-build team will be formulated, taking into consideration several factors such as the project type, the level of design completion and degree of project complexity. Those recommendations will be developed with the aim to assist owners, both private owners and public agencies, in making informed decisions during the procurement process of the design-build team.

2.3 Limitations to the Study

This research study is limited by a number of factors. Regarding the cost growth performance metric, the increase in the project cost may originate from an addition to the project scope or a budget overrun cause by the design-build team. For the analysis purpose, it was assumed that the cost growth originated only from increase in cost by the design-build team. Also, the quality metrics represent the subjective viewpoints and expectations of owners. Accordingly, those metrics were considered to be the least objective measure that is highly dependent on the owner's level of expertise with the design-build method and the procurement approach. Those limitations were also identified in the CII "Comparison of U.S. Project Delivery Systems" study (Konchar and Sanvido 1998).

3. Literature Review

3.1 Definitions

3.1.1 Design-Build Structural Variations

Structural variations are used to identify the role played by different parties in a design-build arrangement. It was important to define the different design-build structural variations because they relate to the structure of the design-build organization and the different arrangements undertaken within. Identifying the type of the design-build organization can be a factor affecting a potential relation between the procurement of the design-build team and the project performance. Therefore, several questions included in Section II of the survey attached in Appendix I addressed the structure of the design-build organization. According to Beard (2001), there exist five structural design-build variations.

3.1.1.1 Owner and Joint-Venture Design-Builder

Following this arrangement, the owner contracts with a joint venture that consists of 2 or more parties joining together for the purpose of carrying out the design and construction services of the design-build project. The joint venture could be project specific, formed for the purpose of the project only; or temporarily formed, existing through a specific time period that covers the project duration.

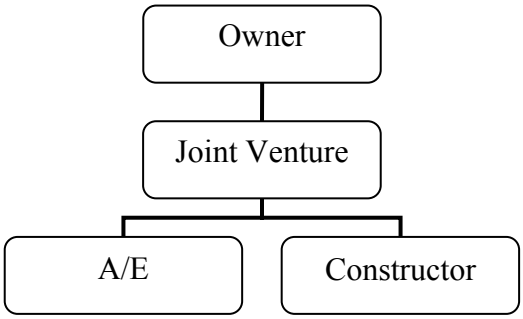

Figure 1 - Joint Venture Design-Builder

3.1.1.2 Owner and Constructor-Led Design-Builder

In this structure, the owner directly contracts with a constructor for all design and construction services necessary to complete the project. The constructor then hires a design consultant to perform professional design services through a subcontract arrangement.

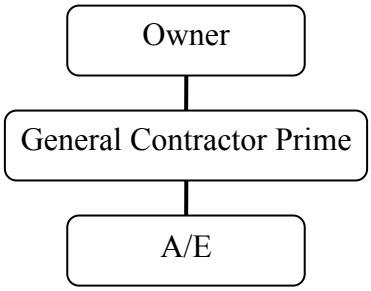

Figure 2 - Constructor-Led Design-Builder

3.1.1.3 Owner and Designer-Led Design-Builder

The owner signs a design-build contract with the designer. Construction services are performed by a constructor under a subcontract arrangement with the prime A/E. In this design-build method, the A/E prime is responsible for the design services, maintaining construction cost and schedule, in addition to supervising construction methods.

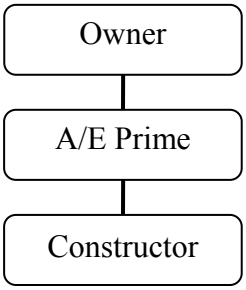

Figure 3 - Designer-Led Design-Builder

3.1.1.4 Owner and Integrated Design-Builder

The owner contracts with an integrated design-build firm acting as a single source of responsibility. The integrated entity provides direct contact with the design professional and the constructor.

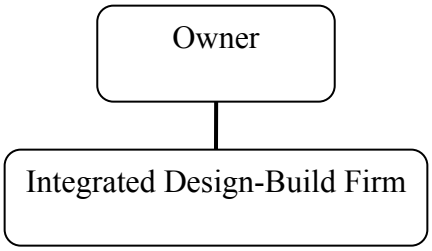

Figure 4 - Integrated Design-Builder

3.1.1.5 Owner and Developer-Led Design-Builder

The owner contracts with an independent developer to design and build the facility that will be owned and operated by the owner. The developer subcontracts the design and construction tasks to outside designers and constructors.

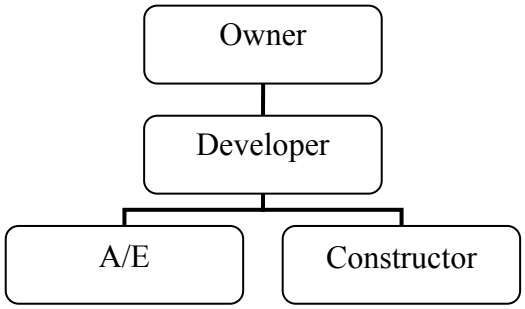

Figure 5 - Developer-Led Design-Builder

3.1.2 Design-Build Operational Variations

Operational variations for design-build delivery systems refer more to the level of design completed at the time of team procurement. Those variations range from minimal design performed, reaching only 10%, to a preliminary design phase where the design completed amounts to 35%. This level is dependent on two factors. In some instances, the owner decides to achieve some design work prior to contracting with the design-builder, whether from within its organization or through an architectural consultant. Also, the owner's decision regarding when to communicate his requirements to the design-build team determines the amount of design work the design-build would have to complete. It was important to define the different operational variations for the design-build delivery method to categorize the data accordingly after being collected. It is a critical decision regarding the selected procurement method, affecting the project performance (Beard et al. 2001). Section I and II of the survey in Appendix I show several questions related to the different design-build operational variations.

3.1.2.1 Direct Design-Build

In direct design-build case, the owner contracts with the provider of the design-build services at the earliest possible time during the facility development process. The owner or designer-

builder may develop a program and/or pro-forma. Direct design-build arrangement often results in the owner contracting with an integrated design-build firm, where the design-build team can assist the owner in defining his requirements and set a budget, through estimates and financial feasibility studies.

3.1.2.2 Design Criteria Design-Build

The owner, assisted by professional consultants, determines the facility criteria and the required performance standards. A Request For Proposal (RFP) may be developed where the owner sets out the criteria for the facility in clearly understood performance terms before contracting with a design-build entity. Following, the owner receives several design solutions from the different design-build teams.

3.1.2.3 Preliminary Design Design-Build

The owner, or his retained design consultant, performs a preliminary design to convey the project information graphically. This preliminary design information is included in the RFP for the design-builder's A/E to complete the design accordingly. This operational variation is mostly applicable foe a series of projects that should have similar layout and design and where the project should be completed based on the design concept provided by the owner.

3.1.2.4 Bridging Design-Build

In this arrangement, the owner contracts with a primary design professional to perform partial design that ranges from 30% to 80%. Afterwards, the design documents and the RFP are issued to the prospective contractors. This system is very similar to the traditional approach where the owner manages two separate contracts with the designer and the bridging construction firm respectively. The bridging firm is expected to complete the detailed design, provide costs and value engineering services, obtain the necessary permits and finally construct the facility. Some advantages of this arrangement are the possibility of the owner's organization to maintain control of the project scope, while transferring the errors and omissions risk to the design-build firm. On the other hand, this system is characterized by several inefficiencies. It can be competitively bid in a very similar manner to the traditional approach. Furthermore, it eliminates the possible innovation that should be associated with the design-build delivery system and does

not necessarily allocate risks to the party in the best positions to undertake them (Beard et al. 2001; Molenaar and Gransberg 2001).

3.2 The Importance of Design-Build Delivery Method

Several studies have researched the continuously growing trend towards the use of the design-build delivery method and the shift from other traditional delivery methods. The reasons and factors promoting this trend have been outlined. Sanvido and Konchar (1998) conducted an empirical study whose goal was to compare the different delivery systems that are mostly used nowadays in the U.S. Construction management at risk, design-build and design-bid-build were the three main delivery approaches compared. The research method consisted of identifying the performance metrics for comparison purposes, data collection through a survey and data analysis. Seven performance metrics were developed to provide criteria for evaluating the projects and the systems used to deliver them respectively. These metrics were defined for cost, schedule and quality. Following, the data collection phase was achieved using a survey that gathered data for 301 projects. The survey consisted of questions regarding the project delivery methods, the performance metrics, contract types, project team characteristics, in addition to other project specific information. Finally, the project data was analyzed using several statistical methods, including univariate and multivariate regression analysis.

The results of the research concluded that projects delivered using the design-build approach perform better than those delivered through the construction management at risk or the design-bid-build delivery systems. Specifically, the univariate analysis revealed that design-build projects experienced less cost and schedule growth. Also, the univariate analysis conducted for the quality metrics indicated that the design-build approach resulted in better start-up quality, callbacks, in addition to operation and maintenance quality. Moreover, design-build projects surpassed design-bid build system with regards to the envelope, roof, structure and foundation metrics. Interior space and layout together with process equipment and layout metrics had higher mean scores in case of design-build projects. In conclusion, the study revealed that design-build delivery system often resulted in time and cost savings. With regard to quality performance and owner satisfaction, design-build projects led to higher or equal quality product than construction management at risk and design-bid build projects (Konchar and Sanvido 1998).

In another study that emphasizes the importance of design-build delivery system, Songer and Molenaar (1996) point out the high growth of this delivery approach and the need to examine the owners' attitudes towards it. The research also aimed at determining a number of selection criteria that lead owners to select design-build delivery method. Those criteria were related to the project duration, budget, number of claims, project size and complexity, in addition to project constructability and innovation. Data was collected through a survey questionnaire that targeted 209 owners with experience in design-build projects. Owners were asked to determine how they rank each of the selection criteria.

Based on means and medians calculations, each selection criterion was assigned an overall ranking. The scores indicated that the primary reason why owners select the design-build delivery method is the possibility of reducing the project duration. The factor that received the least ranking was the large project size together with high level of complexity. Frequency histograms also confirmed the owners' attitudes regarding the highest and least ranking factors. The research also concluded that the other criteria could be a basis for selecting design-build delivery method, depending on the specific project requirements (Songer and Molenaar 1996).

Those results were also confirmed in another study that indicated that the owner's requirements with regard to cost, time and quality often impact the delivery system selection decision. For design-build projects, time and budget were the main drivers for the design-build delivery method. Also, the owners' requirements were mostly directed towards benefiting from contracting with a single entity. Those findings were established through studying several projects and interviewing owners to help formulate a general conclusion (Tookey el al. 2001).

Another goal of Molenaar and Songer's research was to compare private and public owners' attitudes toward the design-build approach. The study showed that private and public owners' rankings for the different factors did not significantly differ. Only the criteria of reducing claims ranked significantly differently for both owners' types. Public owners were more concerned about reducing the number of claims and thus were more inclined to choose design-build delivery method to mitigate the effects of claims. The study attributed this to the fact that claims

are more likely to occur in public projects and handling them could hinder the project performance (Songer and Molenaar 1996).

Results from the previously mentioned study led Molenaar et al. (1999) to focus on design-build public projects and how they evolved within the public sector. Different procurement methods public owners follow, contract awarding, owners' experience and level of design completion are among the issues outlined in the research. In particular, the findings indicate that nearly 60% of the design-build projects were completed within 2% or higher of the originally set budget. The number of projects completed within 2% or higher of the time schedule amounted to 77%. Regarding quality, the case studies indicated that the majority of the design-build projects conformed to owners' expectations. On the other hand, several owners viewed that design-build projects are associated with rather high administrative burden. This is illustrated in the slightly higher than average score this criterion that may be due to owners initially believing that contracting with a single entity would impose less administrative burden. This is particularly true for owners that are still experiencing with the design-build approach. Finally, the study provides guidelines for public agencies as how to manage a design-build project with regards to procurement aspects that would be discussed later in section 3.5 (Molenaar et al. 1999).

3.3 Contractor Selection as an Important Project Success Factor for Projects

Several studies have been performed to identify the factors that should be available to ensure a successful project delivery for different delivery systems types. For design-build projects in particular, an empirical study was conducted to identify the different project success factors. Owners selecting a design-build team should take into consideration those success factors and identify the project requirements accordingly. Time and cost metrics were used to evaluate the project performance and determine how successful the delivery was.

The results concluded that teamwork and efficient coordination between different project players were the most important among the main 6 factors identified. In addition, contractors' competencies factor was identified as a critical success one. The contractors' financial capabilities, effective implementation of project planning, design and construction within a design-build environment are crucial elements that should be considered by owners when

procuring for a design-build project. Technical abilities and past experience are also elements of the contractor's competencies that should be part of the evaluation process. As noted, it is essential that the contractor engaged in a design-build project possesses the appropriate knowledge and ability to manage the project, as it highly impacts the project performance (Chan et al. 2001).

Design-build projects that successfully performed, together with newly introduced changes in procurement regulations encouraged numerous public owners to select the design-build project delivery method. Molenaar and Songer analyzed 122 case studies of public design-build projects to help public owners make informed decisions when selecting the design-build delivery system. In this study, several project characteristics were used to identify the correlations necessary for the model development. Project-specific attribute, owner's agency experience and staffing, design-build market and relationship are the most important characteristics public owners should consider to fully benefit from the design-build delivery method.

Relationship characteristics refer to the design-builder prequalification and selection. Analysis of the case studies indicates that the later characteristics are of crucial importance because they deeply impact other factors such as the administrative burden and satisfaction of the owner's requirements. It is recommended that owners dedicate special attention to design-builder procurement, together with the other identified characteristics to improve the learning curve for public design-build projects (Molenaar and Songer 1998).

3.4 Measuring Project Performance Using Time, Cost and Quality

Time, cost and quality were always the key measures used to quantitatively evaluate the success of projects, and particularly design-build projects. A recent study on design-build projects indicated that objective success factors such as time, cost, profitability and quality are the main performance measures. However, they should not be the only criteria to evaluate a project performance. A more comprehensive list should include subjective success factors such as technical performance, several quality measures, functionality, productivity, owner's satisfaction and environmental sustainability. Based on an exhaustive review of the past 10

years literature, the study concluded, however, that time, cost and quality remain the three most significant success factors (Chan et al. 2002)

Molenaar et al. (1998) with the aim of developing "an automated tool for public sector design-build project selection," used five criteria to evaluate a design-build project performance. Schedule variance and budget variance, which respectively refers to performance with regard to time and cost, were among the identified evaluation factors. Schedule performance is important as a measure for design-build projects because often, owners are inclined to use the design-build delivery method to shorten the project duration. Budget variance is another essential measure that illustrate to which extent the project met the owner's financial requirements. Statistical correlations with high-level of confidence exist between budget variance and successful project performance (Molenaar and Songer 1998).

3.5 Contractor Selection Practices

3.5.1 Assessment of the Existing Contracting Selection Practices

A study conducted within the U.K. construction industry indicated that some of the current practices for contractor selection are characterized by major weaknesses. Usually, cost is the decisive factor based on which the contractor is selected. Contractors' capabilities to deliver a project on time, within budget and satisfactorily complying with requirements are not highly considered during the contractor selection process. Although the reasoning behind the competitive approach is to allow free market competition, which results in better value for the owner's money, this competitive approach sometimes leads to the acceptance of the lowest cost, non-competent contractor. Consequently, several owners have shifted towards the use of different procurement methods.

As noted, cost-based contractor's selection, used by majority of the owners in the U.K., tends to be less successful. It may achieve lower costs, but not necessarily the best value for money. Non-compliance with schedule is also noticed in some cases of cost-based selection. Public owners mostly use the competitive approach because it offers a more structured justified methodology. On the other hand, negotiated and two-step selection practices result in less cost growth and are more likely to be used by private owners because it is more flexible. As revealed

in the findings of the study, negotiated selection methods successfully delivered projects within time limits but sometimes failed to meet budget requirements.

There exist four major areas of deficiency within the current contractor selection approaches. First, a universal approach to contract selection is missing. Poorly specified contractor selection guidelines render the selection process rather subjective and fragmented due to the varying level of experience of the owner's organization. Also, the prequalification process often leads to long-term confidence regarding the contractors' corporate stability, without soliciting further investigation in future projects. Another deficiency can be found in complete reliance on cost factor to evaluate the different contractors. Finally, subjectivity of the selection analysis, which derives from the application of the weighted criteria method, may add risks to the best contractor procurement method (Holt et al. 1995).

According to Kumaraswamy, "the right choice of construction contractor is crucial to project success". Therefore, he tried to evaluate different selection strategies both internationally and in Hong Kong. Ultimately, the goal of the study was to provide a set of recommendations to improve the current selection practices. Based on studies conducted in the U.S. and the U.K., three main different contractor selection approaches were identified. Those include sole or multiple source negotiation, cost-based tender evaluation and tender evaluation based on price, capabilities and past performance combination.

It is worth noting that the shift towards procurement methods that do not only rely on cost as a basis for evaluation emerged from the increasing risks contractors had to assume due to the changing delivery methods systems. Consequently, a growing trend was to list several criteria, in addition to cost, to evaluate a certain contractor. Following, several studies have been performed in the U.S. and the U.K. to develop contractor selection systems, rank the current evaluation criteria or use financial ratios analysis to aid in the contractor selection process. A common issue is the decreasing emphasis on the cost criteria and growing emphasis on "value for money" approach, in addition to technical and past experience capabilities.

As to the construction industry in Hong Kong, while in many aspects is similar to the industry in the U.S. and the U.K., it mainly relies on the distinction in the selection methods originating from the differences between owners. Private owners, government agencies and semi-public organization constitute the three main types of clients to the construction industry. Private owners are more likely to follow a less rigid procurement system and have the opportunity to shortlist and prequalify contractors. Cost-based selection is not an essential requirement. In contrast, Hong Kong government agencies follow a detailed procedure for contractor selection. Like private owners, government agencies are more concerned with the time factor of the project. Often, contractors are required to submit the net present worth of the project cash flow, to avoid front-end loading some items of the schedule. A number of semi-public agencies have developed their own contractor selection approach that depends on evaluating the contractors based on their performance in current projects (Kumaraswamy 1996).

Other researchers have also attempted to evaluate several contractor selection methodologies. A review of different selection techniques such as the bespoke approaches, multi-attribute analysis, multi-attribute utility theory and cluster analysis helped in presenting several selection methods. Statistical approaches like multiple regression, fuzzy set theory and multivariate discriminant analysis were also evaluated. The advantages and disadvantages of those methods were outlined, in addition to potential applications, to provide guidance for concerned parties (Holt 1998).

In view of the selection systems deficiencies outlined before, several authors have suggested means to improve processes. Standardization of the selection systems should take place based on previous projects experience, while taking into consideration priorities that are specific to future projects. If implemented, standardization processes will enable construction organizations to be more flexible and coping with change, a characteristic especially for local contractors considering moving to the international level (Kumaraswamy 1996). Others have recommended that the selection should be composed of a two-step approach: prequalification and tenders evaluation. The first stage should emphasize more on the contractor's organization capabilities such as past experience and financial health, while the second stage should evaluate more those

contractor's competencies that enable him to qualify for project-specific criteria such proposed construction method or previous expertise in the same geographical area (Holt 1998).

3.5.2 Approaches to Contractor Selection

Models and criteria evaluation systems are very important in the contractor selection process. They offer an objective approach to evaluate a prospective contractor and eliminate any subjective measures. This is particularly important for public agencies, especially those who are shifting from the cost-based selection to other procurement methods. Originally, several public and governmental agencies, which use public funding, were bound to report to localities the basis on which a contract was awarded. In this case, abiding by the lowest cost criteria was efficient in eliminating any doubts regarding corruption. A major advantage of models and criteria evaluation systems is that they can easily provide justification why a particular contractor was eliminated during the selection process (Mahdi et al. 2002; Fong et al. 2000).

Another important aspect is that they allow different factors to be incorporated together to evaluate a contractor. Rather than only considering the cost of the project to the owner, other factors like contractor past experience, technical capabilities, conformity to the project requirements and several other measures can be all considered simultaneously. Furthermore, those selection systems eliminate the need to rely on the owner's level of experience and knowledge. Even though an owner may possess the skill to select the contractor, the approach will still tend to be unmethodical, which renders it questionable. Following a systematic procedure greatly improved the evaluation process and consequently, the potential success of the project is more likely to materialize (Mahdi et al.2002; Alhazmi and McCaffer 2000).

3.5.2.1 Contractor Selection using Evaluation Criteria

The Evidential Reasoning (ER) approach integrates both quantitative and qualitative hierarchally to solve the contractor selection problem (CSP). It compensates the fact that the owner may be presented with incomplete data and mitigates the risk factor associated inherent in the selection process (Sonmez et al. 2001). Also, others have attempted to identify a set of "universal criteria" for prequalification and selection of contractors. The findings of literature reviews and different research methods indicate that the criteria commonly used for

prequalification include the financial and technical capabilities, management competency and safety records of the contractor. In addition, project specific criteria, such as ability to complete project on time, problem-solving strategies, current workload and others, were also deemed necessary to be included in any evaluation system (Hatush et al. 1997; Wong et al. 2000).

A majority of the studies present a selection approach from the perspective of owners and how to assist them in choosing the appropriate contractor. Contractors' viewpoints are also of equal importance because they are major players in the project delivery process. When surveyed, contractors presented a ranking of the different evaluation criteria that is very similar to the one identified previously by owners. Both parties agreed that a multi-criteria evaluation system should include the cost of the tender factor together with the contractor's past experience, financial health, firm's reputation and key personnel expected to be assigned to the project (Jennings and Holt 1998).

3.5.2.2 Contractor Selection Models

Models are considered another systematic procedure to approach the contractor procurement problem. They are useful in eliminating any subjectivity and incorporating a rather comprehensive selection methodology. One of the models developed to assist owners is the Multiple Criteria Decision Support System (MCDSS). This model takes into consideration the unique characteristics of each project and relates them to the numerous qualifications of the contractor being evaluated. Project characteristics identified are those items specific to each project such as 1) budget, 2) quality standard, 3) level of complexity, 4) risk allocation, 5) schedule limitations, and 6) owner's level of experience. Qualifications, as referred to in the model, include the contractor past expertise, current workload, and financial capabilities.

The model consists of two main steps. Owners use the first phase as a screening process to shortlist contractors and come up with a smaller range of candidates that would be asked to submit their plans for the considered project. Then, the contractor selection phase takes place using the Analytic Hierarchy Process (AHP). The contractor's capabilities are evaluated against the submitted plans and anticipated work strategy. The advantage of the model is that it can be easily modified to accommodate the specific project requirements and characteristics. It can also

assist the decision-maker in selecting the contractor most suitable to undertake construction works (Mahdi et al. 2002).

Alhazmi and McCaffer et al. (2000) developed a model, the Project Procurement System Selection Model (PPSSM), which attempted to prevent difficulties encountered in previous contractor selection models. Some of those difficulties include limitation on the evaluation criteria, complex mathematical techniques, and high level of owner's experience, in addition to limited alternatives with regard to contractor selection. Using four screening processes, the model combines AHP and value engineering techniques into multi-criteria selection system (Alhazmi and McCaffer 2000).

Another model was developed based on the AHP and targeted the final selection phase. The model consisted of three main stages an owner would follow to identify the contractor possessing the capabilities that qualify him to successfully deliver the project. The hierarchic structure is the phase where the criteria and decision alternatives are identified and arranged hierarchally. To provide input for this phase, a survey instrument collected owners rankings to a number of criteria the researchers have previously identified as critical. The results showed that tender price possessed the highest ranking, followed by contractor's financial stability and past performance. Next, the prioritization procedure determines the weight that should be assigned to each criterion according to its relative importance. Finally, calculation of the results is the stage where the best decision alternative is determined (Fong et al. 2000).

A different approach in developing a model was illustrated in a study that formulated a conceptual benchmarking contractor selection model. The study relied on evaluating different effective current contractor selection practices adopted by public owners like the U.S. Department of Agriculture (USDA) and the Florida Department of Transportation (FDOT). Those owners' organizations incorporate time or quality factors together with cost criteria to evaluate a contractor's proposal. The evaluation of the current best practices provides the framework for the benchmarking model whose aim is to allow public owners to ensure a better project delivery and increased productivity. Issues such as barriers facing the shift from the

competitive approach towards the best practices are also addressed in the proposed model (Palaneeswaran et al. 2000).

Not only researches have studied how to select the appropriate contractor, a review of the existing literature indicates that some models have been developed to address the selection of architectural consultants. Because choosing a qualified architect is as important to a successful project delivery as the contraction selection, the process should not rely only on the lowest cost factor. The Architectural Consultant Selection System (ACSS) incorporates criteria very similar to those used for the contractor selection. It emphasizes the elimination of subjective judgment and ensures a logical and systematic selection procedure (Cheung et al. 2002).

3.6 Design-Build Project Procurement Approaches

3.6.1 Definitions of Design-Build Procurement Methods

Several definitions have been developed for the various design-build teams procurement approaches. Molenaar and Gransberg (2001) indicated that the fixed–price approach, located at one end of the continuum they developed that is shown in fig. (6), takes into consideration only the price as the sole criteria for selection. Accordingly, the lowest bidder is awarded the contract, an approach very similar to the traditional general contractors' procurement. In a one-step procurement procedure, the design-build team may be selected based on price only or a best value combination of financial and technical criteria. Two-step selection approach consists of prequalification of the prospective design-build teams using a Request For Qualification (RFQ), followed by an evaluation of the price and technical aspects. This represents the "best value" approach and the weights given to each of the technical and financial criteria differs from one organization to the other (Molenaar and Gransberg 2001). It is worth noting that the best value procurement approach considers numerous factors other than price submitted, such as the technical capabilities, management aspects, organization's financial standing, in addition to previous experience (Molenaar and Johnson 2001).

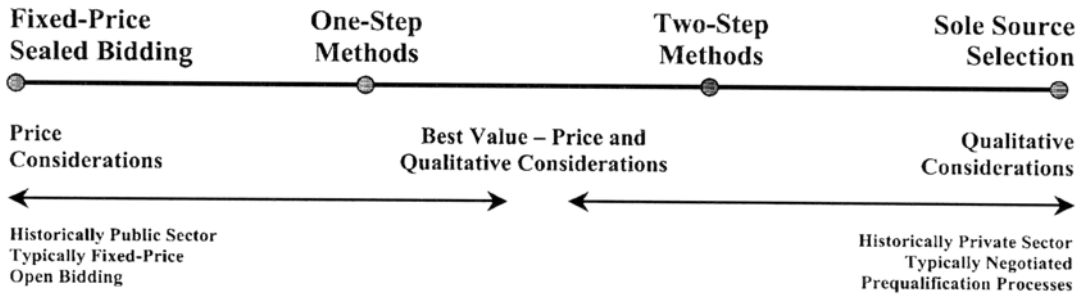

Figure 6 - Selection Methodology Continuum

Another study defined three procurement methods for design-build highway contracts, mostly used by several DOTs in the U.S. The Low-Bid Design-Build (LBDB) process consists of first evaluating the price of the proposal to determine the lowest bidder. Following, the technical aspects are assessed to determine whether they are responsive to the RFP or not. If responsive, the lowest bid proposal is accepted. In an Adjusted Score Design-Build (ASDB) procurement method, the proposal price is not disclosed until the technical review committee reviews the technical proposal and assigns specific rating criteria previously determined in the RFP. The design-build team that possesses the lowest adjusted score, obtained by dividing the price by the technical score, is awarded the contract. Finally, the Best Value Design-Build (BVDB) was defined as the procurement method that evaluates simultaneously both the technical and price proposal. The design-build team selected did not necessarily submit the lowest price proposal (Gransberg and Senadheera 1999).

The three main procurement methods that will be used to categorize the projects in the data collection phase are based on the definitions identified by Beard et al. (2001). The procurement methods are located in the continuum shown in fig. (7) and are defined as follows:

1. ***Subjective & Qualitative Factors***

   Using this approach, the owner negotiates with one or two design-build teams. Selection of the team is primarily based on qualitative criteria such as past performance, design-builder reputation, technical competence and financial stability. The later non-cost criteria represent 50% or more of the evaluation process. In this arrangement, owners may choose to award the project to a design-build team with whom they have established long-term relationships.

Otherwise, they may issue request for qualifications (RFQs) or request for proposals (RFPs) in a process that often involves negotiation with the design-build team.

2. Best Value: Subjective, Qualitative & Quantitative Factors

The owner selects the design-build team based on the technical evaluation of the proposal together with the associated cost of the project as determined by the team. Negotiations may take place after the proposal submittals phase. The technical evaluation accounts for 10% to 20% of the selection process. A weighting criteria evaluation method is usually used to identify the right design-build team and the weights assigned to each of the factors are usually function of the owner's organization and the type and size of the project.

3. Price-Based Factors

The owner mainly selects the design-build team based on the project value and related cost items. Cost items represent more than 90% of the design-build team procurement selection process (Beard et al. 2001).

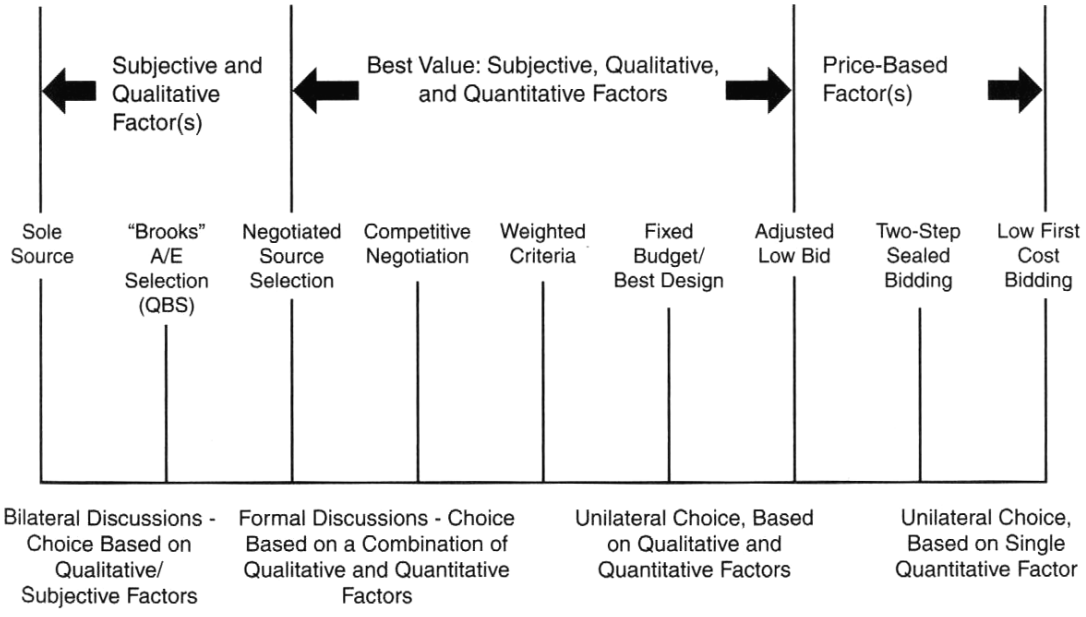

Figure 7 - Procurement Spectrum

3.6.2 Selection Approaches for Design-Build Projects

The contractor's selection for a design-build project is more critical and rather complex than for other delivery methods systems. Because this delivery type mainly relies on contracting with a single entity to deliver the project, the procurement method should be as comprehensive as possible to allow full benefit of this delivery method. Accordingly, it was necessary to highlight what some of the research studies have indicated regarding the selection of the design-builder for a design-build project. With regard to prequalification, Potter et al.developed the Design-Build Prequalification System (DBPS) to be used by public owners to appropriately identify the deciding evaluation criteria. The model is composed of six categories of criteria that represent a framework of constraints the owner has to consider for each design-build team. These criteria are economical, political, technological, corporate policy, labor/personnel and legal. A survey that targeted public agencies showed that owners assigned different levels of importance to each of the previously mentioned category. This model is particularly significant to assist owners in preparing Request For Proposals (RFP) by ensuring the project-specific characteristics are included. In addition, it provides a systematic selection procedure (Potter et al. 1995).

Several authors have agreed on the fact that the lowest bid criterion does not suit the design-build delivery method and may decrease its benefits. Therefore, adopting a multi-criteria approach for contactor selection increase the probability of the overall project success and is advantageous for both the owner and the design-build team (Potter et al.1995; Palaneeswaran et al. 2000).

Public organizations such as the Departments of Transportation (DOTs) across the United States are increasingly delivering transportation and highway projects using the design-build approach due to the numerous advantages it offers them. Florida DOT reported that the cost growth for design-build projects amounted to only 1.9%, as opposed to 8.78% for design-bid-build projects. The Department of the Navy indicated that design-build projects achieved 15% cost savings and were delivered at 12% less time than design-bid-build projects. Several awards methods have been also been used by those governmental organizations, ranging from the lowest bid method to the weighted criteria and best value approaches (Gransberg et al.1999).

3.6.3 Performance of Procurement Methods for Design-Build Projects

The review of the current practices in procuring for design-build transportation projects reveals that the best value approach is the most flexible as it allows specifying those factors that are specific to each project requirements. Although it may be complex and more susceptible to speculations from a non-qualified design-build team, the best value practice allows evaluation of different aspects simultaneously. In addition, projects that mostly conformed to owner's expectations were procured using the best value approach, which is "a combination of price and quality" (Gransberg et al. 1999). To enhance it effectiveness as a selection approach, the best value method should be accompanied by an appropriate project type selection, consideration of the level of design completion at time the RFP is issued and an efficient prequalification procedure (Molenaar et al. 2000).

On the other hand, when owners chose the design-build team based solely on qualifications, the administrative burden was reduced. Qualifications-based procurement method is usually characterized by a low level of design completion. In this case, the design-build team can exercise more control on the project scope, cost and time schedule, which coincides with less administrative burden from the owner's side (Molenaar and Songer 1998; Gransberg et al. 1999).

Prequalification of the design-build team is also viewed as an important component of the two-step and qualifications-based approaches. When owners prequalify design-build organizations, less schedule growth and administrative burden are expected. Prequalification also allows for more competitive prices and provides the owner with an opportunity to deeply analyze the design-build teams past experience and technical competencies (Molenaar and Songer 1998).

A case study analysis that studied the performance of public design-build projects provides definitions for the different procurement methods used by owners. The findings of the analysis indicated that 50% of public owners use the one-step method to procure design-builders, which is characterized by high level of design completion at the time of procurement. However, the majority of the projects that performed well were when the level of design completion at the time of procurement of the design-build team was within 25% or less.

With regards to project performance according to the selected procurement method, it was illustrated that cost and schedule growth in case of the two-step procurement were the least. The two-step procured projects were 1% closer to budget and 1.5% over schedule, in contrast with the one step projects; and 2.6% closer to budget than qualifications-based procured projects. The results also showed that the qualifications-based procurement performed the worst with regard to project budget and schedule. Despite the fact that qualifications-based procurement may use a prequalification process, which is proved to be advantageous; the lack of price competition outweighs the prequalification benefits. Because the scope of the project is not determined in a qualifications-based arrangement, cost-growth is more likely to occur.

In case of the one-step procurement method, budget and schedule performance were better than the qualifications-based approach, but worse than the two-step procurement. Lack of prequalification and design documents completion to 35% render this approach very similar to the traditional lowest bid procedure. The project may be awarded to the lowest bidder with unsatisfactory previous budget and schedule performance. Thus the findings support that owners should implement the two-step selection procedure whenever cost and schedule of the project are considered critical, because this procedure performs the best under these conditions.

On the other hand, results of the case study indicate that quality is not best achieved with the two-step procedure. The one step approach results in a project that conforms more to the owner's expectations. This is justified because this approach is characterized by a relatively high-defined project scope. Accordingly, the design-build team has a better chance in conforming to expectations. In case of the two-step approach, the team is required to provide a project scope, while the team is not required to identify any project scope. In both cases, the design-build team provide more input to the project scope and the owner's requirements definition than the one-step method. The administrative burden for qualifications-based selection was the least because the design-build firm was solely selected based on past performance and expertise and owner had little to do with the project process. On the overall, public owners were almost equally satisfied with the overall quality performance for the three procurement methods (Molenaar et al. 1999).

A study that targeted small highway projects also investigated the previously discussed procurement methods, one-step, two-step and qualifications-based. The findings indicated that the level of design completion at time of procurement associated with each of the methods is highly important. A procurement process that involves less than 30% of the design completed cannot be competitively bid, an issue important to some of the public agencies. However, as previously discusses, a higher level of design decreases the benefits of design-build innovation and may produce increased number of change orders. Although the selection process is less elaborate, minimal design completion allows more innovation and could be efficiently associated with a two-step process.

Project complexity was also found to impact the procurement process. Fixed price, sealed-bid selection approaches were more likely to be used for less complex projects that require minimal innovation. Therefore, using a fixed price method for simple projects, with high level of design completion, can achieve the project faster and with lower administrative burden. A noticed trend is that public agencies are shifting from the use of fixed price method towards the two-step approach. At first, agencies attempt the fixed price approach, but with changes in regulations, they usually transition to the on-step and two-step approaches, where more than cost criteria are considered (Molenaar and Gransberg 2001).

3.7 Contracts Issues for Design-Build Projects

3.7.1 Incentive and Disincentive Clauses

Some of the contract issues that are addressed in the survey designed to collect the data regarding the procurement methods for design-build projects include incentive clauses and liquidated damages clauses. It is important to know whether such clauses are included in the contract or not as they can greatly impact the project performance. The presence of such clauses is often dictated by the owner's requirements and several specific project objectives. Incentive/disincentive (I/D) clauses are implemented to ensure one or many objectives are satisfied (Arditi et al. 1997). These objectives can be reducing construction costs and duration, preserving required levels of safety and productivity or achieving quality standards (Arditi et al. 1998). A "combined incentive/disincentive" clause may be used in case several objectives are to

be emphasized upon simultaneously. In a contract that includes an I/D clause, the contractor is awarded a predetermined incentive value for each day the project is completed earlier than the schedule. This arrangement may differ according to the project size and the number of contractors involved (Arditi et al. 1997).

Numerous research studies have investigated the effect of I/D contract clauses on the project performance, in particular completion within time. It was concluded that the majority of the projects whose contracts incorporated and I/D clause were completed on time or earlier, with a minimal percentage of contractors that were subject to pay disincentive clause fees. Time extensions and large frequency of change orders were less likely to take place for those projects. However, projects with I/D clauses experienced larger budget overruns than those with no I/D clauses. On the other hand, less than 50% of the contracts that did not contain a D/I clause were achieved ahead of the time schedule (Arditi et al. 1997). Despite the latter fact, research has concluded that the implementation of contracts with I/D clauses face critical problems such as challenges regarding scheduling, crew productivity and redundancy, working conditions in harsh weather to keep up with the schedule and adversarial relationships within the contractor's team (Arditi et al. 1998).

Liquidated damages clauses are frequently used in construction contracts. They are considered another measure employed by owners to compensate for any losses they may incur if the contractor does not complete the project within the specified schedule. The notion of liquidated damages may act as a form of a disincentive clause, stimulating contractors to attempt every effort in achieving the work according to the contract schedule. However, it is worth noting that liquidated damages are different from disincentive clauses. The effects induced by liquidated damages are weaker than those induced by disincentive clauses, which are larger in value and are usually associated with incentive clauses to promote early completion (Arditi et al. 1997). In general, incentives/disincentives are efficient management tools, provided a project study is performed to ensure benefits would be realized from their implementation (Arditi et al. 1998).

3.7.2 Types of Project Specifications

The type of specifications used for the project is closely related to the level of design completed prior to procurement of the contractor. Performance type specifications usually describe the quality or the end result the contractor should achieve. They are mostly used when minimal design is achieved. On the other hand, prescriptive specifications, mostly used in the traditional approach, describe elaborately the methods and materials necessary to complete the project. They are associated with a simple selection process based on cost criteria only, relying on the fact that the owner's requirements are clearly defined (Molenaar et al. 1999; Palaneeswaran et al., 2000).

A study of public design-build projects indicate that few owners used purely prescriptive specifications, while the others resorted to different degrees of performance specifications. In a design-build arrangement, performance specifications are used to encourage innovative design solutions from the part of the design-build firm. The specifications outline the traditional quality assurance process used in prescriptive one, but allow more alternatives and design options. In general, prescriptive specifications are not preferred for design-build projects due to the reduced role of the owner regarding the quality control process, which renders this type of specifications inefficient in achieving the desired quality standards (Molenaar et al. 1999; Palaneeswaran et al. 2000).

3.8 Conclusions

The review of the existing literature indicates that numerous studies have developed selection models to help in procuring the appropriate contractor. Different systems with evaluation criteria have been developed to assist owners during the contractor selection process. The main advantages of these models and evaluation systems is that they provide a systematic and objective procurement approach that takes into consideration numerous factors other than the price of the proposal. Other studies have identified the various procurement methods of the design-build teams for transportation projects. In addition, one study showed the effect of the procurement method on some measures of the project performance.

This shows that few quantitative studies have been performed to analyze the impact of the procurement methods of the design-build team on the project performance. Also, limited studies have been developed to guide owners through the process of design-build teams' selection. The emphasis of this study will be to quantitatively identify a potential relationship between the selection process and the project performance, which may help in formulating a set of recommendations for owners to use through the procurement process.

4. Summary

4.1 Concluding Notes

The importance of the research is derived from several factors. Owners, both public and private, because of the potential time and cost savings it may result it, are increasingly using the design-build project delivery method. This delivery method also decreases the amount of coordination required from the owner, since the contract is made with a single entity that is responsible for both design and construction of the facility. Contractor selection is a critical decision also made by owners that supposedly has a great impact on the project performance, with regards to time, cost and quality. The procurement of the appropriate contractor can ensure a smooth delivery process and eliminate several problems during construction.

Various criteria, in addition to the lowest cost factor, are used to evaluate a potential contractor. Numerous research studies have been developed to help owners follow a systematic and objective procedure for contractor section that incorporates several criteria for evaluation. This was particularly crucial for public owners who shifted from the cost-based procurement method towards the use of the best value procurement method, which considers the technical capabilities of the contractor together with the price of the proposal. However, the majority of those studies targeted the contractor selection in general and did not study the potential relationship that may exist between the selection of procurement method and the project performance.

Although Molenaar et al. attempted to quantitatively identify the impact the procurement method has on cost growth, schedule growth and several quality metrics, the study was conducted for public design-build projects. Also, the data analysis was conducted through descriptive statistics, which mainly relies on basic means and standard deviations calculations (Simon 1969). It follows that no study has really addressed the possible correlation that may exist between the procurement method and the project performance for design-build projects in general. The aim of this current research is to quantify the performance measures and use advanced statistical methods like univariate and multivariate analysis to determine the potential correlation between the different variables. However, it is worth noting that the results of the study may conclude that no correlation between the variables was identified. For this reason, an

owner's guidelines section is to be developed to assist owners selecting the most appropriate design-build team given a set of different project-specific characteristics.

4.2 Progress and Research Timeline

1. ***Fall'02:*** Survey development phase will take place during this period. Different questions to be included in the survey will be developed to serve the purpose of the study and help collecting the required project information. A tentative version of the survey is to be examined by the rest of the DBIA research team for approval.

2. ***Spring'03:*** During this time period, a preliminary survey will be sent to a selected number of participants to provide feedback and help refining the survey questions. After the survey is finally revised, it will be mailed to the rest of participants to be completed and forwarded back. The data gathered from the returned surveys will be categorized to identify the procurement method used for each project. Following, the statistical analysis, previously outlined, will be used to identify the potential correlation between the project performance and the procurement method of the deign-build team.

3. ***Fall'03:*** Based on the data evaluation and analysis phase, conclusions regarding whether the selection method of the design-build team has an impact on the various performance metrics or not. In addition, the study aims at identifying a set of recommendations to assist owners in procuring the appropriate design-build entity, taking into consideration other project-specific factors.

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Appendix I

Research Survey

16. What type of specifications was used for the project?
    [ ] Performance-based specifications
    [ ] Prescriptive specifications

SECTION V: GENERAL COMMENTS

Please provide any other relevant comments or lessons learned.

_____

_____

_____

Penn State Research Team
Dr. John I. Messner
Dr. Michael Horman
Marwa El Wardani

PROCUREMENT METHODS FOR DESIGN-BUILD PROJECTS

DESIGN-BUILD INSTITUTE OF AMERICA

THE PENNSYLVANIA STATE UNIVERSITY

DESCRIPTION

Penn State has been selected by the Design-Build Institute of America (DBIA) to conduct a survey of the procurement methods for design-build projects in the U.S. The survey is part of a follow-up study to a Construction Industry Institute (CII) "Comparison of U.S. Project Delivery Systems" research project.

You or someone in your company provided information on a project for the initial CII study. Using the same project you used for that study, please respond to the following short survey. This information is being used to further investigate design-build procurement methods. Upon receipt of your data, Penn State will number each copy, remove all personal information and remove project identification. The information you provide will be kept strictly confidential and solely used for research purposes.

Please provide the contact information of the person completing the survey and the company information for the purpose of any further clarification. We will e-mail the results of the study to all participants after completion.

Please return the completed questionnaire by mail or fax before <date> to:

Dr. John Messner, Dept. of Architectural Engineering
Penn State University, 104 Engineering Unit A
University Park PA 16802
Fax: 208-248-7702 Phone: 814-865-4578

RESPONDENT INFORMATION

Name : _____

Company : _____

E-Mail Address: _____

Project Name : _____

Phone Number : _____

SECTION I: PROJECT TEAM SELECTION

1. Was the primary process for selecting the design-build team competitive or negotiated?

[ ] Competitive Was there a prequalification process? [ ] Yes [ ] No

[ ] Negotiated Was this sole source or multi-source? [ ] Sole source
[ ] Multi-source

Comment on the nature of the selection process:

_____
_____
_____

2. If there was a prequalification process, how many teams were prequalified for the project? _____

3. How many proposals were received from design-build teams? _____

4. Rate on a percentage basis the importance of each of the following factors to the final selection process. Select all that are relevant. Make sure the percentages total 100 %.

[ ] Cost
[ ] Technical Proposal
[ ] Qualifications
[ ] Design
[ ] Other _____
[ ] Other _____
[100%] Total

5. What was the design status at the time of procurement? ____ % complete

SECTION II: DELIVERY SYSTEM STRUCTURE

6. What entity holds the design-build contract with the owner?

[ ] Integrated design-build firm
[ ] Joint Venture Company
[ ] Developer

7. If it was a joint venture company, who led the design-build team?

[ ] Designer
[ ] Contractor
[ ] Developer

8. Did a bridging architect/design firm assist in formulating the owner's project requirements? [ ] Yes [ ] No

If yes, what level did this design stage reach?

[ ] Schematic Design [ ] Design Development Stage

SECTION III: CONTRACT

9. Was a standard design-build contract form used? [ ] Yes [ ] No
If yes, what contract form was used? [ ] AIA [ ] AGC [ ] DBIA
[ ] EJCDC [ ] Other, please specify _____

10. Did the contract include any incentive clauses for good performance on schedule, cost, quality, safety or project team? [ ] Yes [ ] No

If yes, please specify the type of the incentive clause(s) used

_____
_____
_____

11. If the contract included a liquidated damages clause, please indicate its amount /day : $_____

SECTION IV: OTHER INFORMATION

12. Did the owner use a wrap-up insurance program (Owner Controlled Insurance Program (OCIP)) policy on the project?
[ ] Yes [ ] No

13. Did the owner have past work experience with the selected design-build organization? [ ] Yes [ ] No

14. Did the design-build team have design-build specialty subcontractor(s) for the following trades?

[ ] Mechanical
[ ] Electrical
[ ] Steel
[ ] Other: _____
[ ] Other: _____

15. Was it important to the owner to have design-build subcontractors?
[ ] Yes [ ] No