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DESIGN-BUILD VS DESIGN-BID-BUILD: A PROCUREMENT METHOD SELECTION FRAMEWORK

BY

Griffin K. Stauffer
LT, CEC, USN

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Purdue University
Division of Construction
Engineering and Management
School of Civil Engineering
West Lafayette, Indiana 47907-2051

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Griffin K. Stauffer
LT, CEC, USN

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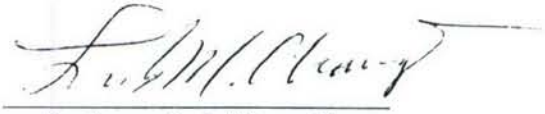
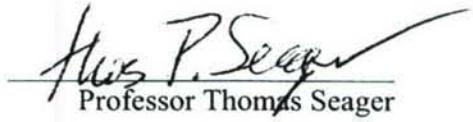


Professor Luh-Mann Chang



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ABSTRACT

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Design-Build vs. Design-Bid-Build: A Procurement Method Selection Framework.
Major Professor: Luh-Mann Chang.

Proper procurement method selection is an integral part of project success. Better informed owners are able to more successfully select the project delivery systems that best suit their needs. This study utilizes utility theory to construct a framework to assist in the procurement decision making process. Through the use of expert weighting of important procurement criteria, real world projects were used to develop an overall threshold to which future owner's can compare their subsequent projects. This threshold, which marks the boundary between Design-Build and Design-Bid-Build, can be used to measure an owner's propensity to use either procurement method. It is fully tailorable to any owner, as owner-specific inputs are used.

This ability for owners to objectify the largely subjective procurement decision making process allows owners to create a predictable, measurable trend, thereby improving their overall decision making ability.

CHAPTER 1. INTRODUCTION

1.1 Problem Statement

A reoccurring question facing owners is how to best meet their evolving needs. When it comes to expanding mission or capacity, those needs are often met through the construction of a new facility. One important driving factor contributing to the success of the new facility is the procurement method used to deliver the facility to the owner. The two most prevalent procurement methods, Design-Build (DB) and Design-Bid-Build (DBB), are well known. Less available, however, are tailorable tools or guidelines that illustrate or suggest when a particular procurement method is superior. It is perceived that more research is needed to develop a useful tool to assist in procurement method decision making.

1.2 Objectives

Procurement method selection is directly linked to owners' project goals, preferences, and unique circumstances surrounding their specific projects [1]. The goal of this research is to explore a generic framework to assist owners in determining which procurement method, specifically Design-Build or Design-Bid-Build, would be most beneficial to meeting their unique needs.

Several factors play a role in the level of success of a construction project. Different procurement methods each possess unique characteristics, emphasize different focus areas, and have inherent strengths and weaknesses [2]. Owners' failure to identify or understand these characteristics place them in a precarious position when committing funds to a project. At best, they run the risk of not giving themselves the fullest possible chance to fulfill their expectations, and at worst, may position themselves where different

aspects of the project and/or project team goals are in direct competition, possibly resulting in project failure [5,16].

In an attempt to improve the owner's ability to make informed procurement method decisions, it is hypothesized that by following the procurement selection framework constructed herein to determine the procurement method best suited to a particular owner's needs, an owner's requirements will be better satisfied than if an alternate method is used. The model incorporates several expert opinions and transforms them into a singular recommendation through the use of utility theory. This compilation of expert input into the framework of procurement method decision making delivers proven expertise into the hands of the owner.

The supporting evidence behind the procurement selection model rests largely on expert input throughout the entire process. As outlined by Love *et al.*, given the high variability of application across numerous projects, objective measures cannot be used to obtain procurement method selection criteria [3,5]. Therefore, actual project data will be used to validate the model, and experts will evaluate the actual degree to which their expectations and needs were met [3]. Similarly, expert surveys have proven highly useful in determining construction industry performance and productivity trends [4].

Results of this study are generic and can be adapted to other owners utilizing construction as a means to meet their expanding needs. This study utilized U.S. Navy data to exemplify the model. For the U.S. Navy, making better procurement selection decisions carries with it a substantial monetary savings. Since the Navy's construction organization, the U. S. Naval Facilities Engineering Command (NAVFAC), is a global entity performing over $10 billion in business annually, even slight improvement in selecting how to procure facilities to meet its needs can translate into significant savings. In short, this framework can help to further the Navy's goal of establishing "best practices" for the government as well as being fully adaptable to any owner desiring improved procurement method decision making.

Additionally, the need for the U.S. Navy to strive for the best value in procurement goes beyond simple economics and improved profitability. Though profitability might be the case in the civilian sector, the requirement for a government to

best utilize its taxpayer's dollars adds an important social context to the equation. The socio-political impacts of proper public funds expenditures can be significant and should in no case be overlooked. Proper spending in the form of best value projects resulting from proper procurement is a guiding principle that the government must adhere to, as it will certainly be judged by it.

1.3 Organization

This report outlines the methodology and process used in reaching an overall procurement method threshold between DB and DBB. It presents a literature background and discusses the different characteristics of each procurement method. It also offers a synopsis of previous work performed in this field and its influence on this report. The data collected from the experts is presented and subsequently analyzed; examples are provided to demonstrate the various formulas used in the calculation of each step. Finally, overall findings are presented and discussed, along with recommendations, possible future extensions of this work, and overall conclusions.

1.4 Research Summary

Through expert input on important procurement method selection criteria and application to real-world projects, this research demonstrates a framework that assists in improving future procurement method decision making. Utility functions synthesized the raw data to yield repeatable, predictable results and the formulation of an overall threshold. Owners are able to apply their future projects to this framework in a unique comparison of their current situation to the reference data. It is expected that those projects scoring above the threshold lend themselves to being more successful if procured as DB. Similarly, projects scoring below the model's threshold are expected to be better suited to be delivered via DBB means.

CHAPTER 2. RESEARCH METHODOLOGY

2.1 Methodology

The crux of the model lies in the selection and prioritization of certain procurement selection criteria to consider when choosing a procurement method. Owners must determine their position on each of these criteria prior to making a procurement method selection. Examples of these criteria include sustainability and speed required to deliver a facility.

An initial list of criteria was developed through literature review and content analysis. Experts were asked to evaluate the criteria on their level of importance for consideration prior to deciding on a particular procurement method. If experts felt there was an important criterion absent from the list provided to them, they were asked to add it and score it accordingly. Next, the list was streamlined to include only those criteria that the group of experts collectively graded as the most important. Third, the experts were asked to assign relative weights to the criteria, evaluate their positions on real-world projects relative to each criterion, rate their overall level of satisfaction with the project, and offer any confounding factors present. Finally, utility theory was used to convert the experts' marks into overall criterion scores. Utility theory was further utilized to compile these overall criterion scores together with their corresponding expert assigned weights into an overall threshold. This threshold, or total utility value, indicates the framework's recommendations of either DB or DBB to increase owner satisfaction.

This method allowed this independent research study to establish a reference to which future projects can be compared based upon how experts score individual procurement performance criteria. This can be extremely versatile and useful in future

projects as a way to evaluate an owner's specific project situation.

The independent variable used in this report was the individual project's score for each criterion. This scoring of specific performance criteria reflected the unique result of the expert's situation prior to the procurement of the project. This score proved a solid independent variable on which to determine relative dependent variable performance. The overall threshold, or dependant variable, is a product of a utility function and consequently serves as the reference to which an owner can compare future projects.

As with any study, the model offered herein cannot completely capture all possible variables contributing to each project's outcome. While procurement method selection plays a prominent role in determining project success, other confounding factors may be present that contribute (either positively or negatively) to the results suggested by procurement method selection alone.

Possible confounding factors may include poor contractor performance, unilateral funding reduction on the part of the owner, or other unforeseen circumstances. Any confounding factors encountered on a project will be noted by the experts. This will be accomplished by asking the experts in addition to scoring each project, to annotate if there were specific situations that affected project performance external to the procurement criteria in question.

2.2 Research Process

Literature review, expert input, and personal experience contributed to the creation of an initial procurement method performance criteria listing [5]. This list contained the top 13 criterion thought to matter most in determining which procurement method will best meet an owner's needs (see Table 2.1). In short, these criteria were thought to be the top parameters on which owners must define their position when going through the procurement method selection process.

Once an initial criteria list was built, that list was sent to 5 experts on facility management and source selection. The experts were asked to use their professional judgment to independently rank which of the criteria they felt was most important to consider when making a procurement method selection. The results of the expert's

	Criteria
1	Availability of experienced contractors
2	Flexibility of owner's requirements
3	Need for owner involvement during process
4	Owner's experience
5	Owner's in-house technical capability
6	Owner's willingness to accept risk
7	Presence of known site factors that may cause problems
8	Project completion within original budget
9	Project completion within original schedule
10	Project size
11	Project type
12	Speed to deliver project
13	Sustainability of structure

Table 2.1: Criteria Listing

rankings were collected and compiled into a single list. A 2-sample T test was then applied to the data to determine if any of the graded criteria were statistically less significant than the rest. Any criterion failing the T test for significance was discarded from further analysis. This yielded a final listing that included only the top criteria that the experts collectively chose as most important (see Figure 2.1).

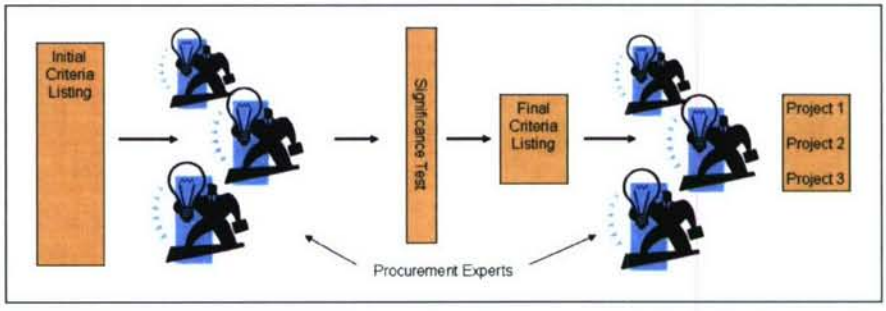

Figure 2.1: Criteria Listing Evolution and Project Scoring

Once the final list of collectively chosen important decision influencing criteria was constructed, it was returned to the experts for weighting and use in the evaluation of real-world projects. Each expert was asked to provide a single overall weight for each criterion, summing to 100%. Additionally, each expert was asked to score 3 projects relative to each item on the list of criteria. For each criterion, a range from 0-10 was

developed representing the two opposite extremes of the criterion. For example, for the criterion 'availability of experienced contractors', the scale ranged from 'very limited competitive environment' to 'several contractors available in market'. Projects represented both the DB and DBB procurement method. Experts placed a mark corresponding to their specific position for that project relative to each criterion. For example, a project to construct a barracks in time for a ship's return to port may have caused an expert to score the criterion of 'speed required to deliver facility' on the extreme upper end of that criterion's range, corresponding with 'outside time constraints present and highly influential of project success'.

In addition to scoring each criterion and annotating which procurement was actually used, the experts were also asked to comment generally on the extent to which the project satisfied their needs as well as any unique circumstances surrounding the project. These other circumstances were collected to help explain project success (or failure) outside of the procurement method.

Once the project evaluations had been collected from each expert, results were collated to yield average highs and average lows for each criterion. These averages were used to develop corresponding utility functions [4]. Figure 2.2 illustrates a generic representation of a utility function generated in this study. All criterion scores above the average high value were fixed as totally Design-Build, and all scores below the average low value were fixed as totally Design-Bid-Build. In other words, the example in Figure 2.2 shows that any value above 4.5 is 100% suited for DB and any value below 1.5 is 0% suited for DB. Only in the range between the average low and average high is there variation in the utility score. This variation is determined by the equation of the function and ranges between 0 and 1. (In this example, the variation between 0 and 1 is determined by the equation $u(y) = 0.33y - 0.5$.) This utility function, combined with the product of the criterion score and corresponding weight, yielded a total criterion utility value.

The use of utility functions as a means to evaluate multiple criteria has been effectively utilized in the past [19]. According to Baird, the term 'utility' refers to the measurement of relative "liking" on the part of an owner for particular outcomes [20]. A

major benefit to using this approach is that traditional multiple attribute utility theory provides a methodology for selecting from among a set of alternatives in the presence of uncertainty [21]. This allows several independent variables or decision outcomes to be described as probability density functions, thus uniformly representing varying inputs as a common output [19]. This common output serves as a singular representation of several different owner, project, and external environment characteristics.

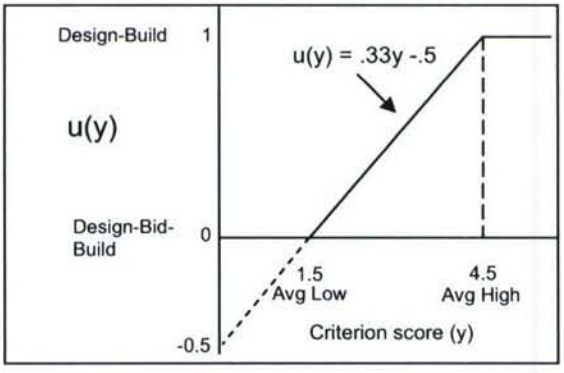

Figure 2.2: Individual Criterion Utility Function

The summation of all criterion utility values resulted in a single project utility value. Averaging all project utility values yielded an overall total utility value, or framework threshold. This threshold, based directly on the expert-inputted performance criteria scores, serves as a reference, or boundary, between the two procurement types, DB and DBB. Future projects can be compared to this total utility value to assist in procurement selection; higher values lend themselves to DB, while values lower than the threshold are better suited for DBB.

CHAPTER 3. PROCUREMENT SELECTION PARAMETERS

3.1 Literature Review

A brief overview, history, and trend analysis of the Design-Build and Design-Bid-Build procurement methods follow in an attempt to describe the choices that owners face for project delivery system. Figure 3.1 illustrates the different owner-contractor-designer relationships present in each delivery method.

Under Design-Bid-Build, the owner enlists an architect to prepare the design of the complete facility, including construction drawings, specifications, and contract packages. The design package is then presented to general contractors who bid for the work and engage subcontractors to provide various aspects of the project. Usually the lowest bid is selected. The selected contractor is then responsible for building the facility according to the design. With this project delivery system, the owner retains increased control over the project due to the separate selection of architect and contractor [6].

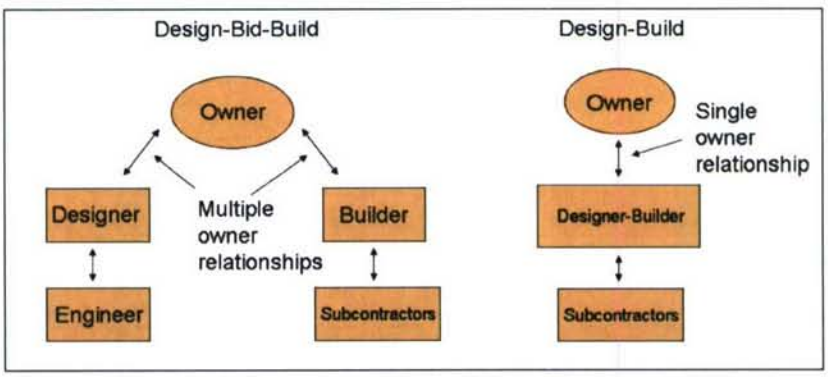

Figure 3.1: Procurement Method Relationships

In contrast, when Design-Build is the procurement method of choice, an owner contracts with a DB team, which is often a joint venture of a general contractor and a designer. Usually led by a general contractor (though a push for an increase in architect/designer lead teams is in progress [7]), the team designs the facility based on discussions with the owner about the needed functionality of the new facility. At an early point in the process, the DB team and the owner negotiate a contract to complete the design and construction of the facility. Once the owner approves the design, the design-build team is then responsible for construction of the project and for the coordination between design and construction [6].

Though often referred to as an 'alternative delivery method', Design-Build is not a new concept. In fact, it is most likely the earliest and oldest form of project delivery. Its roots originate in the ancient "Master Builder" concept where responsibility for both design and construction resided with one person [8]. From the Great Pyramids to the Parthenon, owners looked to a single person to both envision a structure that met the owner's needs and construct that structure based on a design that took specific constructability-related issues into account.

During the last century, however, project procurement systems have primarily utilized the so-called "traditional" process of Design-Bid-Build [9]. The federal government has undoubtedly steered the public sector toward DBB through the enactment of federal laws such the Federal Acquisition Regulation (FAR) and the 1972 Brooks Act [10]. As originally passed, these statues inhibited the use of DB in public projects, and state and local procurement statutes generally followed the federal procurement models. As a result of the continuous use of these approaches, a litigious environment of clients, contractors, lawyers, and claim consultants since the 1970's had begun to characterize the industry [10]. By the 1990's, however, issues such as accelerated project delivery, qualification of bidders, lack of innovation, and quality construction had challenged the public sector to rethink its position on other alternative delivery methods and restructure governing regulations to allow the use of Design-Build [10,13].

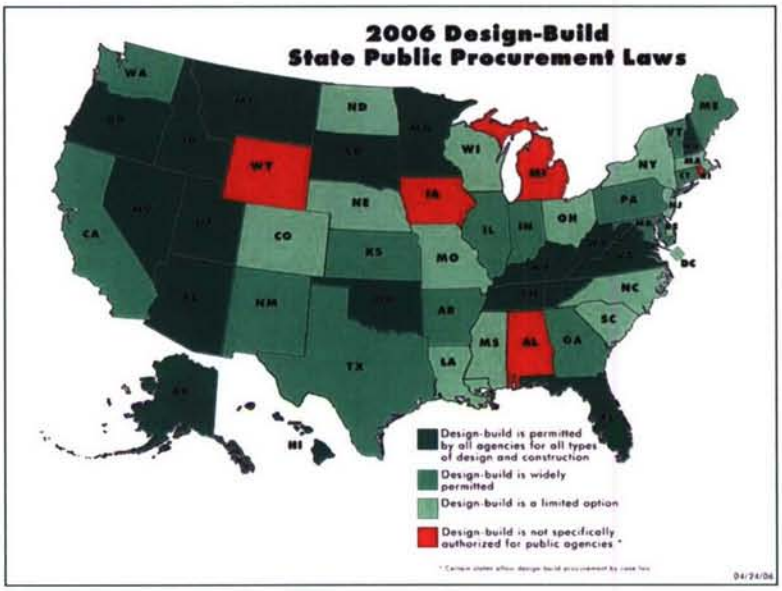

Figure 3.2: Current DB Regulatory Environment [11]

This amending of regulations has resulted in the current project delivery market experiencing a resurgence in the use of Design-Build procurement. Figure 3.2 illustrates the current U.S. regulatory environment as it relates to Design-Build [11]. Figure 3.3 outlines the historical usage of both DB and DBB and provides the Design-Build Institute of America's future projections on their use [11].

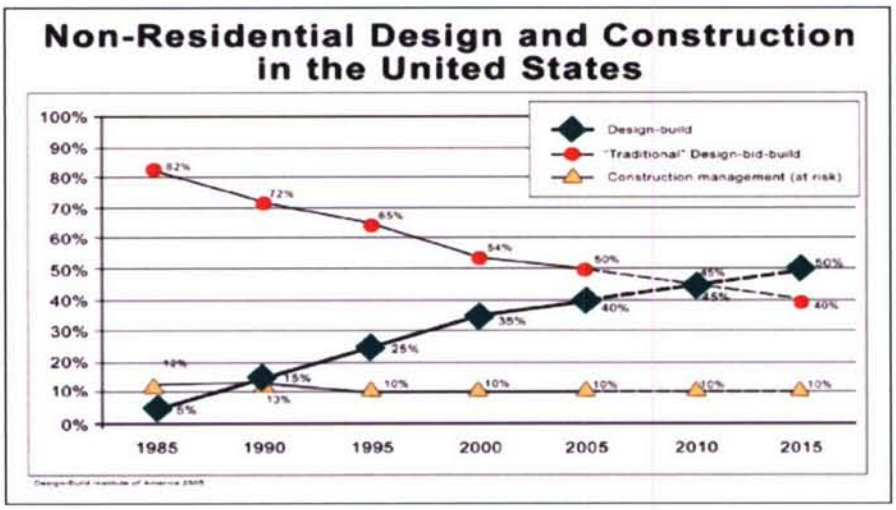

Figure 3.3: Procurement Method Usage Trends [11]

3.2 Procurement Method Characteristics

As stated earlier, different procurement methods each possess unique characteristics, which lead to advantages and disadvantages of using each one. According to Ling, *et al.*, it has been shown that most clients consistently use the procurement method with which they are most familiar [14]. Unfortunately, relatively few construction industry professionals both fully understand the differences in the various procurement systems and are subsequently unable to make recommendations on which system would be more appropriate for a specific project. It is therefore no surprise why owners and building professionals often resort to the procurement system with which they are most familiar, regardless of its appropriateness for the project [14].

Indeed, the DBB method has survived for so many years because it has several advantages. These include familiarity to participants in the construction process, firmly defined contractual relationships, and increased owner control over the design through direct contractual relationship with the designer [14].

DBB does, however, contain some limitations. Most notably is the greater propensity for conflict due to greater fragmentation throughout the project. In Design-Bid-Build, the designer creates the plans for a structure with little to no outside influence. The constructor then bids upon these documents on which he has had no constructive input. In fact, design and constructor rarely interact during the construction phase unless there is a conflict. Sitting squarely in the middle of this conflict (given his separate contractual relationships) is the owner. As a result, the contractor is encouraged to submit for extra payment to correct any design deficiencies (which takes added time), and the designer is encouraged to report that any deficiencies are due to improper construction by the contractor. This adversarial situation often results in the owner bearing increased cost and/or forcibly accepting increased time to complete the project.

The owner's single relationship and point of responsibility to the contractor is said to be the greatest strength of Design-Build [14]. Owners are able to enjoy efficient and centralized accountability and authority. In DB, there is no adversarial relationship between contractor and designer since they work together as a single project team [14].

Both the ability for this combined team to resolve issues internally much faster than in DBB along with the often non-linear project schedule often results in reduced time necessary to complete the project.

DB has its disadvantages as well. Because of its ability for design and construction to take place non-linearly, an owner must commit to decisions earlier in the process. While not an absolute necessity in DB, "fast-tracking", or the construction of certain approved portions of the project prior to a complete set of project plan documents, is not uncommon. As in any construction project, the changing of a parameter by the owner once construction has begun is much more costly than had the owner changed it prior to construction.

Table 3.1 outlines some additional strengths and weaknesses of each procurement method for quick reference.

Procurement Method	Strength	Weakness
Design-Build	Team concept focuses on common goals and objectives as single responsible entity for entire project	Requires decisions to be made earlier in the process
	Takes advantage of the contractor's ingenuity and innovation	More difficult to question decisions of engineer or architect of record
	Saves time because it is on a faster track with a faster schedule delivery	Commitment, communication, and trust, must be implemented early in the process
	Enhanced constructability infused into design	Owner ignorance to possible overdesign
Design-Bid-Build	Design is more precise and detailed at outset	More likely to be a higher overall cost and require a longer schedule
	The engineer/architect of record works for the owner	Increased probability of disputes

Table 3.1: Procurement Method Characteristics [2].

3.3 Procurement Method Selection Research

As a result of studies conducted in the past, a consensus exists that while one procurement method may outperform another for a specific project, no single procurement selection method is superior to others for any project [3]. Furthermore, Luu *et al.* points out that a mutually exclusive list of procurement selection parameters hardly exists due to the uniqueness of the myriad of construction projects today [5]. Therefore,

prior research in this area demonstrates that a tailored approach involving surveys of procurement experts is the preferred method by which to collect data [3,5,9].

As this project's focus is toward the U. S. Navy, the project experts polled in this study were from the Naval Facilities Engineering Command. NAVFAC is responsible to the U. S. Navy for over $10 billion in annual work. In a hierarchical system typical of the U. S. Government, NAFVAC is divided into three levels: an overall headquarters, two overall regional commands (NAVFAC Atlantic and Pacific), 12 geographic divisions (NAVFAC Northwest, Southwest, Europe, Hawaii, etc.), and several Integrated Project Teams (IPTs) consisting of contract field offices and installation public works offices. Appendix A has a brief graphical breakdown of the NAVFAC organization. The experts in this study are employed at the IPT level. They represent the level at which most project-level decisions are made. They routinely decide which procurement method to utilize on projects. On average, the experts in this study have over 18 years of experience in procurement selection; all have a minimum of 10 years of experience. These experts serve as either project managers, business directors, or public works officers responsible for overall management of construction and maintenance on a naval installation.

Research into procurement methods and the related success or failure of each method has been accomplished in the past. Among the most notable are Kumaraswamy and Dissanayaka [16,17], Molenaar [12], Love, Skitmore, and Earl [3], and Konchar and Sanvido [13]. Kumaraswamy and Dissanayaka explored the impacts of both procurement and non-procurement related variables (such as project conditions and team characteristics) on project performance by measuring 11 performance areas [16, 17]. Love, Skitmore, and Earl used expert surveys to poll attitudes toward different delivery options [3], while Molenaar specifically investigated the DB delivery system and developed key criteria to measure performance in comparison to other project delivery systems such as DBB [12]. Similarly, Konchar and Sanvido relied on empirical studies to develop specific Design-Build performance parameters upon which they could recommend the use of DB [13].

Luu, *et al.*'s work took elements of many of these previous studies into account when developing a listing of procurement selection parameters to be considered prior to

procurement selection. Luu, *et al.* also utilized expert input to determine specific areas of interest (client's characteristics and objectives, project characteristics, and external environment) while developing a model to evaluate procurement selection methods [5]. The parameters outlined by Luu, *et al.* (criteria 1-2, and 4-11) were selected following responses by 84 industry leaders as to what items were most important to consider prior to procurement method selection. This independent research study draws on several of the above listed individual's work for support.

While Luu, *et al.* provided a solid basis for the initial criteria listing generated in this study, the initial listing also included Hibberd and Basden's important criteria of "owner's propensity to accept risk" [15]. This facet gave insight into an owner's propensity to assume a decision-making role throughout the project's life. Criteria 3, 12, and 13 were also added to the initial listing. They were not explicitly annotated in prior research, but were considered important through the investigator's field experience.

CHAPTER 4. DATA COLLECTION

4.1 Procurement Selection Criteria List Formulation

Table 4.1 shows the initial criteria listing sent for expert review. The experts were asked to score the importance of each criteria listed as well as add and score any additional criteria they felt demanded consideration.

The aim of this initial listing was to adequately represent the various main categories of inputs into procurement selection: owner characteristics, project characteristics, and external environment [5]. To that end, criteria such as "need for owner involvement during process" and "owner's willingness to accept risk" represent owner characteristics. Similarly, criteria such as "project size" and "project type" illustrate project characteristics, and "availability of experienced contractors" and "presence of known site factors that may cause problems" represent external environment factors.

Type	Criteria name	Further criteria description
Owner Characteristics	Flexibility of owner's requirements	Very narrow specification allowing for little or no contractor flexibility vs. widely flexible performance specification
	Need for owner involvement during process	Extent to which owner must be involved in design review, specification creation or enforcement, etc.
	Owner's experience	Owner's experience with similar projects
	Owner's in-house technical capability	Owner's ability to act as design engineer or answer technical questions during construction
	Owner's willingness to accept risk	Propensity for owner to assume decision making role throughout project design & construction
External Env	Presence of known site factors that may cause problems	Soil conditions, unknown utility conditions, etc.
	Availability of experienced contractors	Extent of owner's pool of contractors from which to receive offers
Project Characteristics	Project completion within original budget	N/A
	Project completion within original schedule	N/A
	Project size	Owner's ability to manage contract via single/multiple contract(s)
	Project type	New technology or innovative vs. well understood or proven scope
	Speed to deliver project	Necessity to meet delivery date due to outside constraint vs. ability for schedule to slip
	Sustainability of structure	Whether sustainable or other "green" building techniques are to be implemented

Table 4.1: Initial Criteria Listing with Descriptions

Experts receiving the initial criteria listing were asked to rate the level of each criterion's importance using a 6-point Likert scale. Likert scaling is widely used in measuring respondents' replies in questionnaires and is a demonstrated acceptable method in procurement method research [5]. Responses ranged from criteria being extremely important and receiving a score of 5 to not important at all and receiving a score of 0. Table 4.2 illustrates the range of possible responses and amplifying descriptions of consideration frequency.

Score	Response	Description
5	Extremely Important	Owners should consider this criterion every time
4	Very Important	Owners should consider this criterion most times
3	Somewhat Important	Owners should consider this criterion occasionally or only on specific projects
2	Somewhat Unimportant	Owners may or may not consider this criterion without expected effect
1	Not Very Important	Owners seldom consider this criterion or only for specifically unique projects
0	Not at All Important	Owners rarely if ever consider this criterion

Table 4.2: Criteria Listing Response Scale

The results of each expert's responses were collected and compiled into Table 4.3. Averages and standard deviations were calculated for each. These were later used to determine if any criteria should be discarded from further analysis.

	Criterion	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Average	Std Dev
1	Availability of experienced contractors	1	5	5	4	4	3.80	1.64
2	Flexibility of owner's requirements	3	3	4	4	4	3.60	0.55
3	Need for owner involvement during process	4	2	2	5	5	3.60	1.52
4	Owner's experience	1	2	5	3	3	2.80	1.48
5	Owner's in-house technical capability	3	4	4	3	5	3.80	0.84
6	Owner's willingness to accept risk	5	3	5	3	4	4.00	1.00
7	Presence of known site factors that may cause problems	1	4	5	4	5	3.80	1.64
8	Project completion within original budget	4	4	5	5	5	4.60	0.55
9	Project completion within original schedule	5	4	5	4	4	4.40	0.55
10	Project size	3	2	3	4	3	3.00	0.71
11	Project type	1	3	3	4	5	3.20	1.48
12	Speed to deliver project	5	3	5	4	4	4.20	0.84
13	Sustainability of structure	2	2	4	4	5	3.40	1.34

Table 4.3: Criteria List Expert Responses

4.2 Project Scoring and Expert Evaluation

The second step in this survey asked the experts to score 3 projects from their installations on each of the criteria. Successful responses were received from all experts queried and the projects received represented a range of sizes and both Design-Build and

Design-Bid-Build project delivery systems. See Figure 4.1 for a graphical representation of the projects characteristics.

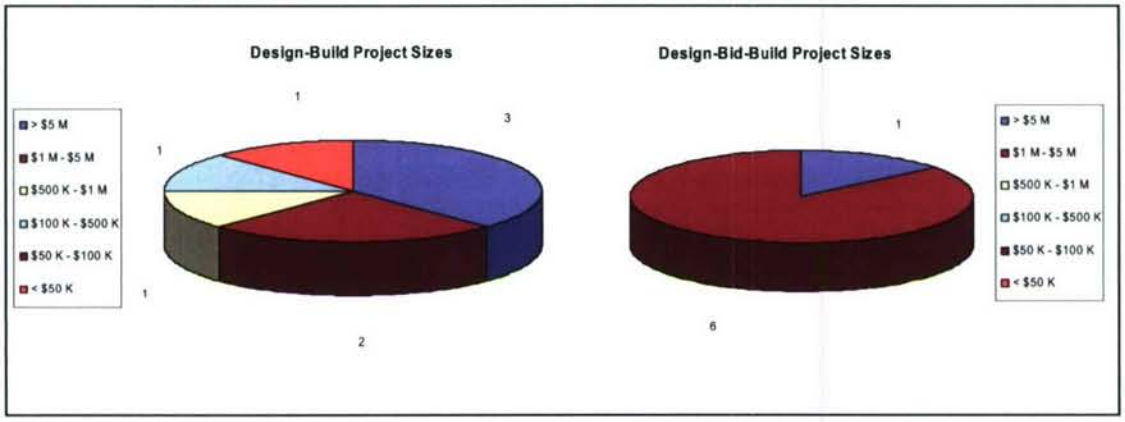

Figure 4.1: Study Project Characteristics

These projects served as the building blocks of the procurement framework. The scores that the experts submitted were the inputs that determined the corresponding utility function shapes and ultimately led to an overall utility value. Appendices G through K contain the scoring data for each expert.

In addition to scoring individual projects, experts also provided weights for each criterion. These weights represented the relative importance each criterion had with respect to one another. Table 4.4 shows the compiled result of each expert's input and the average value used in the further calculations of utility functions.

Criterion	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Average	Std Dev
1	5%	30%	13%	5%	10%	12.6%	0.103
2	5%	5%	6%	0%	5%	4.2%	0.024
3	10%	5%	5%	0%	10%	6.0%	0.042
4	1%	5%	10%	10%	5%	6.2%	0.038
5	2%	5%	6%	10%	10%	6.6%	0.034
6	5%	5%	10%	0%	5%	5.0%	0.035
7	10%	5%	5%	0%	5%	5.0%	0.035
8	5%	10%	12%	30%	15%	14.4%	0.094
9	15%	10%	12%	15%	5%	11.4%	0.042
10	20%	5%	2%	5%	5%	7.4%	0.072
11	5%	5%	2%	0%	0%	2.4%	0.025
12	15%	10%	7%	5%	5%	8.4%	0.042
13	2%	0%	10%	20%	20%	10.4%	0.095

Table 4.4: Expert criteria weights

CHAPTER 5. DATA ANALYSIS

5.1 Criteria List Analysis

Once the experts' results were received on the initial criteria listing survey, it was necessary to analyze them to determine if any of the criteria ought to be excluded from further calculations due to insignificance with the remainder of the data. This was done utilizing 2-sample T test methodology. Figure 5.1 illustrates the governing formula for the t-value used in the 2-sample test where $\bar{x}$ is the average criterion score, s is the standard deviation, and n is the sample size [18].

$$t = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{s_1^{\,2}}{n_1} + \frac{s_2^{\,2}}{n_2}}}$$

Figure 5.1: t-value equation

Rearranging the equation in Figure 5.1 solves for the difference in two criterion's means (See Figure 5.2).

$$\overline{x_1} - \overline{x_2} = t * \sqrt{\frac{s_1^{\,2}}{n_1} + \frac{s_2^{\,2}}{n_2}}$$

Figure 5.2: Significant mean difference equation

For example, the t-value corresponding to a 90% degree of confidence and sample size of 10 is 1.38 [18]. With standard deviations of 1.5 and 1.8 respectively, the equation in Figure 5.2 yields the result illustrated in Figure 5.3.

$$\overline{x_1} - \overline{x_2} = 1.38 * \sqrt{\frac{1.5^2}{10} + \frac{1.8^2}{10}} = 1.02$$

Figure 5.3: Example significant mean difference calculation

Therefore, given the confidence level and sample size, the result is that for x_2 to be significantly different than x_1, its mean must differ from x_1's by more than 1.02.

For this study, a confidence level of 75% was utilized. This was chosen because the inputs are, unlike highly predictable laboratory experiments, based on human experience and therefore widely variable. Using a 90% or higher level of confidence was therefore avoided, and lower confidence values were not chosen to retain meaningfulness in the resulting analysis. The t-value corresponding to a 75% degree of confidence and a sample size of 5 is 0.741 [18].

The result in this study was for a criterion not to be considered significant when compared to the remainder of the group, its mean must have differed by at least 0.544 based on the equation in Figure 5.2. Figure 5.4 shows the sorted list of criteria based on criteria averages. It also shows +/- one standard deviation for each criterion. "Project completion on original budget" received the highest average score of 4.6 while "owner's experience" received the lowest at 2.8.

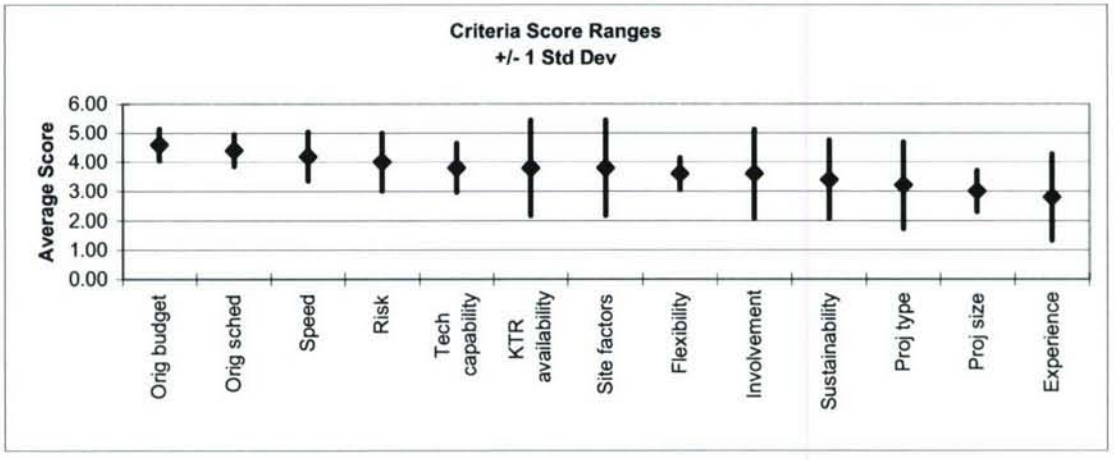

Figure 5.4: Initial criteria list results

All thirteen criteria's means differed by 0.2 or less. Since none of the criteria scores were greater than 0.544 apart, it was determined that all thirteen criteria annotated on the initial list were significant and were therefore all included in further analysis. Additionally, nearly all criteria yielded average values above 3.0, corresponding to "somewhat important". Only 'owner's experience' fell below that mark at 2.8, but was considered close enough to warrant continued inclusion. In essence, since none of the criteria needed to be discarded, the initial criteria listing became the final criteria listing.

5.2 Utility Function Generation

This framework applied procedures previously outlined in Chang, *et al.* utilizing utility functions to quantify subjective expert input [4]. Since all 13 criteria were deemed valid for further consideration, this system requested that all 5 experts each score 3 projects on all 13 criteria. The result was a database of fifteen projects representing a range of project types, sizes, and both DB and DBB delivery methods. The scores for these projects were used to calculate a utility function for each criterion.

Earlier, Figure 2.2 showed how the utility function for each criterion encapsulated both the average high and average low scores received from the experts. For example, Table 5.1 demonstrates the approach for the third criterion "owner involvement during process". It uses inputs from 2 experts scoring 3 projects each.

Owner involvement during process					
	1	2	3	4	5
Expert 1	X	X		X	
Expert 2		X X			X

Table 5.1: Sample Expert scoring input

From this data, average low and average high values were calculated. In this example, low values of 1 from Expert 1 and 2 from Expert 2 yield an average low value of 1.5. Similarly, high values of 4 from Expert 1 and 5 from Expert 2 yield an average high value of 4.5. Consequently, any value below the average low is fixed (in this

framework as Design-Bid-Build), as is any value above the average high value (in this framework as Design-Build). Calculating the slope between the two points yields the equation of the line. In this example, the line rises from 0 to 1 over a run of 3 (4.5 – 1.5). Therefore, the slope is calculated by dividing the rise by the run or a = 1/3 = 0.33. Substituting the Average Low (1.5, 0) into the equation for a line (u(y) = ay + b) and solving for b, the y-intercept is found to be 0 = (0.33 * 1.5) + b, therefore b = -0.5. Figure 5.5 illustrates this graphically. The framework repeats this process for each of the 13 criteria, yielding 13 utility functions.

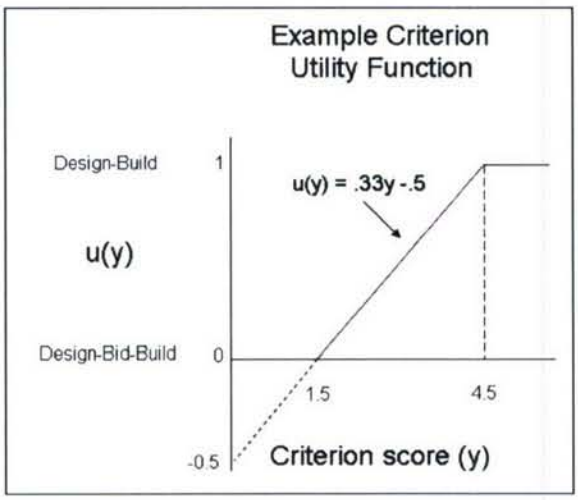

Figure 5.5: Sample Utility Function

5.3 Project and Total Utility Value Generation

Next, the average weight for each criterion, w, is used to indicate relative importance between criteria. Each expert assigned weights to each criterion. Those weights were averaged to produce an overall criterion weight. Figure 5.6 illustrates the results of the expert input, with "project completion within original budget" receiving the most weight of 14.4% and "project type" receiving the least relative weight of 2.4%.

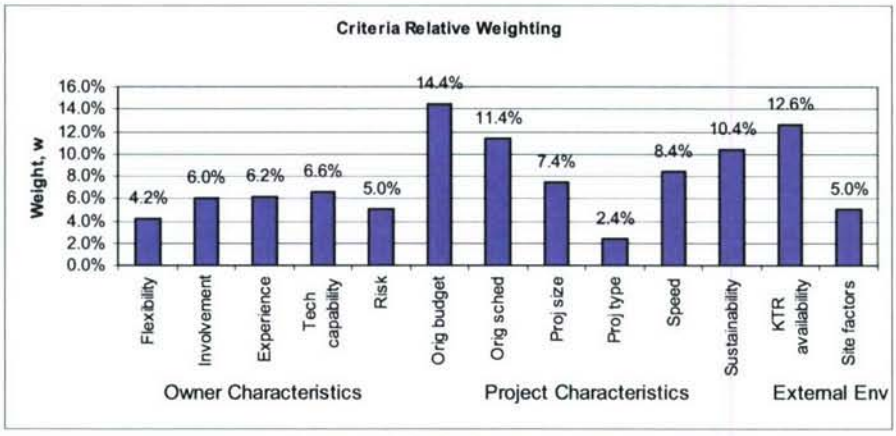

Figure 5.6: Criteria relative weighting results

It is interesting to note that the criterion "availability of experienced contractors" received the second highest weight of 12.6%, yet did not break out from the group in survey #1 as very important. This can be explained by the averaging process. In an attempt to encompass the widest base of Navy experts for this study, experts from different parts of the country were asked to participate. One expert in particular was from Hawaii. That expert placed a relative weight of 30% on criterion, which was dramatically higher than other experts. This is due to the geographic isolation that Hawaii faces with respect to contractors available to perform work. The average value of 12.6%, therefore, was a result of this expert's 30% weighting; the average of the other 4 experts' weights was only 8.25%. It is expected that for most owners, this criterion would be weighted less than in this study, as most owners are not faced with geographic situations typical of remote areas.

The equation illustrated in Figure 5.7 demonstrates the method utilized to reach a utility value (U(y)) for each criterion [4].

$$U_i = w_i * u_i * y_i$$

Figure 5.7: Utility value equation

Continuing the example on the third criterion "owner involvement in process," individual expert weights of 0.01, 0.05, 0.1, 0.1, and 0.05 were averaged to yield a weight for this criterion of 0.062. Assuming the next project evaluated was given a score of 3

for this criterion, the corresponding utility value would be 0.09114 as shown in Figure 4.8 below.

$$w = .062 \qquad \overbrace{u(y) = (.33 * 3) - .5 = .49}^{from\ utility\ function} \qquad y = 3$$

See Figure 5.5

$$U_3 = w_3 * u_3 * y_3 \rightarrow .062 * .49 * 3 = 0.09114$$

Figure 5.8: Criterion U value sample calculation

0.09114 is the utility value for the third criterion only, represented by U_3. To reach the project's U value, this process must be repeated for each of the remaining 12 criteria. The summation of all 13 criterion utility values (U_1 through U_{13}) results in a single project U value ($U_{Project}$). For example, Project 3 yielded criteria values of 0.711, 0.752, 0.056, -0.051, 0.867, -0.021, 0.138, 0.360, 0.960, 0.056, 0.504, 0.672, and -0.437 for a project utility value of 4.57. This study yielded project U values ranging from -0.27 to 13.28. Each project's U values were then averaged to yield a total utility value, or threshold, for the entire study (U_T). This threshold represents the collective input of the experts and reflects a single value to which future projects can be compared. Figure 5.9 illustrates the hierarchical process undertaken to reach the total utility value [4].

$$\overbrace{w_1 * u_1 * y_1}^{Criteria} = U_1 \rightarrow \overbrace{\sum U_1 \ldots U_{13}}^{Project} = U_{Project1} \rightarrow \frac{\overbrace{\sum U_{Project1} \ldots U_{Project15}}^{Total}}{15} = U_T$$

Figure 5.9: Hierarchical process used to reach Total Utility Value U_T

5.4 Purpose and Use of Threshold Value

The framework described above yielded project utility values of 7.10, 9.76, 4.56, 5.20, 3.04, 6.65, 9.09, 6.78, 6.98, 6.82, 6.23, 13.28, -0.27, -0.07, and 0.15 for each of the 15 projects. Following the framework, the average of these project utility values yields a total utility value of 5.69. This number, therefore, represents these 5 Navy experts' current position with respect to importance of procurement method selection criteria,

their relationship to one another in the form of relative weights, and their personal tolerance within a range of each criterion. Another way this can be expressed is to treat the threshold value as a "Navy industry average". This is useful because future owners can utilize this same framework to establish their own average. As more projects are undertaken, the total utility value will track as appropriate to reveal the owner's true threshold between Design-Build and Design-Bid-Build.

For example, the current Navy threshold (understanding that "the Navy" is being represented by the 5 experts and 15 projects polled in this study) is 5.69 as stated earlier. As future projects come about, Navy owners can score them as they see fit (assigning individual y values to each of the 13 criteria), and the system will produce that project's corresponding U value. This project U value will either be above or below the Navy threshold. If the project is substantially below the threshold, then it is well suited for Design-Bid-Build. On the other hand, if the project is well above the Navy total utility value, it would serve the owner more to procure it via Design-Build. It is important to note that this is a sliding scale, meaning that the further away from the threshold a future project scores (either above or below) the more convincing it is to follow the procurement method recommended.

5.5 Framework Recommendation vs. Actual Project Procurement Method

Figure 5.10 illustrates framework performance in recommending procurement method. The threshold of 5.69 is clearly indicated by a solid green line. The clear area

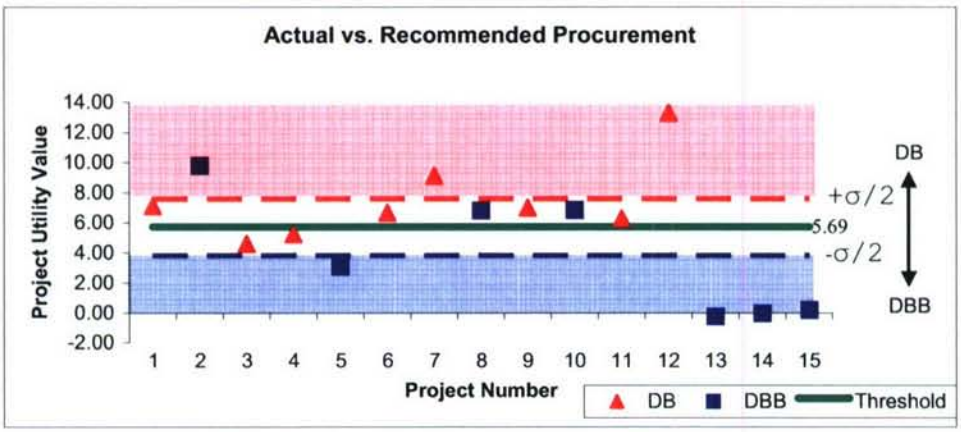

Figure 5.10: Actual vs. Recommended Procurement

surrounding the threshold is bound by +/- half of one standard deviation ($\sigma/2$). Beyond this clear area are red and blue regions corresponding to stronger recommendations of DB and DBB, respectively. Projects falling in the clear area are close to the threshold value and can be reasonably expected to be successful if procured by either method.

Overall, Projects 1, 5-7, 9, 11, and 12-15, or 67% of the projects were actually procured by the same method recommended by the framework (i.e. had project utility values above or below the threshold corresponding to either DB or DBB). Specifically, 75% of DB projects (Projects 1, 6, 7, 9, 11, and 12) agreed with the framework while 57% of DBB projects (Projects 5, and 13-15) also followed the recommendation. While having two thirds overall support the framework lends credibility to the process, further investigation reveals an even stronger result. In the areas beyond half of one standard deviation, 85.7%, (Projects 5, 7, and 12-15) followed the framework. These are the areas which the framework more strongly recommends a particular procurement method, as it is further away from the midpoint where either method may be acceptable.

Nearly every project was either successful in its procurement method or poor performance explained through one or more confounding factors. Specifically, the projects located in the stronger areas of recommendations that followed the framework's recommendation had acceptable performance. The owner of Project 12 indicated that despite a tight budget and timeline, the Design-Build project had both successful design and construction phases. Additionally, the owner of Projects 13, 14, and 15 did not indicate any negative effects suffered during these projects. See Appendicies G-K for expert comments on each project.

Project 2 is the only project that did not follow the framework outside of the clear area. This project was actually procured using DBB means while the framework clearly recommends DB for a project having a utility value of 9.7. The expert overseeing this project reported serious problems with the performance of this project. Specifically, he cited schedule delays and conflicts over design flaws and the need for change orders.

This project involved the renovation of an existing facility. Renovation projects are often subject to numerous changes due to unforeseen conditions differing from what

was originally specified or thought to be true on design documents. The inflexibility of the DBB contract to compensate for this fact resulted in low owner satisfaction and overall poor contract performance. The fact that the one and only project that did not follow the framework's recommendation suffered from poor performance even further bolsters the credibility of the system.

It is important to note that the projects used to develop this framework were not selected retrospectively based on their compliance with the study. Conversely, the framework was established first, and the fifteen projects (which made up the entire project database) were subsequently subjected to the process and the results calculated.

5.6 Confounding Factors

It is important to mention that simply following the procurement method recommended as a result of following this framework does not guarantee project success. There are several confounding factors external to procurement method that may significantly influence a project's outcome. In this study, the majority of the projects illustrated the standard strengths and weaknesses of their procurement type. According to the project owners, most DB procured projects completed on time and were sufficiently flexible to cope with varying design and site conditions. Furthermore, the DBB procured projects often completed behind schedule, had greater communication difficulties, and in extreme cases, were fraught with claims over design omissions and differing site conditions.

Some projects used in this study, however, had confounding factors override the standard procurement method parameters. For example, a boiler replacement project procured via DB suffered from design omission discovered following project closeout. Similarly, an armory renovation and decontamination project procured via DB suffered from poor contractor performance in the form of a delayed start and subsequent late finish. Finally, a DBB project to install a flightline fuel tank delivered a successful product on time with minimal changes. These exceptions demonstrate that the procurement method alone does not automatically deliver a successful project.

CHAPTER 6. RECOMMENDATIONS AND CONCLUSIONS

6.1 Results and Findings

Using U.S. Navy data, a total utility value, or threshold, was determined to be 5.69 based on 5 experts and 15 projects. While not intended to be all inclusive, this study demonstrated a generic framework by which owners can follow to determine their own threshold between Design-Build and Design-Bid-Build. As future projects come about, owners can compare the new projects scores to their threshold to determine which delivery method better suits their individual needs.

It was found that the framework successfully recommended either the DB or DBB procurement method based on owner inputs. Within the boundaries of 5 experts and 15 projects this study's data set included, 67% of projects tested agreed with the system regardless of distance from the threshold. Beyond half of one standard deviation, the framework properly recommended 87% of the projects' actual procurement methods. The sole project in this realm that did not follow the framework's recommendation suffered from poor contract performance and low owner satisfaction.

6.2 Research Limitations

It is important to note that while this study has produced encouraging results, it does have its limitations. Specifically, the study group utilized in this work consisted of only five experts to represent the U.S. Navy, an extremely diverse owner. Additionally, the project database consisted of 15 projects, only a minute fraction of the total projects procured by this owner. This framework attempt to demonstrate method over individual figures, as these figures will be different for each owner utilizing this methodology.

6.3 Recommendations

It is the recommendation of this study for owners to utilize the generic framework developed herein to improve their procurement method selection and decision making capability. By establishing a threshold unique to them, owners can quantify their subjective biases on various procurement criteria. Furthermore, they can compare future projects to this threshold to better select the procurement method that leads to project success.

This framework can be improved through future extensions that subject a great many more projects to this framework. By polling several owners spanning different backgrounds, areas, and expertise in the construction industry, a large number of projects inputted into this framework would yield an overall industry average for many different construction sectors. This extension would add an additional benefit to the framework, allowing owners to not only compare their future projects against their own threshold, but against a threshold representing the sector of construction in which their project lies.

6.4 Research Conclusions

This study was successful in using utility theory to produce a potential framework to measure owner propensity toward either the Design-Build or Design-Bid-Build procurement method. Its use will allow owners to quantify an often subjective process to assist in procurement method decision making. It is fully tailorable to the owners' needs and reflects owners' individual preferences toward their specific projects. The end result is more informed owners who can better determine the proper procurement method best suited to meet their needs.

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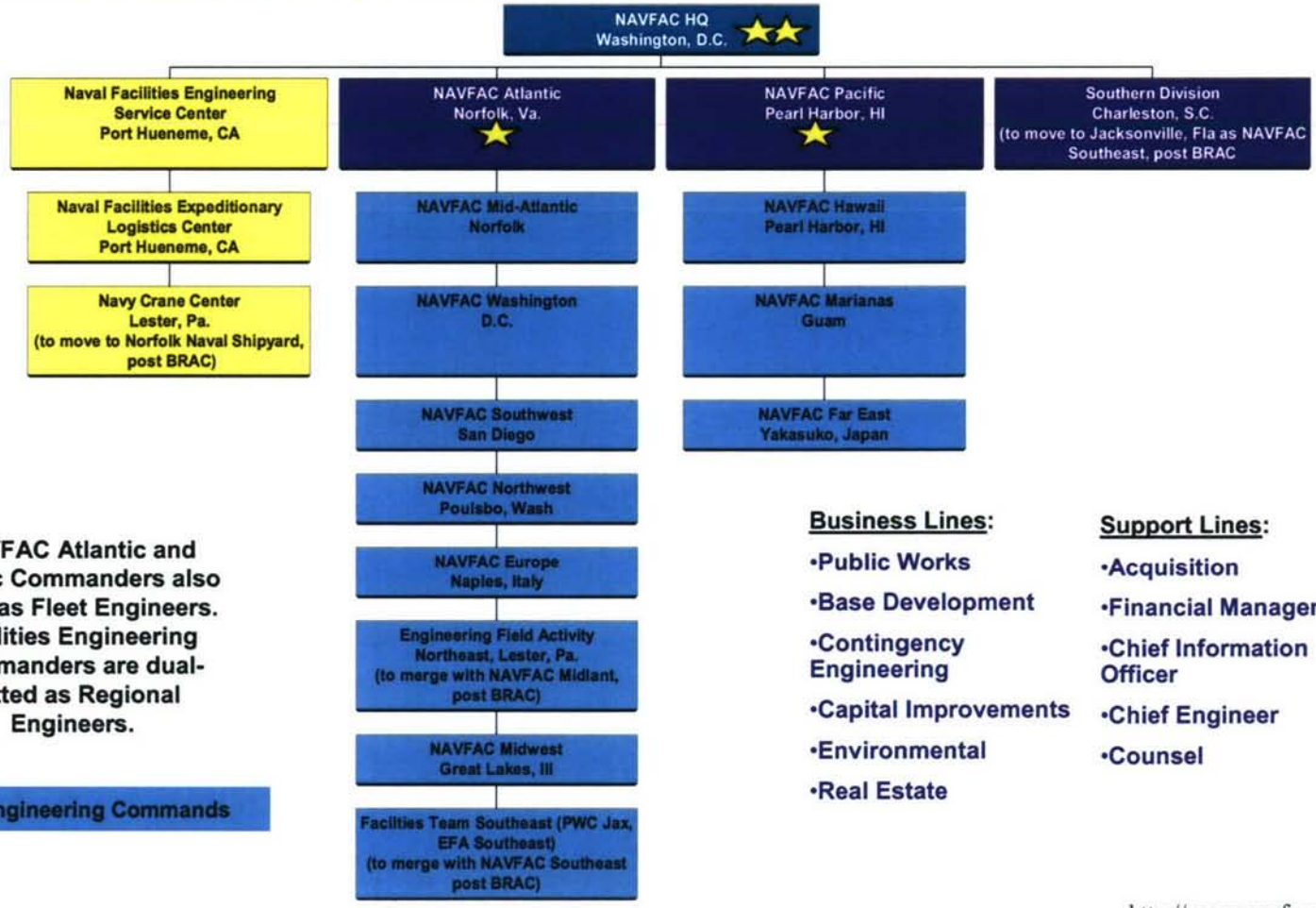

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This survey is attempting to gather data on those criteria which owners should consider when choosing a particular procurement method, specifically Design-Build or Design-Bid-Build. The criteria are not intended to be biased toward any particular method.

Instructions:

The survey below contains a list of 13 criteria to be considered in varying degrees when determining the procurement method of choice. Please score each criteria on the degree of importance which owners must determine thier positions on prior to procuring a project via Design-Build or Design-Bid-Build. There should be only one mark in each row, corresponding with the degree of importance for that criterion. If applicable, a more detailed description for the criterion name is provided. For each criterion, if you have specific comments explaining or amplifying your mark, please include them under the comment block. If you feel an important criterion was not listed, please add it, provide a further description as necessary, and score it accordingly.

For example: If it is perceived that owners ought to consider the degree to which contractors exist in the marketplace who are competent to complete their project each and every time they procure a new project, a mark should be placed under "extremely important" for that criterion.

Expert #1

Importance for Consideration when Deciding Procurement Method

Criterion	Further criteria description	Extremely Important (owners should consider this criterion every time)	Very Important (owners should consider this criterion most times)	Somewhat Important (owners should consider this criterion occasionally)	Somewhat Unimportant (owners may or may not consider this criterion without expected effect)	Not Very Important (owners seldom consider this criterion or only for specifically unique projects)	Not at all Important (owners rarely if ever consider this criterion)	Comments (optional)
Availability of experienced contractors	Extent of owner's pool of contractors from which to receive offers					X		
Flexibility of owner's requirements	very narrow specification allowing for little or no contractor flexibility vs. ability to use widely flexible performance specification			X				
Need for owner involvement during process	Extent to which owner must be involved in design review, specification creation or enforcement, etc.		X					
Owner's experience	owner's experience with similar projects					X		
Owner's in-house technical capability	owner's ability to act as design engineer or answer technical questions during construction			X				
Owner's willingness to accept risk		X						
Presence of known site factors that may cause problems						X		
Project completion within original budget			X					
Project completion within original schedule		X						
Project size	owner's ability to manage contract via single/multiple contract(s)			X				
Project type	new technology or innovative vs. well understood or proven scope					X		
Speed to deliver project	Necessity to meet delivery date due to outside constraint vs. ability for schedule to slip	X						
Sustainability of structure	whether sustainable or other "green" building techniques are to be implemented				X			

Please add any additional criteria as necessary	Please include as detailed description as possible	Extremely Important	Very Important	Somewhat Important	Somewhat Unimportant	Not Very Important	Not at all Important	Comments (optional)
Capability of the procurement agency	Owners have choices of agencies that set the stage for the whole process.			X				
Cost of the procurement process	Procurement agencies have different levels of service and different "rates" for service. Selecting a "rate" can limit the acquisition options.					X		

This survey is attempting to gather data on those criteria which owners should consider when choosing a particular procurement method, specifically Design-Build or Design-Bid-Build. The criteria are not intended to be biased toward any particular method.

Instructions:

The survey below contains a list of 13 criteria to be considered in varying degrees when determining the procurement method of choice. Please score each criteria on the degree of importance which owners must determine thier positions on prior to procuring a project via Design-Build or Design-Bid-Build. There should be only one mark in each row, corresponding with the degree of importance for that criterion. If applicable, a more detailed description for the criterion name is provided. For each criterion, if you have specific comments explaining or amplifying your mark, please include them under the comment block. If you feel an important criterion was not listed, please add it, provide a further description as necessary, and score it accordingly.

For example: If it is perceived that owners ought to consider the degree to which contractors exist in the marketplace who are competent to complete their project each and every time they procure a new project, a mark should be placed under "extremely important" for that criterion.

Expert #2

Importance for Consideration when Deciding Procurement Method

Criterion	Further criteria description	Extremely Important (owners should consider this criterion every time)	Very Important (owners should consider this criterion most times)	Somewhat Important (owners should consider this criterion occasionally)	Somewhat Unimportant (owners may or may not consider this criterion without expected effect)	Not Very Important (owners seldom consider this criterion or only for specifically unique projects)	Not at all Important (owners rarely if ever consider this criterion)	Comments (optional)
Availability of experienced contractors	Extent of owner's pool of contractors from which to receive offers	X						Working on Hawaii this becomes critical to price as there is a limited number of KTRs to choose from
Flexibility of owner's requirements	very narrow specification allowing for little or no contractor flexibility vs. ability to use widely flexible performance specification			X				
Need for owner involvement during process	Extent to which owner must be involved in design review, specification creation or enforcement, etc.				X			
Owner's experience	owner's experience with similar projects				X			
Owner's in-house technical capability	owner's ability to act as design engineer or answer technical questions during construction		X					Issue for NAVFAC currently; new instruction released April 06 provides guidance on requiring FEC review of Des-Build projects
Owner's willingness to accept risk				X				
Presence of known site factors that may cause problems			X					Differening site conditions claim is problematic
Project completion within original budget			X					
Project completion within original schedule			X					
Project size	owner's ability to manage contract via single/multiple contract(s)				X			
Project type	new technology or innovative vs. well understood or proven scope			X				Unfortunately, we (govt) do not usually get the most technologically advanced product unless Value Engineering proposal is used by KTR
Speed to deliver project	Necessity to meet delivery date due to outside constraint vs. ability for schedule to slip			X				
Sustainability of structure	whether sustainable or other "green" building techniques are to be implemented				X			but not generally considered except for large (MILCON) scope projects

Please add any additional criteria as necessary	Please include as detailed description as possible	Extremely Important	Very Important	Somewhat Important	Somewhat Unimportant	Not Very Important	Not at all Important	Comments (optional)

This survey is attempting to gather data on those criteria which owners should consider when choosing a particular procurement method, specifically Design-Build or Design-Bid-Build. The criteria are not intended to be biased toward any particular method.

Instructions:

The survey below contains a list of 13 criteria to be considered in varying degrees when determining the procurement method of choice. Please score each criteria on the degree of importance which owners must determine thier positions on prior to procuring a project via Design-Build or Design-Bid-Build. There should be only one mark in each row, corresponding with the degree of importance for that criterion. If applicable, a more detailed description for the criterion name is provided. For each criterion, if you have specific comments explaining or amplifying your mark, please include them under the comment block. If you feel an important criterion was not listed, please add it, provide a further description as necessary, and score it accordingly.

For example: If it is perceived that owners ought to consider the degree to which contractors exist in the marketplace who are competent to complete their project each and every time they procure a new project, a mark should be placed under "extremely important" for that criterion.

Expert #3

Importance for Consideration when Deciding Procurement Method

Criterion	Further criteria description	Extremely Important (owners should consider this criterion every time)	Very Important (owners should consider this criterion most times)	Somewhat Important (owners should consider this criterion occasionally)	Somewhat Unimportant (owners may or may not consider this criterion without expected effect)	Not Very Important (owners seldom consider this criterion or only for specifically unique projects)	Not at all Important (owners rarely if ever consider this criterion)	Comments (optional)
Availability of experienced contractors	Extent of owner's pool of contractors from which to receive offers	X						
Flexibility of owner's requirements	very narrow specification allowing for little or no contractor flexibility vs. ability to use widely flexible performance specification		X					
Need for owner involvement during process	Extent to which owner must be involved in design review, specification creation or enforcement, etc.				X			
Owner's experience	owner's experience with similar projects	X						
Owner's in-house technical capability	owner's ability to act as design engineer or answer technical questions during construction		X					
Owner's willingness to accept risk		X						
Presence of known site factors that may cause problems		X						
Project completion within original budget		X						
Project completion within original schedule		X						
Project size	owner's ability to manage contract via single/multiple contract(s)			X				
Project type	new technology or innovative vs. well understood or proven scope			X				
Speed to deliver project	Necessity to meet delivery date due to outside constraint vs. ability for schedule to slip	X						
Sustainability of structure	whether sustainable or other "green" building techniques are to be implemented		X					

Please add any additional criteria as necessary	Please include as detailed description as possible	Extremely Important	Very Important	Somewhat Important	Somewhat Unimportant	Not Very Important	Not at all Important	Comments (optional)

This survey is attempting to gather data on those criteria which owners should consider when choosing a particular procurement method, specifically Design-Build or Design-Bid-Build. The criteria are not intended to be biased toward any particular method.

Instructions:

The survey below contains a list of 13 criteria to be considered in varying degrees when determining the procurement method of choice. Please score each criteria on the degree of importance which owners must determine thier positions on prior to procuring a project via Design-Build or Design-Bid-Build. There should be only one mark in each row, corresponding with the degree of importance for that criterion. If applicable, a more detailed description for the criterion name is provided. For each criterion, if you have specific comments explaining or amplifying your mark, please include them under the comment block. If you feel an important criterion was not listed, please add it, provide a further description as necessary, and score it accordingly.

For example: If it is perceived that owners ought to consider the degree to which contractors exist in the marketplace who are competent to complete their project each and every time they procure a new project, a mark should be placed under "extremely important" for that criterion.

Expert #4

Importance for Consideration when Deciding Procurement Method

Criterion	Further criteria description	Extremely Important (owners should consider this criterion every time)	Very Important (owners should consider this criterion most times)	Somewhat Important (owners should consider this criterion occasionally)	Somewhat Unimportant (owners may or may not consider this criterion without expected effect)	Not Very Important (owners seldom consider this criterion or only for specifically unique projects)	Not at all Important (owners rarely if ever consider this criterion)	Comments (optional)
Availability of experienced contractors	Extent of owner's pool of contractors from which to receive offers		X					
Flexibility of owner's requirements	very narrow specification allowing for little or no contractor flexibility vs. ability to use widely flexible performance specification		X					
Need for owner involvement during process	Extent to which owner must be involved in design review, specification creation or enforcement, etc.	X						
Owner's experience	owner's experience with similar projects			X				
Owner's in-house technical capability	owner's ability to act as design engineer or answer technical questions during construction			X				
Owner's willingness to accept risk				X				
Presence of known site factors that may cause problems			X					
Project completion within original budget		X						
Project completion within original schedule			X					
Project size	owner's ability to manage contract via single/multiple contract(s)		X					
Project type	new technology or innovative vs. well understood or proven scope		X					
Speed to deliver project	Necessity to meet delivery date due to outside constraint vs. ability for schedule to slip		X					
Sustainability of structure	whether sustainable or other "green" building techniques are to be implemented		X					

Please add any additional criteria as necessary	Please include as detailed description as possible	Extremely Important	Very Important	Somewhat Important	Somewhat Unimportant	Not Very Important	Not at all Important	Comments (optional)

This survey is attempting to gather data on those criteria which owners should consider when choosing a particular procurement method, specifically Design-Build or Design-Bid-Build. The criteria are not intended to be biased toward any particular method.

Instructions:

The survey below contains a list of 13 criteria to be considered in varying degrees when determining the procurement method of choice. Please score each criteria on the degree of importance which owners must determine thier positions on prior to procuring a project via Design-Build or Design-Bid-Build. There should be only one mark in each row, corresponding with the degree of importance for that criterion. If applicable, a more detailed description for the criterion name is provided. For each criterion, if you have specific comments explaining or amplifying your mark, please include them under the comment block. If you feel an important criterion was not listed, please add it, provide a further description as necessary, and score it accordingly.

For example: If it is perceived that owners ought to consider the degree to which contractors exist in the marketplace who are competent to complete their project each and every time they procure a new project, a mark should be placed under "extremely important" for that criterion.

Expert #5

Importance for Consideration when Deciding Procurement Method

Criterion	Further criteria description	Extremely Important (owners should consider this criterion every time)	Very Important (owners should consider this criterion most times)	Somewhat Important (owners should consider this criterion occasionally)	Somewhat Unimportant (owners may or may not consider this criterion without expected effect)	Not Very Important (owners seldom consider this criterion or only for specifically unique projects)	Not at all Important (owners rarely if ever consider this criterion)	Comments (optional)
Availability of experienced contractors	Extent of owner's pool of contractors from which to receive offers		X					
Flexibility of owner's requirements	very narrow specification allowing for little or no contractor flexibility vs. ability to use widely flexible performance specification		X					
Need for owner involvement during process	Extent to which owner must be involved in design review, specification creation or enforcement, etc.	X						
Owner's experience	owner's experience with similar projects			X				
Owner's in-house technical capability	owner's ability to act as design engineer or answer technical questions during construction	X						
Owner's willingness to accept risk			X					
Presence of known site factors that may cause problems		X						
Project completion within original budget		X						
Project completion within original schedule			X					
Project size	owner's ability to manage contract via single/multiple contract(s)			X				
Project type	new technology or innovative vs. well understood or proven scope	X						
Speed to deliver project	Necessity to meet delivery date due to outside constraint vs. ability for schedule to slip		X					
Sustainability of structure	whether sustainable or other "green" building techniques are to be implemented	X						

Please add any additional criteria as necessary	Please include as detailed description as possible	Extremely Important	Very Important	Somewhat Important	Somewhat Unimportant	Not Very Important	Not at all Important	Comments (optional)

Expert #1

Procurement Survey #2
There are 2 tabs for this survey. Please be sure to complete both tabs.

Part 1

Criteria Weights

Instructions:

For part 1 of this survey, please assign weights to each criterion indicating their relative importance when used in deciding which procurement method to select. The more important a criterion is to the selection process, the higher weight it should receive. The weights should be entered as a decimal and will appear as a percentage. Any breakdown is acceptable, provided the weights sum to 100%. This is intended to be *general characterization of importance* under most situations. While it is understood that these weights may vary somewhat depending on the uniqueness of each project, please annotate only one number for each criterion.

Criterion	Weight
Availability of experienced contractors	5%
Flexibility of owner's requirements	5%
Need for owner involvement during process	10%
Owner's experience	1%
Owner's in-house technical capability	2%
Owner's willingness to accept risk	5%
Presence of known site factors that may cause problems	10%
Project completion within original budget	5%
Project completion within original schedule	15%
Project size	20%
Project type	5%
Speed to deliver projec	15%
Sustainability of structure	2%
	100%

*** Please proceed to the second tab labeled "Project Scoring".

Expert #1

Part 2

Project Scoring

Instructions:
For Part 2, please select 3 projects from your installation of substantial size and scope. These need not be at the MILCON level, but should be significant enough to warrant detailed consideration of procurement method prior to solicitation. Indicate their names below. There is no need for a technical name or MILCON number; cells will populate with this name to assist you in scoring the criteria. Under General Description, please provide a simple description of the project (i.e. construct 3 floor barracks, rehab pier decking, etc). Place a single mark each for size of project and actual procurement method used. Finally, please indicate the general outcome of the project and how satisfied you were as an owner (i.e. project finsihed ahead of sched, contractor defaulted, frequent communication problems between KTR and A/E firm, etc). Projects may (and are encouraged to be) from both delivery systems.

			Project Size						Procurement		
Project #	Project Name	General Description	< $50 K	$50 K - $100 K	$100 K - $500 K	$500 K - $1 M	$1 M - $5 M	> $5 M	Design-Build	Design-Bid-Build	General project performance comments
Example	Barracks 3 Rehab	Renovate interior of 4-ft barracks to include drywall, paint, carpet, and mechanical ductwork		X					X		Good comminication, KTR worked fast, finished early, diff site cond resolved easily.
1	Renovate Ford Island utilties	Complete replacement of the utility distribution system.						X	X		Expensive delivery method but very flexible. Contractor was selected based on experience and that experience made the contract go smoothly.
2	Reuse Marine Barracks Bldg for Reserve Center	Renovation of 15K SF WWII era structure.					X			X	Typical renovation problems. Slowed down the process having to deal with contract changes driven by design flaws.
3	Construct Admin Bldg	Procure 55K SF admin building via Enhanced Use Lease process.	X						X		Exceptionally simple acquisition method. The developer builds to suit with the Navy one of many tenants in the complex. Developer's profits pay for Navy facility.

Instructions:

Each criterion is listed on the far left. For each, a scale ranging from 0 to 10 is present along with a description of both extremes. Please place an X corresponding to the point on the scale that represents your position prior to procuring that particular project. There should be only one mark per row, corresponding to each project. Multiple projects within one criterion may receive the same score. For example, if the Barracks 3 project had a highly specific spec with little tolerance for variation, a mark might be placed under "1" for the criterion "Flexibility of owner's requirements". Likewise, if it was performance based allowing the KTR to make suggestions, a mark might be placed under "8".

Criterion

Availability of experienced contractors	Very limited competitive environment	0	1	2	3	4	5	6	7	8	9	10	Several contractors available in market
Renovate Ford Island utilties				X									
Reuse Marine Barracks Bldg for Reserve Center												X	
Construct Admin Bldg									X				

Flexibility of owner's requirements	Highly specific, narrow spec.	0	1	2	3	4	5	6	7	8	9	10	Widely performance spec acceptable
Renovate Ford Island utilties											X		
Reuse Marine Barracks Bldg for Reserve Center								X					
Construct Admin Bldg												X	

Need for owner involvement during process	Thorough, frequent involvment	0	1	2	3	4	5	6	7	8	9	10	Limited involvement
Renovate Ford Island utilties				X									
Reuse Marine Barracks Bldg for Reserve Center											X		
Construct Admin Bldg						X							

Owner's experience	Very limited experience	0	1	2	3	4	5	6	7	8	9	10	Extensive experience
Renovate Ford Island utilties				X									
Reuse Marine Barracks Bldg for Reserve Center						X							
Construct Admin Bldg					X								

Owner's in-house technical capability	Extensive technical ability	0	1	2	3	4	5	6	7	8	9	10	Very limited technical ability
Renovate Ford Island utilties											X		
Reuse Marine Barracks Bldg for Reserve Center									X				
Construct Admin Bldg										X			

Owner's willingness to accept risk	Aggressively speculative	0	1	2	3	4	5	6	7	8	9	10	Very conservative
Renovate Ford Island utilties												X	
Reuse Marine Barracks Bldg for Reserve Center										X			
Construct Admin Bldg				X									

Presence of known site factors that may cause problems	High certainty of no problems	0	1	2	3	4	5	6	7	8	9	10	High certainty of problems
Renovate Ford Island utilties												X	
Reuse Marine Barracks Bldg for Reserve Center											X		
Construct Admin Bldg							X						

Project completion within original budget	Substantial contingency funds available	0	1	2	3	4	5	6	7	8	9	10	Limited budget with no contingency
Renovate Ford Island utilties				X									
Reuse Marine Barracks Bldg for Reserve Center											X		
Construct Admin Bldg							X						

Project completion within original schedule	Project schedule highly negotiable	0	1	2	3	4	5	6	7	8	9	10	Project schedule firm
Renovate Ford Island utilties				X									
Reuse Marine Barracks Bldg for Reserve Center											X		
Construct Admin Bldg										X			

Project size	Easily managed with multiple contracts	0	1	2	3	4	5	6	7	8	9	10	Too large or cumbersome to manage with multiple contracts
Renovate Ford Island utilties												X	
Reuse Marine Barracks Bldg for Reserve Center										X			
Construct Admin Bldg					X								

Project type	Specific, understood by owner, particular result necessary	0	1	2	3	4	5	6	7	8	9	10	Innovative, unique
Renovate Ford Island utilties				X									
Reuse Marine Barracks Bldg for Reserve Center								X					
Construct Admin Bldg												X	

Speed to deliver project	Outside time constraints not present or not important	0	1	2	3	4	5	6	7	8	9	10	Outside time constraints present and highly influential of project success
Renovate Ford Island utilties									X				
Reuse Marine Barracks Bldg for Reserve Center											X		
Construct Admin Bldg										X			

Sustainability of structure	Sustainability not important	0	1	2	3	4	5	6	7	8	9	10	Sustainability highly importan
Renovate Ford Island utilties												X	
Reuse Marine Barracks Bldg for Reserve Center						X							
Construct Admin Bldg					X								

Expert #2

Procurement Survey #2
There are 2 tabs for this survey. Please be sure to complete both tabs.

Part 1

Criteria Weights

Instructions:

For part 1 of this survey, please assign weights to each criterion indicating their relative importance when used in deciding which procurement method to select. The more important a criterion is to the selection process, the higher weight it should receive. The weights should be entered as a decimal and will appear as a percentage. Any breakdown is acceptable, provided the weights sum to 100%. This is intended to be *general characterization of importance* under most situations. While it is understood that these weights may vary somewhat depending on the uniqueness of each project, please annotate only one number for each criterion.

Criterion	Weight
Availability of experienced contractors	30%
Flexibility of owner's requirements	5%
Need for owner involvement during process	5%
Owner's experience	5%
Owner's in-house technical capability	5%
Owner's willingness to accept risk	5%
Presence of known site factors that may cause problems	5%
Project completion within original budget	10%
Project completion within original schedule	10%
Project size	5%
Project type	5%
Speed to deliver projec	10%
Sustainability of structure	0%
	100%

*** Please proceed to the second tab labeled "Project Scoring".

Expert #2

Part 2

Project Scoring

Instructions:
For Part 2, please select 3 projects from your installation of substantial size and scope. These need not be at the MILCON level, but should be significant enough to warrant detailed consideration of procurement method prior to solicitation. Indicate their names below. There is no need for a technical name or MILCON number; cells will populate with this name to assist you in scoring the criteria. Under General Description, please provide a simple description of the project (i.e. construct 3 floor barracks, rehab pier decking, etc). Place a single mark each for size of project and actual procurement method used. Finally, please indicate the general outcome of the project and how satisfied you were as an owner (i.e. project finsihed ahead of sched, contractor defaulted, frequent communication problems between KTR and A/E firm, etc). Projects may (and are encouraged to be) from both delivery systems.

			Project Size						Procurement Method		
Project #	Project Name	General Description	< $50 K	$50 K - $100 K	$100 K - $500 K	$500 K - $1 M	$1 M - $5 M	> $5 M	Design-Build	Design-Bid-Build	General project performance comments
Example	Barracks 3 Rehab	Renovate interior of 4-fl barracks to include drywall, paint, carpet, and mechanical ductwork		X					X		Good comminication, KTR worked fast, finished early, diff site cond resolved easily.
1	K10/11	Renovate wharfs to include new piles, repair concrete spalls on deck, and construct new supply						X	X		Completed ahead of schedule and underbudget
2	K12	soil to support future loads including parking						X		X	Project onhold as there are design problems and potential differing site claim
3	Smallwood hall boiler	Replace existing boiler with new boiler and solar panels					X		X		Project completed successfully however, operational problems developed due to design omissions

Instructions:

Each criterion is listed on the far left. For each, a scale ranging from 0 to 10 is present along with a description of both extremes. Please place an X corresponding to the point on the scale that represents your position prior to procuring that particular project. There should be only one mark per row, corresponding to each project. Multiple projects within one criterion may receive the same score. For example, if the Barracks 3 project had a highly specific spec with little tolerance for variation, a mark might be placed under "1" for the criterion "Flexibility of owner's requirements". Likewise, if it was performance based allowing the KTR to make suggestions, a mark might be placed under "8".

Criterion

Availability of experienced contractors	Very limited competitive environment	0	1	2	3	4	5	6	7	8	9	10	Several contractors available in market
K10/11										X			
K12					X								
Smallwood hall boiler												X	

Flexibility of owner's requirements	Highly specific, narrow spec.	0	1	2	3	4	5	6	7	8	9	10	Widely performance spec acceptable
K10/11									X				
K12									X				
Smallwood hall boiler										X			

Need for owner involvement during process	Thorough, frequent involvment	0	1	2	3	4	5	6	7	8	9	10	Limited involvement
K10/11											X		
K12											X		
Smallwood hall boiler											X		

Owner's experience	Very limited experience	0	1	2	3	4	5	6	7	8	9	10	Extensive experience
K10/11				X									
K12				X									
Smallwood hall boiler					X								

Owner's in-house technical capability	Extensive technical ability	0	1	2	3	4	5	6	7	8	9	10	Very limited technical ability
K10/11								X					
K12								X					
Smallwood hall boiler								X					

Owner's willingness to accept risk	Aggressively speculative	0	1	2	3	4	5	6	7	8	9	10	Very conservative
K10/11											X		
K12					X								
Smallwood hall boiler											X		

Presence of known site factors that may cause problems	High certainty of no problems	0	1	2	3	4	5	6	7	8	9	10	High certainty of problems
K10/11					X								
K12										X			
Smallwood hall boiler						X							

Project completion within original budget	Substantial contingency funds available	0	1	2	3	4	5	6	7	8	9	10	Limited budget with no contingency
K10/11					X								
K12					X								
Smallwood hall boiler					X								

Project completion within original schedule	Project schedule highly negotiable	0	1	2	3	4	5	6	7	8	9	10	Project schedule firm
K10/11							X						
K12				X									
Smallwood hall boiler										X			

Project size	Easily managed with multiple contracts	0	1	2	3	4	5	6	7	8	9	10	Too large or cumbersome to manage with multiple contracts
K10/11										X			
K12										X			
Smallwood hall boiler					X								

Project type	Specific, understood by owner, particular result necessary	0	1	2	3	4	5	6	7	8	9	10	Innovative, unique
K10/11					X								
K12						X							
Smallwood hall boiler					X								

Speed to deliver project	Outside time constraints not present or not important	0	1	2	3	4	5	6	7	8	9	10	Outside time constraints present and highly influential of project success
K10/11										X			
K12					X								
Smallwood hall boiler										X			

Sustainability of structure	Sustainability not important	0	1	2	3	4	5	6	7	8	9	10	Sustainability highly important
K10/11									X				
K12									X				
Smallwood hall boiler										X			

Expert #3

Procurement Survey #2
There are 2 tabs for this survey. Please be sure to complete both tabs.

Part 1

Criteria Weights

Instructions:

For part 1 of this survey, please assign weights to each criterion indicating their relative importance when used in deciding which procurement method to select. The more important a criterion is to the selection process, the higher weight it should receive. The weights should be entered as a decimal and will appear as a percentage. Any breakdown is acceptable, provided the weights sum to 100%. This is intended to be *general characterization of importance* under most situations. While it is understood that these weights may vary somewhat depending on the uniqueness of each project, please annotate only one number for each criterion.

Criterion	Weight
Availability of experienced contractors	13%
Flexibility of owner's requirements	6%
Need for owner involvement during process	5%
Owner's experience	10%
Owner's in-house technical capability	6%
Owner's willingness to accept risk	10%
Presence of known site factors that may cause problems	5%
Project completion within original budget	12%
Project completion within original schedule	12%
Project size	2%
Project type	2%
Speed to deliver projec	7%
Sustainability of structure	10%
	100%

*** Please proceed to the second tab labeled "Project Scoring".

Expert #3

Part 2

Project Scoring

Instructions:
For Part 2, please select 3 projects from your installation of substantial size and scope. These need not be at the MILCON level, but should be significant enough to warrant detailed consideration of procurement method prior to solicitation. Indicate their names below. There is no need for a technical name or MILCON number; cells will populate with this name to assist you in scoring the criteria. Under General Description, please provide a simple description of the project (i.e. construct 3 floor barracks, rehab pier decking, etc). Place a single mark each for size of project and actual procurement method used. Finally, please indicate the general outcome of the project and how satisfied you were as an owner (i.e. project finsihed ahead of sched, contractor defaulted, frequent communication problems between KTR and A/E firm, etc). Projects may (and are encouraged to be) from both delivery systems.

			Project Size						Procurement Method		
Project #	Project Name	General Description	< $50 K	$50 K - $100 K	$100 K - $500 K	$500 K - $1 M	$1 M - $5 M	> $5 M	Design-Build	Design-Bid-Build	General project performance comments
Example	Barracks 3 Rehab	Renovate interior of 4-fl barracks to include drywall, paint, carpet, and mechanical ductwork		X					X		Good comminication, KTR worked fast, finished early, diff site cond resolved easily.
1	Armory Repairs	Replace bullet trap, rpr mech sys, abate lead dust				X			X		8A contractor got off to a slow start and finished late. Still exceeds lead standards
2	Reserve Center Rehab	Renovate multi story Reserve Center. Mech, elec,paint, carpet					X			X	Project at remote location. Problems with communication between A/E and contractor. Many change orders.
3	Constr Post Off	Convert warehouse space to Post Office. Mech. Elec, drywall			X				X		KTR was efficient, fast, produced quality work. Finished ahead of sched with few ch. orders

Instructions:

Each criterion is listed on the far left. For each, a scale ranging from 0 to 10 is present along with a description of both extremes. Please place an X corresponding to the point on the scale that represents your position prior to procuring that particular project. There should be only one mark per row, corresponding to each project. Multiple projects within one criterion may receive the same score. For example, if the Barracks 3 project had a highly specific spec with little tolerance for variation, a mark might be placed under "1" for the criterion "Flexibility of owner's requirements". Likewise, if it was performance based allowing the KTR to make suggestions, a mark might be placed under "8".

Criterion

Availability of experienced contractors	Very limited competitive environment	0	1	2	3	4	5	6	7	8	9	10	Several contractors available in market
Armory Repairs			X										
Reserve Center Rehab										X			
Constr Post Off											X		

Flexibility of owner's requirements	Highly specific, narrow spec.	0	1	2	3	4	5	6	7	8	9	10	Widely performance spec acceptable
Armory Repairs					X								
Reserve Center Rehab			X										
Constr Post Off										X			

Need for owner involvement during process	Thorough, frequent involvment	0	1	2	3	4	5	6	7	8	9	10	Limited involvement
Armory Repairs			X										
Reserve Center Rehab					X								
Constr Post Off							X						

Owner's experience	Very limited experience	0	1	2	3	4	5	6	7	8	9	10	Extensive experience
Armory Repairs										X			
Reserve Center Rehab											X		
Constr Post Off											X		

Owner's in-house technical capability	Extensive technical ability	0	1	2	3	4	5	6	7	8	9	10	Very limited technical ability
Armory Repairs			X										
Reserve Center Rehab					X								
Constr Post Off				X									

Owner's willingness to accept risk	Aggressively speculative	0	1	2	3	4	5	6	7	8	9	10	Very conservative
Armory Repairs			X										
Reserve Center Rehab			X										
Constr Post Off			X										

Presence of known site factors that may cause problems	High certainty of no problems	0	1	2	3	4	5	6	7	8	9	10	High certainty of problems
Armory Repairs			X										
Reserve Center Rehab				X									
Constr Post Off				X									

Project completion within original budget	Substantial contingency funds available	0	1	2	3	4	5	6	7	8	9	10	Limited budget with no contingency
Armory Repairs												X	
Reserve Center Rehab											X		
Constr Post Off										X			

Project completion within original schedule	Project schedule highly negotiable	0	1	2	3	4	5	6	7	8	9	10	Project schedule firm
Armory Repairs												X	
Reserve Center Rehab										X			
Constr Post Off									X				

Project size	Easily managed with multiple contracts	0	1	2	3	4	5	6	7	8	9	10	Too large or cumbersome to manage with multiple contracts
Armory Repairs			X										
Reserve Center Rehab			X										
Constr Post Off			X										

Project type	Specific, understood by owner, particular result necessary	0	1	2	3	4	5	6	7	8	9	10	Innovative, unique
Armory Repairs			X										
Reserve Center Rehab			X										
Constr Post Off			X										

Speed to deliver project	Outside time constraints not present or not important	0	1	2	3	4	5	6	7	8	9	10	Outside time constraints present and highly influential of project success
Armory Repairs												X	
Reserve Center Rehab									X				
Constr Post Off										X			

Sustainability of structure	Sustainability not important	0	1	2	3	4	5	6	7	8	9	10	Sustainability highly important
Armory Repairs												X	
Reserve Center Rehab										X			
Constr Post Off										X			

Expert #4

Procurement Survey #2
There are 2 tabs for this survey. Please be sure to complete both tabs.

Part 1

Criteria Weights

Instructions:

For part 1 of this survey, please assign weights to each criterion indicating their relative importance when used in deciding which procurement method to select. The more important a criterion is to the selection process, the higher weight it should receive. The weights should be entered as a decimal and will appear as a percentage. Any breakdown is acceptable, provided the weights sum to 100%. This is intended to be *general characterization of importance* under most situations. While it is understood that these weights may vary somewhat depending on the uniqueness of each project, please annotate only one number for each criterion.

Criterion	Weight
Availability of experienced contractors	5%
Flexibility of owner's requirements	0%
Need for owner involvement during process	0%
Owner's experience	10%
Owner's in-house technical capability	10%
Owner's willingness to accept risk	0%
Presence of known site factors that may cause problems	0%
Project completion within original budget	30%
Project completion within original schedule	15%
Project size	5%
Project type	0%
Speed to deliver projec	5%
Sustainability of structure	20%
	100%

*** Please proceed to the second tab labeled "Project Scoring".

Expert #4

Part 2

Project Scoring

Instructions:
For Part 2, please select 3 projects from your installation of substantial size and scope. These need not be at the MILCON level, but should be significant enough to warrant detailed consideration of procurement method prior to solicitation. Indicate their names below. There is no need for a technical name or MILCON number; cells will populate with this name to assist you in scoring the criteria. Under General Description, please provide a simple description of the project (i.e. construct 3 floor barracks, rehab pier decking, etc). Place a single mark each for size of project and actual procurement method used. Finally, please indicate the general outcome of the project and how satisfied you were as an owner (i.e. project finsihed ahead of sched, contractor defaulted, frequent communication problems between KTR and A/E firm, etc). Projects may (and are encouraged to be) from both delivery systems.

			Project Size						Procurement Method		
Project #	Project Name	General Description	< $50 K	$50 K - $100 K	$100 K - $500 K	$500 K - $1 M	$1 M - $5 M	> $5 M	Design-Build	Design-Bid-Build	General project performance comments
Example	Barracks 3 Rehab	Renovate interior of 4-fl barracks to include drywall, paint, carpet, and mechanical ductwork		X					X		Good comminication, KTR worked fast, finished early, diff site cond resolved easily.
1	Install 4.7 million gallon fuel tank	Install above ground fuel tank for jet fuel, including containment.					X			X	Good contractor, finished on time with minmal changes and problems
2	Corrosion Control Hangar	Hangar will be able to house two planes at once. Environmental controls.						X	X		Construction went well, some design issues.
3	JUAV Admin Building	7400 SF general admin beuiding					X		X		Design and construction went well on very tigh budget and timeline.

Instructions:

Each criterion is listed on the far left. For each, a scale ranging from 0 to 10 is present along with a description of both extremes. Please place an X corresponding to the point on the scale that represents your position prior to procuring that particular project. There should be only one mark per row, corresponding to each project. Multiple projects within one criterion may receive the same score. For example, if the Barracks 3 project had a highly specific spec with little tolerance for variation, a mark might be placed under "1" for the criterion "Flexibility of owner's requirements". Likewise, if it was performance based allowing the KTR to make suggestions, a mark might be placed under "8".

Criterion

Availability of experienced contractors	Very limited competitive environment	0	1	2	3	4	5	6	7	8	9	10	Several contractors available in market
Install 4.7 million gallon fuel tank						X							
Corrosion Control Hangar					X								
JUAV Admin Building											X		

Flexibility of owner's requirements	Highly specific, narrow spec.	0	1	2	3	4	5	6	7	8	9	10	Widely performance spec acceptable
Install 4.7 million gallon fuel tank						X							
Corrosion Control Hangar			X										
JUAV Admin Building										X			

Need for owner involvement during process	Thorough, frequent involvment	0	1	2	3	4	5	6	7	8	9	10	Limited involvement
Install 4.7 million gallon fuel tank											X		
Corrosion Control Hangar					X								
JUAV Admin Building											X		

Owner's experience	Very limited experience	0	1	2	3	4	5	6	7	8	9	10	Extensive experience
Install 4.7 million gallon fuel tank											X		
Corrosion Control Hangar							X						
JUAV Admin Building											X		

Owner's in-house technical capability	Extensive technical ability	0	1	2	3	4	5	6	7	8	9	10	Very limited technical ability
Install 4.7 million gallon fuel tank										X			
Corrosion Control Hangar				X									
JUAV Admin Building											X		

Owner's willingness to accept risk	Aggressively speculative	0	1	2	3	4	5	6	7	8	9	10	Very conservative
Install 4.7 million gallon fuel tank							X						
Corrosion Control Hangar										X			
JUAV Admin Building							X						

Presence of known site factors that may cause problems	High certainty of no problems	0	1	2	3	4	5	6	7	8	9	10	High certainty of problems
Install 4.7 million gallon fuel tank													
Corrosion Control Hangar													
JUAV Admin Building													

Project completion within original budget	Substantial contingency funds available	0	1	2	3	4	5	6	7	8	9	10	Limited budget with no contingency
Install 4.7 million gallon fuel tank					X								
Corrosion Control Hangar										X			
JUAV Admin Building												X	

Project completion within original schedule	Project schedule highly negotiable	0	1	2	3	4	5	6	7	8	9	10	Project schedule firm
Install 4.7 million gallon fuel tank									X				
Corrosion Control Hangar									X				
JUAV Admin Building											X		

Project size	Easily managed with multiple contracts	0	1	2	3	4	5	6	7	8	9	10	Too large or cumbersome to manage with multiple contracts
Install 4.7 million gallon fuel tank			X										
Corrosion Control Hangar									X				
JUAV Admin Building						X							

Project type	Specific, understood by owner, particular result necessary	0	1	2	3	4	5	6	7	8	9	10	Innovative, unique
Install 4.7 million gallon fuel tank		X											
Corrosion Control Hangar										X			
JUAV Admin Building		X											

Speed to deliver project	Outside time constraints not present or not important	0	1	2	3	4	5	6	7	8	9	10	Outside time constraints present and highly influential of project success
Install 4.7 million gallon fuel tank								X					
Corrosion Control Hangar								X					
JUAV Admin Building												X	

Sustainability of structure	Sustainability not important	0	1	2	3	4	5	6	7	8	9	10	Sustainability highly important
Install 4.7 million gallon fuel tank												X	
Corrosion Control Hangar												X	
JUAV Admin Building												X	

Expert #5

Procurement Survey #2

There are 2 tabs for this survey. Please be sure to complete both tabs.

Part 1

Criteria Weights

Instructions:

For part 1 of this survey, please assign weights to each criterion indicating their relative importance when used in deciding which procurement method to select. The more important a criterion is to the selection process, the higher weight it should receive. The weights should be entered as a decimal and will appear as a percentage. Any breakdown is acceptable, provided the weights sum to 100%. This is intended to be a *general characterization of importance* under most situations. While it is understood that these weights may vary somewhat depending on the uniqueness of each project, please annotate only one number for each criterion.

Criterion	Weight
Availability of experienced contractors	10%
Flexibility of owner's requirements	5%
Need for owner involvement during process	10%
Owner's experience	5%
Owner's in-house technical capability	10%
Owner's willingness to accept risk	5%
Presence of known site factors that may cause problems	5%
Project completion within original budget	15%
Project completion within original schedule	5%
Project size	5%
Project type	
Speed to deliver project	5%
Sustainability of structure	20%
	100%

*** Please proceed to the second tab labeled "Project Scoring".

Expert #5

Part 2

Project Scoring

Instructions:

For Part 2, please select 3 projects from your installation of substantial size and scope. These need not be at the MILCON level, but should be significant enough to warrant detailed consideration of procurement method prior to solicitation. Indicate their names below. There is no need for a technical name or MILCON number; cells will populate with this name to assist you in scoring the criteria. Under General Description, please provide a simple description of the project (i.e. construct 3 floor barracks, rehab pier decking, etc). Place a single mark each for size of project and actual procurement method used. Finally, please indicate the general outcome of the project and how satisfied you were as an owner (i.e. project finsihed ahead of sched, contractor defaulted, frequent communication problems between KTR and A/E firm, etc). Projects may (and are encouraged to be) from both delivery systems.

			Project Size						Procurement Method		
Project #	Project Name	General Description	< $50 K	$50 K - $100 K	$100 K - $500 K	$500 K - $1 M	$1 M - $5 M	> $5 M	Design-Build	Design-Bid-Build	General project performance comments
Example	Barracks 3 Rehab	Renovate interior of 4-fl barracks to include drywall, paint, carpet, and mechanical ductwork		X					X		Good comminication, KTR worked fast, finished early, diff site cond resolved easily.
1	Paving Repairs, Station Roads	Grind and 2" overlay					X			X	
2	Hangar 1 Repairs						X			X	
3	Aifield Lighting Rep						X			X	

Instructions:

Each criterion is listed on the far left. For each, a scale ranging from 0 to 10 is present along with a description of both extremes. Please place an X corresponding to the point on the scale that represents your position prior to procuring that particular project. There should be only one mark per row, corresponding to each project. Multiple projects within one criterion may receive the same score. For example, if the Barracks 3 project had a highly specific spec with little tolerance for variation, a mark might be placed under "1" for the criterion "Flexibility of owner's requirements". Likewise, if it was performance based allowing the KTR to make suggestions, a mark might be placed under "8".

Criterion

Availability of experienced contractors	Very limited competitive environment	0	1	2	3	4	5	6	7	8	9	10	Several contractors available in market
Paving Repairs, Station Roads			X										
Hangar 1 Repairs					X								
Aifield Lighting Rep				X									

Flexibility of owner's requirements	Highly specific, narrow spec.	0	1	2	3	4	5	6	7	8	9	10	Widely performance spec acceptable
Paving Repairs, Station Roads			X										
Hangar 1 Repairs			X										
Aifield Lighting Rep			X										

Need for owner involvement during process	Thorough, frequent involvment	0	1	2	3	4	5	6	7	8	9	10	Limited involvement
Paving Repairs, Station Roads			X										
Hangar 1 Repairs			X										
Aifield Lighting Rep			X										

Owner's experience	Very limited experience	0	1	2	3	4	5	6	7	8	9	10	Extensive experience
Paving Repairs, Station Roads			X										
Hangar 1 Repairs					X								
Aifield Lighting Rep						X							

Owner's in-house technical capability	Extensive technical ability	0	1	2	3	4	5	6	7	8	9	10	Very limited technical ability
Paving Repairs, Station Roads			X										
Hangar 1 Repairs						X							
Aifield Lighting Rep						X							

Owner's willingness to accept risk	Aggressively speculative	0	1	2	3	4	5	6	7	8	9	10	Very conservative
Paving Repairs, Station Roads							X						
Hangar 1 Repairs					X								
Aifield Lighting Rep					X								

Presence of known site factors that may cause problems	High certainty of no problems	0	1	2	3	4	5	6	7	8	9	10	High certainty of problems
Paving Repairs, Station Roads									X				
Hangar 1 Repairs						X							
Aifield Lighting Rep					X								

Project completion within original budget	Substantial contingency funds available	0	1	2	3	4	5	6	7	8	9	10	Limited budget with no contingency
Paving Repairs, Station Roads			X										
Hangar 1 Repairs			X										
Aifield Lighting Rep			X										

Project completion within original schedule	Project schedule highly negotiable	0	1	2	3	4	5	6	7	8	9	10	Project schedule firm
Paving Repairs, Station Roads					X								
Hangar 1 Repairs				X									
Aifield Lighting Rep					X								

Project size	Easily managed with multiple contracts	0	1	2	3	4	5	6	7	8	9	10	Too large or cumbersome to manage with multiple contracts
Paving Repairs, Station Roads			X										
Hangar 1 Repairs								X					
Aifield Lighting Rep									X				

Project type	Specific, understood by owner, particular result necessary	0	1	2	3	4	5	6	7	8	9	10	Innovative, unique
Paving Repairs, Station Roads				X									
Hangar 1 Repairs						X							
Aifield Lighting Rep							X						

Speed to deliver project	Outside time constraints not present or not important	0	1	2	3	4	5	6	7	8	9	10	Outside time constraints present and highly influential of project success
Paving Repairs, Station Roads					X								
Hangar 1 Repairs					X								
Aifield Lighting Rep					X								

Sustainability of structure	Sustainability not important	0	1	2	3	4	5	6	7	8	9	10	Sustainability highly important
Paving Repairs, Station Roads			X										
Hangar 1 Repairs			X										
Aifield Lighting Rep			X										

Y

	Criterion	Expert 1			Expert 2			Expert 3			Expert 4			Expert 5			Low	Std Dev	High	Std Dev	Slope	Y-Int
1	Availability of experienced contractors	2	7	10	3	8	10	1	8	9	3	4	9	1	2	3	2.00	1.00	8.20	2.95	0.161	-0.323
2	Flexibility of owner's requirements	6	9	10	7	7	8	1	3	8	1	4	8	1	1	1	3.20	3.03	7.00	3.46	0.263	-0.842
3	Need for owner involvement during process	2	4	9	9	9	9	1	3	5	3	9	9	1	1	1	3.20	3.35	6.60	3.58	0.294	-0.941
4	Owner's expenence	2	3	4	2	2	3	8	9	9	5	9	9	1	3	4	3.60	2.88	5.80	2.95	0.455	-1.636
5	Owner's in-house technical capability	7	8	9	6	6	6	1	2	3	2	8	9	1	4	4	3.40	2.88	6.20	2.77	0.357	-1.214
6	Owner's willingness to accept risk	2	8	10	3	9	9	1	1	1	5	5	8	3	3	5	2.80	1.48	6.60	3.65	0.263	-0.737
7	Presence of known site factors that may cause problems	5	9	10	3	4	8	1	2	2	2	3	7	3	4	7	2.80	1.48	6.80	2.95	0.250	-0.700
8	Project completion within original budget	2	5	9	3	3	3	8	9	10	3	8	10	1	1	1	3.40	2.70	6.60	4.28	0.313	-1.063
9	Project completion within original schedule	2	8	9	2	5	8	7	8	10	7	7	9	2	3	3	4.00	2.74	7.80	2.77	0.263	-1.053
10	Project size	3	8	10	3	8	8	1	1	1	1	4	7	1	6	7	1.80	1.10	6.60	3.36	0.208	-0.375
11	Project type	2	6	10	3	3	4	1	1	1	0	0	8	2	4	5	1.60	1.14	5.60	3.51	0.250	-0.400
12	Speed to deliver project	7	8	9	3	8	8	7	8	10	3	8	10	3	3	3	4.60	2.19	8.00	2.92	0.294	-1.353
13	Sustainability of structure	3	4	10	7	7	8	8	8	10	10	10	10	1	1	1	5.80	3.70	7.80	3.90	0.500	-2.900

W

Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Average	Std Dev
5%	30%	13%	5%	10%	12.6%	0.103
5%	5%	6%	0%	5%	4.2%	0.024
10%	5%	5%	0%	10%	6.0%	0.042
1%	5%	10%	10%	5%	6.2%	0.038
2%	5%	6%	10%	10%	6.6%	0.034
5%	5%	10%	0%	5%	5.0%	0.035
10%	5%	5%	0%	5%	5.0%	0.035
5%	10%	12%	30%	15%	14.4%	0.094
15%	10%	12%	15%	5%	11.4%	0.042
20%	5%	2%	5%	5%	7.4%	0.072
5%	5%	2%	0%	0%	2.4%	0.025
15%	10%	7%	5%	5%	8.4%	0.042
2%	0%	10%	20%	20%	10.4%	0.095
100%	100%	100%	100%	100%		

Utility Function

$U_i = \text{slope}_i \times y_i + \text{y-int}_i$

U_1	=	0.161	x	y_1	+	-0.323
U_2	=	0.263	x	y_2	+	-0.842
U_3	=	0.294	x	y_3	+	-0.941
U_4	=	0.455	x	y_4	+	-1.636
U_5	=	0.357	x	y_5	+	-1.214
U_6	=	0.263	x	y_6	+	-0.737
U_7	=	0.250	x	y_7	+	-0.700
U_8	=	0.313	x	y_8	+	-1.063
U_9	=	0.263	x	y_9	+	-1.053
U_{10}	=	0.208	x	y_{10}	+	-0.375
U_{11}	=	0.250	x	y_{11}	+	-0.400
U_{12}	=	0.294	x	y_{12}	+	-1.353
U_{13}	=	0.500	x	y_{13}	+	-2.900

Criteria U value

$U_i = w_i \times y_i \times u_i$

U_1	=	0.126	x	y_1	x u_1
U_2	=	0.042	x	y_2	x u_2
U_3	=	0.060	x	y_3	x u_3
U_4	=	0.062	x	y_4	x u_4
U_5	=	0.066	x	y_5	x u_5
U_6	=	0.050	x	y_6	x u_6
U_7	=	0.050	x	y_7	x u_7
U_8	=	0.144	x	y_8	x u_8
U_9	=	0.114	x	y_9	x u_9
U_{10}	=	0.074	x	y_{10}	x u_{10}
U_{11}	=	0.024	x	y_{11}	x u_{11}
U_{12}	=	0.084	x	y_{12}	x u_{12}
U_{13}	=	0.104	x	y_{13}	x u_{13}

$U_{Project} = \Sigma U_1 \ldots U_{13}$

$U_{Project1}$	$U_{Project2}$	$U_{Project3}$	$U_{Project4}$	$U_{Project5}$	$U_{Project6}$	$U_{Project7}$	$U_{Project8}$	$U_{Project9}$	$U_{Project10}$	$U_{Project11}$	$U_{Project12}$	$U_{Project13}$	$U_{Project14}$	$U_{Project15}$	U_T
7.10	9.76	4.57	5.20	3.05	6.66	9.10	6.78	6.98	6.82	6.26	13.28	-0.27	-0.08	0.15	**5.69**

Project 1

						y										
u_1	=	0.000	=	0.161	x	2	+	-0.323	U_1	=	0.000	=	0.126	x	2	x	0.000
u_2	=	1.526	=	0.263	x	9	+	-0.842	U_2	=	0.577	=	0.042	x	9	x	1.526
u_3	=	-0.353	=	0.294	x	2	+	-0.941	U_3	=	-0.042	=	0.060	x	2	x	-0.353
u_4	=	-0.727	=	0.455	x	2	+	-1.636	U_4	=	-0.090	=	0.062	x	2	x	-0.727
u_5	=	2.000	=	0.357	x	9	+	-1.214	U_5	=	1.188	=	0.066	x	9	x	2.000
u_6	=	1.895	=	0.263	x	10	+	-0.737	U_6	=	0.947	=	0.050	x	10	x	1.895
u_7	=	1.800	=	0.250	x	10	+	-0.700	U_7	=	0.900	=	0.050	x	10	x	1.800
u_8	=	-0.438	=	0.313	x	2	+	-1.063	U_8	=	-0.126	=	0.144	x	2	x	-0.438
u_9	=	-0.526	=	0.263	x	2	+	-1.053	U_9	=	-0.120	=	0.114	x	2	x	-0.526
u_{10}	=	1.708	=	0.208	x	10	+	-0.375	U_{10}	=	1.264	=	0.074	x	10	x	1.708
u_{11}	=	0.100	=	0.250	x	2	+	-0.400	U_{11}	=	0.005	=	0.024	x	2	x	0.100
u_{12}	=	0.706	=	0.294	x	7	+	-1.353	U_{12}	=	0.415	=	0.084	x	7	x	0.706
u_{13}	=	2.100	=	0.500	x	10	+	-2.900	U_{13}	=	2.184	=	0.104	x	10	x	2.100
									$U_{Project1}$	=	**7.101807**						

Project 2

						y										
u_1	=	1.290	=	0.161	x	10	+	-0.323	U_1	=	1.626	=	0.126	x	10	x	1.290
u_2	=	0.737	=	0.263	x	6	+	-0.842	U_2	=	0.186	=	0.042	x	6	x	0.737
u_3	=	1.706	=	0.294	x	9	+	-0.941	U_3	=	0.921	=	0.060	x	9	x	1.706
u_4	=	0.182	=	0.455	x	4	+	-1.636	U_4	=	0.045	=	0.062	x	4	x	0.182
u_5	=	1.286	=	0.357	x	7	+	-1.214	U_5	=	0.594	=	0.066	x	7	x	1.286
u_6	=	1.368	=	0.263	x	8	+	-0.737	U_6	=	0.547	=	0.050	x	8	x	1.368
u_7	=	1.550	=	0.250	x	9	+	-0.700	U_7	=	0.698	=	0.050	x	9	x	1.550
u_8	=	1.750	=	0.313	x	9	+	-1.063	U_8	=	2.268	=	0.144	x	9	x	1.750
u_9	=	1.316	=	0.263	x	9	+	-1.053	U_9	=	1.350	=	0.114	x	9	x	1.316
u_{10}	=	1.292	=	0.208	x	8	+	-0.375	U_{10}	=	0.765	=	0.074	x	8	x	1.292
u_{11}	=	1.100	=	0.250	x	6	+	-0.400	U_{11}	=	0.158	=	0.024	x	6	x	1.100
u_{12}	=	1.294	=	0.294	x	9	+	-1.353	U_{12}	=	0.978	=	0.084	x	9	x	1.294
u_{13}	=	-0.900	=	0.500	x	4	+	-2.900	U_{13}	=	-0.374	=	0.104	x	4	x	-0.900
									$U_{Project2}$	=	**9.761646**						

Project 3

						y										
u_1	=	0.806	=	0.161	x	7	+	-0.323	U_1	=	0.711	=	0.126	x	7	x	0.806
u_2	=	1.789	=	0.263	x	10	+	-0.842	U_2	=	0.752	=	0.042	x	10	x	1.789
u_3	=	0.235	=	0.294	x	4	+	-0.941	U_3	=	0.056	=	0.060	x	4	x	0.235
u_4	=	-0.273	=	0.455	x	3	+	-1.636	U_4	=	-0.051	=	0.062	x	3	x	-0.273
u_5	=	1.643	=	0.357	x	8	+	-1.214	U_5	=	0.867	=	0.066	x	8	x	1.643
u_6	=	-0.211	=	0.263	x	2	+	-0.737	U_6	=	-0.021	=	0.050	x	2	x	-0.211
u_7	=	0.550	=	0.250	x	5	+	-0.700	U_7	=	0.138	=	0.050	x	5	x	0.550
u_8	=	0.500	=	0.313	x	5	+	-1.063	U_8	=	0.360	=	0.144	x	5	x	0.500
u_9	=	1.053	=	0.263	x	8	+	-1.053	U_9	=	0.960	=	0.114	x	8	x	1.053
u_{10}	=	0.250	=	0.208	x	3	+	-0.375	U_{10}	=	0.056	=	0.074	x	3	x	0.250
u_{11}	=	2.100	=	0.250	x	10	+	-0.400	U_{11}	=	0.504	=	0.024	x	10	x	2.100
u_{12}	=	1.000	=	0.294	x	8	+	-1.353	U_{12}	=	0.672	=	0.084	x	8	x	1.000
u_{13}	=	-1.400	=	0.500	x	3	+	-2.900	U_{13}	=	-0.437	=	0.104	x	3	x	-1.400
									$U_{Project3}$	=	**4.567189**						

Project 4

						y												
u_1	=	0.968	=	0.161	x	8	+	-0.323	U_1	=	0.975	=	0.126	x	8	x	0.968
u_2	=	1.000	=	0.263	x	7	+	-0.842	U_2	=	0.294	=	0.042	x	7	x	1.000
u_3	=	1.706	=	0.294	x	9	+	-0.941	U_3	=	0.921	=	0.060	x	9	x	1.706
u_4	=	-0.727	=	0.455	x	2	+	-1.636	U_4	=	-0.090	=	0.062	x	2	x	-0.727
u_5	=	0.929	=	0.357	x	6	+	-1.214	U_5	=	0.368	=	0.066	x	6	x	0.929
u_6	=	1.632	=	0.263	x	9	+	-0.737	U_6	=	0.734	=	0.050	x	9	x	1.632
u_7	=	0.050	=	0.250	x	3	+	-0.700	U_7	=	0.008	=	0.050	x	3	x	0.050
u_8	=	-0.125	=	0.313	x	3	+	-1.063	U_8	=	-0.054	=	0.144	x	3	x	-0.125
u_9	=	0.263	=	0.263	x	5	+	-1.053	U_9	=	0.150	=	0.114	x	5	x	0.263
u_{10}	=	1.292	=	0.208	x	8	+	-0.375	U_{10}	=	0.765	=	0.074	x	8	x	1.292
u_{11}	=	0.350	=	0.250	x	3	+	-0.400	U_{11}	=	0.025	=	0.024	x	3	x	0.350
u_{12}	=	1.000	=	0.294	x	8	+	-1.353	U_{12}	=	0.672	=	0.084	x	8	x	1.000
u_{13}	=	0.600	=	0.500	x	7	+	-2.900	U_{13}	=	0.437	=	0.104	x	7	x	0.600
									$U_{Project4}$	=	**5.20457**						

Project 5

						y												
u_1	=	0.161	=	0.161	x	3	+	-0.323	U_1	=	0.061	=	0.126	x	3	x	0.161
u_2	=	1.000	=	0.263	x	7	+	-0.842	U_2	=	0.294	=	0.042	x	7	x	1.000
u_3	=	1.706	=	0.294	x	9	+	-0.941	U_3	=	0.921	=	0.060	x	9	x	1.706
u_4	=	-0.727	=	0.455	x	2	+	-1.636	U_4	=	-0.090	=	0.062	x	2	x	-0.727
u_5	=	0.929	=	0.357	x	6	+	-1.214	U_5	=	0.368	=	0.066	x	6	x	0.929
u_6	=	0.053	=	0.263	x	3	+	-0.737	U_6	=	0.008	=	0.050	x	3	x	0.053
u_7	=	1.300	=	0.250	x	8	+	-0.700	U_7	=	0.520	=	0.050	x	8	x	1.300
u_8	=	-0.125	=	0.313	x	3	+	-1.063	U_8	=	-0.054	=	0.144	x	3	x	-0.125
u_9	=	-0.526	=	0.263	x	2	+	-1.053	U_9	=	-0.120	=	0.114	x	2	x	-0.526
u_{10}	=	1.292	=	0.208	x	8	+	-0.375	U_{10}	=	0.765	=	0.074	x	8	x	1.292
u_{11}	=	0.600	=	0.250	x	4	+	-0.400	U_{11}	=	0.058	=	0.024	x	4	x	0.600
u_{12}	=	-0.471	=	0.294	x	3	+	-1.353	U_{12}	=	-0.119	=	0.084	x	3	x	-0.471
u_{13}	=	0.600	=	0.500	x	7	+	-2.900	U_{13}	=	0.437	=	0.104	x	7	x	0.600
									$U_{Project5}$	=	**3.04805**						

Project 6

						y												
u_1	=	1.290	=	0.161	x	10	+	-0.323	U_1	=	1.626	=	0.126	x	10	x	1.290
u_2	=	1.263	=	0.263	x	8	+	-0.842	U_2	=	0.424	=	0.042	x	8	x	1.263
u_3	=	1.706	=	0.294	x	9	+	-0.941	U_3	=	0.921	=	0.060	x	9	x	1.706
u_4	=	-0.273	=	0.455	x	3	+	-1.636	U_4	=	-0.051	=	0.062	x	3	x	-0.273
u_5	=	0.929	=	0.357	x	6	+	-1.214	U_5	=	0.368	=	0.066	x	6	x	0.929
u_6	=	1.632	=	0.263	x	9	+	-0.737	U_6	=	0.734	=	0.050	x	9	x	1.632
u_7	=	0.300	=	0.250	x	4	+	-0.700	U_7	=	0.060	=	0.050	x	4	x	0.300
u_8	=	-0.125	=	0.313	x	3	+	-1.063	U_8	=	-0.054	=	0.144	x	3	x	-0.125
u_9	=	1.053	=	0.263	x	8	+	-1.053	U_9	=	0.960	=	0.114	x	8	x	1.053
u_{10}	=	0.250	=	0.208	x	3	+	-0.375	U_{10}	=	0.056	=	0.074	x	3	x	0.250
u_{11}	=	0.350	=	0.250	x	3	+	-0.400	U_{11}	=	0.025	=	0.024	x	3	x	0.350
u_{12}	=	1.000	=	0.294	x	8	+	-1.353	U_{12}	=	0.672	=	0.084	x	8	x	1.000
u_{13}	=	1.100	=	0.500	x	8	+	-2.900	U_{13}	=	0.915	=	0.104	x	8	x	1.100
									$U_{Project6}$	=	**6.656502**						

Project 7

						y											
u_1	=	-0.161	=	0.161	x	1	+	-0.323	U_1	=	-0.020	=	0.126	x	1	x	-0.161
u_2	=	-0.053	=	0.263	x	3	+	-0.842	U_2	=	-0.007	=	0.042	x	3	x	-0.053
u_3	=	-0.647	=	0.294	x	1	+	-0.941	U_3	=	-0.039	=	0.060	x	1	x	-0.647
u_4	=	2.000	=	0.455	x	8	+	-1.636	U_4	=	0.992	=	0.062	x	8	x	2.000
u_5	=	-0.857	=	0.357	x	1	+	-1.214	U_5	=	-0.057	=	0.066	x	1	x	-0.857
u_6	=	-0.474	=	0.263	x	1	+	-0.737	U_6	=	-0.024	=	0.050	x	1	x	-0.474
u_7	=	-0.450	=	0.250	x	1	+	-0.700	U_7	=	-0.023	=	0.050	x	1	x	-0.450
u_8	=	2.063	=	0.313	x	10	+	-1.063	U_8	=	2.970	=	0.144	x	10	x	2.063
u_9	=	1.579	=	0.263	x	10	+	-1.053	U_9	=	1.800	=	0.114	x	10	x	1.579
u_{10}	=	-0.167	=	0.208	x	1	+	-0.375	U_{10}	=	-0.012	=	0.074	x	1	x	-0.167
u_{11}	=	-0.150	=	0.250	x	1	+	-0.400	U_{11}	=	-0.004	=	0.024	x	1	x	-0.150
u_{12}	=	1.588	=	0.294	x	10	+	-1.353	U_{12}	=	1.334	=	0.084	x	10	x	1.588
u_{13}	=	2.100	=	0.500	x	10	+	-2.900	U_{13}	=	2.184	=	0.104	x	10	x	2.100
									U_{T7}	=	**9.095651**						

Project 8

						y											
u_1	=	0.968	=	0.161	x	8	+	-0.323	U_1	=	0.975	=	0.126	x	8	x	0.968
u_2	=	-0.579	=	0.263	x	1	+	-0.842	U_2	=	-0.024	=	0.042	x	1	x	-0.579
u_3	=	-0.059	=	0.294	x	3	+	-0.941	U_3	=	-0.011	=	0.060	x	3	x	-0.059
u_4	=	2.455	=	0.455	x	9	+	-1.636	U_4	=	1.370	=	0.062	x	9	x	2.455
u_5	=	-0.143	=	0.357	x	3	+	-1.214	U_5	=	-0.028	=	0.066	x	3	x	-0.143
u_6	=	-0.474	=	0.263	x	1	+	-0.737	U_6	=	-0.024	=	0.050	x	1	x	-0.474
u_7	=	-0.200	=	0.250	x	2	+	-0.700	U_7	=	-0.020	=	0.050	x	2	x	-0.200
u_8	=	1.750	=	0.313	x	9	+	-1.063	U_8	=	2.268	=	0.144	x	9	x	1.750
u_9	=	1.053	=	0.263	x	8	+	-1.053	U_9	=	0.960	=	0.114	x	8	x	1.053
u_{10}	=	-0.167	=	0.208	x	1	+	-0.375	U_{10}	=	-0.012	=	0.074	x	1	x	-0.167
u_{11}	=	-0.150	=	0.250	x	1	+	-0.400	U_{11}	=	-0.004	=	0.024	x	1	x	-0.150
u_{12}	=	0.706	=	0.294	x	7	+	-1.353	U_{12}	=	0.415	=	0.084	x	7	x	0.706
u_{13}	=	1.100	=	0.500	x	8	+	-2.900	U_{13}	=	0.915	=	0.104	x	8	x	1.100
									$U_{Project8}$	=	**6.780572**						

Project 9

						y											
u_1	=	1.129	=	0.161	x	9	+	-0.323	U_1	=	1.280	=	0.126	x	9	x	1.129
u_2	=	1.263	=	0.263	x	8	+	-0.842	U_2	=	0.424	=	0.042	x	8	x	1.263
u_3	=	0.529	=	0.294	x	5	+	-0.941	U_3	=	0.159	=	0.060	x	5	x	0.529
u_4	=	2.455	=	0.455	x	9	+	-1.636	U_4	=	1.370	=	0.062	x	9	x	2.455
u_5	=	-0.500	=	0.357	x	2	+	-1.214	U_5	=	-0.066	=	0.066	x	2	x	-0.500
u_6	=	-0.474	=	0.263	x	1	+	-0.737	U_6	=	-0.024	=	0.050	x	1	x	-0.474
u_7	=	-0.200	=	0.250	x	2	+	-0.700	U_7	=	-0.020	=	0.050	x	2	x	-0.200
u_8	=	1.438	=	0.313	x	8	+	-1.063	U_8	=	1.656	=	0.144	x	8	x	1.438
u_9	=	0.789	=	0.263	x	7	+	-1.053	U_9	=	0.630	=	0.114	x	7	x	0.789
u_{10}	=	-0.167	=	0.208	x	1	+	-0.375	U_{10}	=	-0.012	=	0.074	x	1	x	-0.167
u_{11}	=	-0.150	=	0.250	x	1	+	-0.400	U_{11}	=	-0.004	=	0.024	x	1	x	-0.150
u_{12}	=	1.000	=	0.294	x	8	+	-1.353	U_{12}	=	0.672	=	0.084	x	8	x	1.000
u_{13}	=	1.100	=	0.500	x	8	+	-2.900	U_{13}	=	0.915	=	0.104	x	8	x	1.100
									$U_{Project9}$	=	**6.980786**						

Project 10

						y											
u_1	=	0.323	=	0.161	x	4	+	-0.323	U_1	=	0.163	=	0.126	x	4	x	0.323
u_2	=	0.211	=	0.263	x	4	+	-0.842	U_2	=	0.035	=	0.042	x	4	x	0.211
u_3	=	1.706	=	0.294	x	9	+	-0.941	U_3	=	0.921	=	0.060	x	9	x	1.706
u_4	=	2.455	=	0.455	x	9	+	-1.636	U_4	=	1.370	=	0.062	x	9	x	2.455
u_5	=	1.643	=	0.357	x	8	+	-1.214	U_5	=	0.867	=	0.066	x	8	x	1.643
u_6	=	0.579	=	0.263	x	5	+	-0.737	U_6	=	0.145	=	0.050	x	5	x	0.579
u_7	=	1.050	=	0.250	x	7	+	-0.700	U_7	=	0.368	=	0.050	x	7	x	1.050
u_8	=	-0.125	=	0.313	x	3	+	-1.063	U_8	=	-0.054	=	0.144	x	3	x	-0.125
u_9	=	0.789	=	0.263	x	7	+	-1.053	U_9	=	0.630	=	0.114	x	7	x	0.789
u_{10}	=	-0.167	=	0.208	x	1	+	-0.375	U_{10}	=	-0.012	=	0.074	x	1	x	-0.167
u_{11}	=	-0.400	=	0.250	x	0	+	-0.400	U_{11}	=	0.000	=	0.024	x	0	x	-0.400
u_{12}	=	0.412	=	0.294	x	6	+	-1.353	U_{12}	=	0.208	=	0.084	x	6	x	0.412
u_{13}	=	2.100	=	0.500	x	10	+	-2.900	U_{13}	=	2.184	=	0.104	x	10	x	2.100

$U_{Project10}$ = **6.823623**

Project 11

						y											
u_1	=	0.161	=	0.161	x	3	+	-0.323	U_1	=	0.061	=	0.126	x	3	x	0.161
u_2	=	-0.579	=	0.263	x	1	+	-0.842	U_2	=	-0.024	=	0.042	x	1	x	-0.579
u_3	=	-0.059	=	0.294	x	3	+	-0.941	U_3	=	-0.011	=	0.060	x	3	x	-0.059
u_4	=	0.636	=	0.455	x	5	+	-1.636	U_4	=	0.197	=	0.062	x	5	x	0.636
u_5	=	-0.500	=	0.357	x	2	+	-1.214	U_5	=	-0.066	=	0.066	x	2	x	-0.500
u_6	=	1.368	=	0.263	x	8	+	-0.737	U_6	=	0.547	=	0.050	x	8	x	1.368
u_7	=	0.050	=	0.250	x	3	+	-0.700	U_7	=	0.008	=	0.050	x	3	x	0.050
u_8	=	1.438	=	0.313	x	8	+	-1.063	U_8	=	1.656	=	0.144	x	8	x	1.438
u_9	=	0.789	=	0.263	x	7	+	-1.053	U_9	=	0.630	=	0.114	x	7	x	0.789
u_{10}	=	1.083	=	0.208	x	7	+	-0.375	U_{10}	=	0.561	=	0.074	x	7	x	1.083
u_{11}	=	1.600	=	0.250	x	8	+	-0.400	U_{11}	=	0.307	=	0.024	x	8	x	1.600
u_{12}	=	0.412	=	0.294	x	6	+	-1.353	U_{12}	=	0.208	=	0.084	x	6	x	0.412
u_{13}	=	2.100	=	0.500	x	10	+	-2.900	U_{13}	=	2.184	=	0.104	x	10	x	2.100

$U_{Project11}$ = **6.258101**

Project 12

						y											
u_1	=	1.129	=	0.161	x	9	+	-0.323	U_1	=	1.280	=	0.126	x	9	x	1.129
u_2	=	1.263	=	0.263	x	8	+	-0.842	U_2	=	0.424	=	0.042	x	8	x	1.263
u_3	=	1.706	=	0.294	x	9	+	-0.941	U_3	=	0.921	=	0.060	x	9	x	1.706
u_4	=	2.455	=	0.455	x	9	+	-1.636	U_4	=	1.370	=	0.062	x	9	x	2.455
u_5	=	2.000	=	0.357	x	9	+	-1.214	U_5	=	1.188	=	0.066	x	9	x	2.000
u_6	=	0.579	=	0.263	x	5	+	-0.737	U_6	=	0.145	=	0.050	x	5	x	0.579
u_7	=	-0.200	=	0.250	x	2	+	-0.700	U_7	=	-0.020	=	0.050	x	2	x	-0.200
u_8	=	2.063	=	0.313	x	10	+	-1.063	U_8	=	2.970	=	0.144	x	10	x	2.063
u_9	=	1.316	=	0.263	x	9	+	-1.053	U_9	=	1.350	=	0.114	x	9	x	1.316
u_{10}	=	0.458	=	0.208	x	4	+	-0.375	U_{10}	=	0.136	=	0.074	x	4	x	0.458
u_{11}	=	-0.400	=	0.250	x	0	+	-0.400	U_{11}	=	0.000	=	0.024	x	0	x	-0.400
u_{12}	=	1.588	=	0.294	x	10	+	-1.353	U_{12}	=	1.334	=	0.084	x	10	x	1.588
u_{13}	=	2.100	=	0.500	x	10	+	-2.900	U_{13}	=	2.184	=	0.104	x	10	x	2.100

$U_{Project12}$ = **13.28208**

Project 13

						y											
u_1	=	-0.161	=	0.161	x	1	+	-0.323	U_1	=	-0.020	=	0.126	x	1	x	-0.161
u_2	=	-0.579	=	0.263	x	1	+	-0.842	U_2	=	-0.024	=	0.042	x	1	x	-0.579
u_3	=	-0.647	=	0.294	x	1	+	-0.941	U_3	=	-0.039	=	0.060	x	1	x	-0.647
u_4	=	-1.182	=	0.455	x	1	+	-1.636	U_4	=	-0.073	=	0.062	x	1	x	-1.182
u_5	=	-0.857	=	0.357	x	1	+	-1.214	U_5	=	-0.057	=	0.066	x	1	x	-0.857
u_6	=	0.579	=	0.263	x	5	+	-0.737	U_6	=	0.145	=	0.050	x	5	x	0.579
u_7	=	1.050	=	0.250	x	7	+	-0.700	U_7	=	0.368	=	0.050	x	7	x	1.050
u_8	=	-0.750	=	0.313	x	1	+	-1.063	U_8	=	-0.108	=	0.144	x	1	x	-0.750
u_9	=	-0.263	=	0.263	x	3	+	-1.053	U_9	=	-0.090	=	0.114	x	3	x	-0.263
u_{10}	=	-0.167	=	0.208	x	1	+	-0.375	U_{10}	=	-0.012	=	0.074	x	1	x	-0.167
u_{11}	=	0.100	=	0.250	x	2	+	-0.400	U_{11}	=	0.005	=	0.024	x	2	x	0.100
u_{12}	=	-0.471	=	0.294	x	3	+	-1.353	U_{12}	=	-0.119	=	0.084	x	3	x	-0.471
u_{13}	=	-2.400	=	0.500	x	1	+	-2.900	U_{13}	=	-0.250	=	0.104	x	1	x	-2.400

$U_{Project13}$ = **-0.27479**

Project 14

						y											
u_1	=	0.161	=	0.161	x	3	+	-0.323	U_1	=	0.061	=	0.126	x	3	x	0.161
u_2	=	-0.579	=	0.263	x	1	+	-0.842	U_2	=	-0.024	=	0.042	x	1	x	-0.579
u_3	=	-0.647	=	0.294	x	1	+	-0.941	U_3	=	-0.039	=	0.060	x	1	x	-0.647
u_4	=	-0.273	=	0.455	x	3	+	-1.636	U_4	=	-0.051	=	0.062	x	3	x	-0.273
u_5	=	0.214	=	0.357	x	4	+	-1.214	U_5	=	0.057	=	0.066	x	4	x	0.214
u_6	=	0.053	=	0.263	x	3	+	-0.737	U_6	=	0.008	=	0.050	x	3	x	0.053
u_7	=	0.300	=	0.250	x	4	+	-0.700	U_7	=	0.060	=	0.050	x	4	x	0.300
u_8	=	-0.750	=	0.313	x	1	+	-1.063	U_8	=	-0.108	=	0.144	x	1	x	-0.750
u_9	=	-0.526	=	0.263	x	2	+	-1.053	U_9	=	-0.120	=	0.114	x	2	x	-0.526
u_{10}	=	0.875	=	0.208	x	6	+	-0.375	U_{10}	=	0.389	=	0.074	x	6	x	0.875
u_{11}	=	0.600	=	0.250	x	4	+	-0.400	U_{11}	=	0.058	=	0.024	x	4	x	0.600
u_{12}	=	-0.471	=	0.294	x	3	+	-1.353	U_{12}	=	-0.119	=	0.084	x	3	x	-0.471
u_{13}	=	-2.400	=	0.500	x	1	+	-2.900	U_{13}	=	-0.250	=	0.104	x	1	x	-2.400

$U_{Project14}$ = **-0.07852**

Project 15

						y											
u_1	=	0.000	=	0.161	x	2	+	-0.323	U_1	=	0.000	=	0.126	x	2	x	0.000
u_2	=	-0.579	=	0.263	x	1	+	-0.842	U_2	=	-0.024	=	0.042	x	1	x	-0.579
u_3	=	-0.647	=	0.294	x	1	+	-0.941	U_3	=	-0.039	=	0.060	x	1	x	-0.647
u_4	=	0.182	=	0.455	x	4	+	-1.636	U_4	=	0.045	=	0.062	x	4	x	0.182
u_5	=	0.214	=	0.357	x	4	+	-1.214	U_5	=	0.057	=	0.066	x	4	x	0.214
u_6	=	0.053	=	0.263	x	3	+	-0.737	U_6	=	0.008	=	0.050	x	3	x	0.053
u_7	=	0.050	=	0.250	x	3	+	-0.700	U_7	=	0.008	=	0.050	x	3	x	0.050
u_8	=	-0.750	=	0.313	x	1	+	-1.063	U_8	=	-0.108	=	0.144	x	1	x	-0.750
u_9	=	-0.263	=	0.263	x	3	+	-1.053	U_9	=	-0.090	=	0.114	x	3	x	-0.263
u_{10}	=	1.083	=	0.208	x	7	+	-0.375	U_{10}	=	0.561	=	0.074	x	7	x	1.083
u_{11}	=	0.850	=	0.250	x	5	+	-0.400	U_{11}	=	0.102	=	0.024	x	5	x	0.850
u_{12}	=	-0.471	=	0.294	x	3	+	-1.353	U_{12}	=	-0.119	=	0.084	x	3	x	-0.471
u_{13}	=	-2.400	=	0.500	x	1	+	-2.900	U_{13}	=	-0.250	=	0.104	x	1	x	-2.400

$U_{Project15}$ = **0.150896**