3-21-2019

Selecting a Construction Contract Acquisition Strategy to Support Foreign Military Sales Facility Construction

Robert H. Shuler

Selecting a Construction Contract Acquisition Strategy to Support Foreign Military Sales Facility Construction

THESIS

Robert H. Shuler, Major, USAF

AFIT-ENV-MS-19-M-196

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

AFIT-ENV-MS-19-M-196

SELECTING A CONSTRUCTION CONTRACT ACQUISITION STRATEGY TO SUPPORT FOREIGN MILITARY SALES FACILITY CONSTRUCTION

THESIS

Presented to the Faculty

Department of Systems Engineering and Management

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Engineering Management

Robert H. Shuler, BS

Major, USAF

March 2019

AFIT-ENV-MS-19-M-196

SELECTING A CONSTRUCTION CONTRACT ACQUISITION STRATEGY TO SUPPORT FOREIGN MILITARY SALES FACILITY CONSTRUCTION

Robert H. Shuler
Major, USAF

Committee Membership:

Alfred E. Thal, Jr., PhD
Chair

Maj Steven J. Schuldt, PhD
Member

Carlos Braziel, EdD
Member

AFIT-ENV-MS-19-M-196

Abstract

"Strengthening Alliances and Attracting New Partners" is one of the three Department of Defense's primary lines of effort as outlined in the 2019 National Defense Authorization Act. The Air Force Security Assistance and Cooperation Directorate (AFSAC) aides in the execution of this line of effort through the execution of Foreign Military Sales (FMS) cases. FMS cases vary in complexity depending on the type of end-item and the capabilities of the purchasing nation. AFSAC must balance multiple objectives and criteria to ensure the needs of the purchasing nation, the end-item, and U.S. government entities are met.

A decision analysis model using Value-Focused Thinking (VFT) was created through this research to assist AFSAC decision-makers in selecting a construction delivery strategy for major construction efforts within FMS cases. The construction delivery strategy for this model is defined by two primary elements: 1) the contracting project delivery method and 2) the construction and contracting agent. The model accounted for the competing objectives from the multiple stakeholders to include cost, schedule, quality, and intergovernmental relationship. The value hierarchy was derived from construction contract acquisition strategy literature, organizational doctrine, and input from key FMS construction decision-makers and proxies. AFSAC can utilize the resulting VFT model on future construction projects to make an objective and defensible recommendation regarding the construction contract acquisition strategy tailored to the parameters of individual FMS cases.

To my family. Without your support, this would not have been possible

Table of Contents

Page

List of Figures

List of Tables

Page

Selecting a Construction Contract Acquisition Strategy to Support Foreign Military Sales Facility Construction

I. Introduction

In an uncertain fiscal environment, the Department of Defense (DoD) looks for opportunities to execute National Defense Strategy objectives the most efficient way possible. One such opportunity that benefits both the U.S. and its allies by promoting regional stability is the Foreign Military Sales (FMS) program. Through the FMS program, U.S. allies are able to augment their defensive capabilities without having to rely on foreign military forces. The United States Air Force assists the FMS program by acting as the implementing agent through the Air Force Security Assistance and Cooperation (AFSAC) Directorate. FMS cases can be complex and can involve the construction of multi-million dollar support facilities prior to the delivery of U.S. end-items and equipment. This research examines how a decision analysis method can assist AFSAC with construction contracting acquisition strategy selection to achieve the desired effect of strengthening alliances through on-time and on-budget construction projects.

Background

The United States National Defense Strategy details the following three strategic approaches to meet its objectives: Build a More Lethal Force, Strengthen Alliances and Attract New Partners, and Reform the Department for Greater Performance and Affordability (Defense, 2018). The United States Air Force supports the second strategic approach of strengthening alliances and attracting new partners through the AFSAC Directorate by facilitating the execution of FMS cases. The FMS program is one of the primary security assistance methods the military offers to bolster the defenses of our allies and ensure global stability. In his press conference announcing the 2017 National Security Strategy, President Trump (2017) called on United States (U.S.) defense allies, specifically North Atlantic Treaty Organization (NATO) countries, to increase their defense spending and rely less on U.S. military troops and hardware for security. This is a departure from previous administrations and shows the shift to a foreign policy with an emphasis on "teach to fish/not fish for them" mentality as the U.S. removes troops from certain areas of conflict. The FMS program solves the gap in organic defensive capabilities (Teeney, 2010).

The FMS program is the mechanism through which a foreign government can purchase defense materials and technology from the U.S. One of the first events to occur once an FMS case is approved by Congress is the construction of supporting facilities. These supporting facilities include but are not limited to hangars for FMS aircraft, bunkers for FMS munitions, hardened facilities for FMS Command and Control (C2) systems, fuel systems for FMS vehicles, and maintenance facilities for FMS aircraft or end-item repair. As the FMS cases become more complex, the operation of the end-item becomes more reliant on the supporting facility. For example, selling complete aircraft systems requires more processes to implement as opposed to selling 5.56 mm rounds.

Many entities are involved during FMS construction projects. For the purposes of this research, the Construction Program Manager (CPM) and Design and Construction Agent (DCA) are examined. The AFSAC Construction Branch functions as the U.S. Air Force construction program manager for FMS cases. As the program manager, the construction branch is responsible for monitoring and reporting progress of the construction programs to the overall FMS case-specific program manager within the AFSAC organization. This research assumes that the Construction Branch has been selected as the program manager for the construction portion of the FMS case. This selection is not automatic depending on host nation capability and the complexity of the FMS case. In addition to the construction program manager, a design and construction agent (DCA) is selected with the responsibility to implement and manage the construction. The construction agent authority can be the Army Corps of Engineers (USACE), Naval Facilities Engineering Command (NAVFAC), or other government agencies (OGAs). The construction agent selection is a complex process which varies from case to case. Depending on the location of the project, the authority is sometimes given to the only entity present in the geographic area by default.

When presented with an FMS construction case, the CPM must gather information from multiple sources to develop a picture of the conditions faced by the program. The CPM must conduct a situation analysis to determine the initial conditions of the project every time a new case is established. This process creates a manpower burden for which the construction branch currently is not staffed. The situation analysis focuses on the values of the FMS program which, when properly monitored and managed, can ensure a successful construction program. The CPM must then select a construction delivery strategy with the greatest probability of delivering the required facilities given the initial conditions and constraints.

Research Problem

Currently, the AFSAC Construction Branch does not have an established procedure to systematically perform a decision analysis to select an appropriate construction contract acquisition strategy. The process is often guided by experienced individuals who travel extensively and rely on intuition or past knowledge. Delays with construction of support facilities impacts the delivery timeline of the end-item associated with FMS cases. Additionally, the current process may give too much flexibility to the buying nation to execute the construction project, thereby possibly resulting in project delays, cost-overruns, and challenged relationships.

Research Objective and Investigative Questions

The objective of this research is to develop a decision support system using a Value-Focused Thinking approach to assist AFSAC construction engineers in the selection of construction contract acquisition strategies. To achieve the research objective, the following questions were addressed.

1. What value hierarchy applies to facility construction in an international environment?
2. How can the Value Focused Thinking approach assist the AFSAC Construction Branch execute their mission?
3. How sensitive is the model to changes in weightings of measurements?

Methodology

This research utilizes the Value-Focused Thinking process to create a decision analysis model. This approach was selected due to its applicability across multiple scenarios while maintaining the fundamental objectives and core values of the organization. The values were derived through doctrinal analysis and interviews with the appropriate authority (decision-maker or decision-maker proxy) to develop the Value Hierarchy to achieve the fundamental objective of the organization. The fundamental and core values were derived from Air Force and AFSAC policy. These values were then applied to multiple situations that can differ by purchasing nation sensitivities, political constraints, foreign capabilities, and end-item conditions. The VFT approach was shown by Shoviak (2001) as a ten-step process based on the Multi-Objective Decision Analysis (MODA) model developed by Kenney (2008).

Research Scope

The scope of this research is to determine and define the value hierarchy parameters and develop a multi-objective decision analysis to select the optimal construction delivery method based on FMS case requirements. This research specifically examines the outputs of selecting the contracting agent, construction execution agent, and project delivery method. The contracting agent is defined as the entity responsible for awarding the construction contract and paying the construction execution agent. The contracting agent must have the authority and capacity through warrants to award major construction efforts. The construction execution agent is defined as the entity that is responsible for construction oversight. The project delivery method is defined as the structure of the contract award and the type of contractor competition being characterized as design-bid-build, design-build, full competition bid, and limited invitation for bid. This research focuses specifically on projects in the Middle East region due to a preponderance of active Air Force FMS cases occurring in the Gulf Countries Cooperation (GCC) area. Furthermore, there is an abundance of historical data available pertaining to GCC cases since FMS cases have existed in the region since the 1980s.

Implications

A successful FMS construction program supports U.S. Air Force objectives in support of the National Defense Strategy. The successful completion of the construction program depends upon the construction delivery strategy which implements the planning, design, and construction of facilities. Selecting the construction contracting acquisition strategy is complex and must consider information from multiple sources, thus complicating the selection process.

Overview

This document is arranged in five separate chapters. Chapter II contains a review of applicable literature that relates to the FMS program, construction contracting, and decision analysis. Chapter III discusses the methodologies used in the creation of the value model. Chapter IV discusses the results of analyzing construction contract acquisition strategies through the value model. Chapter V provides a summary and list of conclusions of the research.

II. Literature Review

This chapter is divided into three sections to establish foundational knowledge and background for this research. The first section provides background information on the United States Air Force Security Assistance and Cooperation (AFSAC) Directorate, specifically examining the Foreign Military Sales (FMS) process. The second section examines existing research regarding decision analysis methods tailored to the construction industry and identifies common variables of "success" to guide the development of a decision analysis model. The third section examines the decision analysis process using Value-Focused Thinking (VFT) and the validity of the VFT process to assist the FMS case decision-makers in selecting an appropriate construction contract acquisition strategy.

Security Assistance and Cooperation

A broad overview of the FMS process is required to establish a foundation regarding how the AFSAC directorate operates and what the organization values. The FMS process is a Security Assistance program associated with Security Cooperation, which is defined as "all activities undertaken by the Department of Defense (DoD) to encourage and enable international partners to work with the United States to achieve strategic objectives" (Defense Security Cooperation Agency, 2012). The U.S. Security Cooperation program receives its authority from three primary U.S. laws: the Foreign Assistance Act (FAA) of 1961, the Arms Export Control Act (AECA) of 1976, and annual appropriations acts for Foreign Operations, Export Financing, and Related Programs. Through these authorizations and oversight, the U.S. can provide "defense articles, military education and training, and other defense-related services by grant, loan, credit, cash sales, or lease, in furtherance of national policies and objectives" (Defense Security Cooperation Agency, 2012). Under the FMS program, military items may be provided from existing DoD stocks or through new procurement from the end-item supplier. The purchasing nation pays for all costs associated with the FMS sale to include supporting items and facilities. Through the FMS program, the U.S. supports its allies by promoting defense interoperability and increasing partner nation defensive capabilities.

AFSAC is the execution arm of the United States Air Force to support the Defense Security Cooperation Agency's (DSCA) mission to advance U.S. national security and foreign policy interests by building the capacity of foreign security forces to respond to shared challenges (USG, 2018). Although the organization receives FMS cases from DSCA, AFSAC reports to the Air Force Life Cycle Cost Management Center (AFLCMC), which itself is a subordinate unit to the Air Force Material Command. As such, ASFAC must meet the customer needs as defined by the host nation through DSCA while adhering to DoD, United States Air Force, and AFMC policies. At times, these multiple objectives of meeting the customer's desire for quality and timeliness while adhering to organizational policy, guidance, law, and regulations can compete with one another.

A review of the organizational mission statements from each organization provides insight into the doctrinal values that influence the FMS process. The Department of Defense (DoD) outlines its values through the Nation Defense Strategy (NDS), which details how the DoD executes the guidance established in the National Security Strategy (NSS). From the highest levels of the U.S. government, there is a focus on building alliances within the constraints of efficiency and affordability. The U.S. Foreign Assistance Act of 1961 and the Arms Export Control Act established DCSA as the government entity to oversee and execute

FMS cases to foreign governments (Rennack, 2011). DCSA crafted its mission statement to meet the NDS task of strengthening alliances and attracting new partners by "advance(ing) U.S. national security and foreign policy interests by building the capacity of foreign security forces to respond to shared challenges" (USG 2018). DSCA further expounds that the organization will accomplish its mission with a focus on being effective, enduring, and timely. DSCA further details its charter by establishing the organizational values shown in Table 1.

Table 1. DCSA Organizational Values (USG, 2018)

Demonstrating the utmost **commitment** to achieving our mission.
Maintaining the **integrity** of our business practices by pursuing a deliberate, accountable approach.
Prioritizing **responsiveness** to our stakeholders' needs.
Maintaining **transparency** with our stakeholders through communication and information sharing.
Maximizing results through **collaboration.**
Encouraging **innovation** to improve how we do business and tackle new challenges.
Prioritizing **investment in the workforce.**
Promoting the **empowerment** of our teammates to take action to achieve our goals.

As previously discussed, the Air Force meets DSCA objectives through the Air Force Life Cycle Cost Management Center (AFLCCMC) and the Air Force Security Assistance and Cooperation (AFSAC) Directorate. AFSAC closely aligns its mission statement with DSCA's mission statement. The directorate identifies its mission as "deliver(ing) airpower capabilities to strengthen international partnerships and advance national security" (USG, 2018). The organization further explains the desire to not only provide airpower capabilities but also to sustain these partnerships and capabilities.

Foreign Military Sales Process

An overall background review of the Foreign Military Sales process is necessary to frame the decision context examined in this research. The FMS program consists of three major phases: pre-case development, case development, and implementation. While each FMS case can differ in complexity, each case follows the same process.

An FMS case begins with pre-case development. The purchasing nation, in coordination with the Security Cooperation Officer (SCO), defines its defense requirements and evaluates available options and sources (DSCA, 2018). A Letter of Request (LOR) capturing the full requirement is drafted and coordinated with the purchasing nation, DSCA, and the DoD Implementing Agency. AFSAC is the implementing agent for Air Force related end-items and is the focus of this research. Proper scope definition and pre-planning efforts are critical to a successful FMS case. Before the LOR is officially submitted, the SCO must coordinate with all stakeholders to ensure that the entire process is executed smoothly.

The next phase to the FMS case is the case development phase. This phase is defined by two sub-phases of offer and acceptance (DSCA, 2018). Once the U.S. government receives a LOR, a Letter of Offer and Acceptance (LOA) is generated and becomes the contractual agreement between the purchasing nation and the U.S. government. The LOA includes a detailed scope of the items requested, supporting logistics and facilities of items requested, a pricing estimate of the case, and a timeline associated with the delivery of the end-item. A timeline of 45 to 150 days is established for the U.S. government to respond to the LOR with the finalized LOA.

The final step of the FMS case is the Implementation, Execution, and Closure phase. This phase occurs when both the U.S. government and the purchasing nation agree to the finalized LOA and if necessary, the FMS case receives congressional approval. The phase consists of the acquisition, logistics, financial, and training elements of the LOA are delivered. The FMS case is closed only when the weapons system and associated its logistical life-cycle support, to include training, are delivered.

Support Activities to Foreign Military Sales - Construction

Roughly 30% of recent FMS cases involve the construction of support facilities as part of the weapons system sale. Construction is often one of the first physical activities to occur in an FMS program and sets the tone for the success of the follow-on acquisition process of the end-item delivery. The success of this initial visible task demonstrates the U.S. government's management capability; thus, it can impact the impressions the foreign government may have of our processes and possibly affect future diplomatic interactions. Selecting the optimal construction contract acquisition strategy is critical to the overall success of the program. A delay due to construction activities in the early stages of the FMS case is magnified as this delay hinders the completion of other critical tasks to delivery of the end-item. Additionally, a delay in schedule often equates to a growth in cost. The cost impact can also derail the overall project as any contingency buffer in time or money is expended at the beginning of the FMS case. If the FMS case is delayed or the project runs out of funding, the purchasing nation must now grant more time and financial resources to the project. In some instances, the purchasing nation may elect to pursue other alternatives and strategic alliances for their defense.

In 2015, the U.S. Government Accountability Office (GAO) conducted an organization-wide audit of the DoD's expenditures and processes. One of the findings that garnered Congressional attention was the FMS process, specifically the cost and timeliness of the program were identified as items of concern (Melito, 2017). From the audit, multiple reports and policies were generated to remedy the congressional concern. DSCA established policy 13-11, "Use of DoD Construction Agents for FMS Cases," to reiterate that the DCA must be the military construction agent for that specific region (DSCA, 2013). This policy was established to provide more transparency and U.S. governmental oversight of FMS construction. However, it limits the four construction delivery strategies (U.S. government agencies, private A&E firms, the end-item supplier, or the purchasing country) to only U.S. government agencies. The policy further states that while using a DoD construction agency is the standard, any waivers to policy must be approved by DSCA for extenuating circumstances such as a DoD construction agent not existing or being allowed to operate in the region. While the DoD construction agencies could be capable of executing FMS construction within cost and timeliness constraints, it may not be the most appropriate construction delivery strategy for every situation.

Additional GAO reports were published to assist the DoD in achieving operational success within congressional constraints. Specifically, the GAO recommended an increase in personnel and resources to not only improve the current information processes but to establish a workforce plan (Melito, 2017). The report cites that, "(t)he military departments' workload and workforce have increased while DSCA's workforce has declined, and DSCA has not developed a workforce plan" (Melito, 2017). This impact to DSCA also translates to AFSAC FMS program execution capability. Thus, one recommendation is to increase the workforce personnel to meet the organizational objectives and congressional mandates of oversight.

Two DoD Construction Agents currently exist for most of the areas in which the U.S. has active FMS cases: U.S. Army Corps of Engineers (USACE) and Naval Facilities Engineering Command (NAVFAC). The Air Force does not have an organic major design and construction (D&C) agent in the focus region of the Middle East. As such, the Air Force and specifically

AFSAC must first rely on USACE and NAVFAC as a DoD D&C Agent. Both agencies provide construction and engineering services to include design, construction, and construction management and administration services. When the DoD Construction Agent is selected, AFSAC submits a request to the agency headquarters identifying the requirement. Upon approval, the DCA and AFSAC create a Memorandum of Understanding (MOU) between the two agencies outlining roles and responsibilities of construction efforts to include a negotiated fee structure. Once the MOU is approved by all parties, USACE or NAVFAC executes the facility construction and reports project status to the AFSAC construction branch. This information is then forwarded to the acquisition officer in charge for overall FMS case execution

A private Architecture and Engineering (A&E) firm can provide the same construction management services as the DoD Construction Agents except for contract administration. Since the A&E firm is contracted by the federal government, it cannot commit resources such as payments to the construction agent on behalf of the DoD (Auletta, 2011). Hiring a private A&E firm is discouraged by the Brooks Act (Public Buildings – Selection of Architects and Engineers) and typically takes eight to twelve months to select due to the advertising and selection processes.

The end-item supplier may also be selected as a construction agent. For example, the purchasing nation may request Boeing to supply not only the aircraft, but to also build the supporting infrastructure supporting their aircraft. A recent FMS case in India used this option for their C-17 program. This process involves identifying the supporting facility construction as a line item in the acquisition of the end-item. However, the end-item companies will sub-contract this service as the weapon supplier is focused on building the end-item. This method is advantageous to the government in that the risk of cost and time overruns is placed solely on the contractor. However, this puts the government at a disadvantage as the U.S. government has less oversight of the project and the weapon supplier may inflate their prices to account for the added risk to their project.

A final construction delivery strategy to examine is the Direct Commercial Sale in which the purchasing nation performs the construction management duties through the execution of the construction project. This strategy must account for the purchasing nation's construction capability and accountability processes. While the FMS case is fully funded by the purchasing nation, any delays or cost overruns can implicate the U.S. government and strain relationships.

Unique Items to FMS Construction

Construction in support of the FMS program faces many challenges that are not common to international construction or military construction, including contingency construction. Ware (2009) made a case for needing innovative solutions to address the unique challenges to FMS construction. He specifically discussed the following three challenges to delivering a "quality" project: adequate initial assessments, Letter of Request scoping, and constrained timelines within the DSCA process (Ware, 2009). In addition to the normal construction contract procurement timelines set forth by DCAs, FMS construction engineers must include all pre-planning efforts and detailed estimates to be included in the Letter of Offer and Acceptance within 90-days of receipt of the Letter of Request from the foreign government. Pre-planning actions include performing the initial site-assessment, performing a detailed engineering assessment, and creating a detailed statement of requirements.

Ware (2009) identified innovative solutions to resolve the three primary concerns through concurrent planning actions and proactive assessments of all potential sites that may host a new end-items. This attention to the uniqueness of FMS construction highlights the potential gap in existing research. DoD-centric research on contingency construction primarily addresses Title 10 construction activities in support of U.S. military forces on established coalition military installations. Civilian international construction research does not account for the concerns of geo-political and security issues.

An additional aspect of FMS facility construction that differs from conventional international construction is the enduring impact it can have on intergovernmental relationships. Facilities can be a long-term visible reminder of the alliance between the U.S. government and the purchasing nation. If the FMS program or the construction of the supporting facilities goes poorly, intergovernmental relationships will be strained and may take years to recover. The success of the FMS case from requirement identification to delivery plays a role in the credibility of the United States (Braziel, 2012). Braziel (2012) examined the relationship of the SCO and the partner nation. This relationship is critical to the goals of the DSCA program and the National Security Strategy to strengthen alliances of U.S. partner nations. Furthermore, credibility and adherence to ethical standards are two factors influencing the public opinion of partner nations (Braziel, 2014). As identified by the complexities involving intergovernmental relationships and unique constraints, FMS construction is a hybrid field in which existing decision analysis research does not currently exist.

Relevant Research

Decision Analysis

The first decision analysis concepts were developed shortly after the publication and codification of decision analysis in the late 1960s through the works of Ronald Howard, Ralph Keeney and Howard Raiffa; each of these professors is regarded as a foundational leader in the

Decision Analysis field of study (Parnell et al., 2013). The construction industry is a prime candidate for decision analysis due the multiple stakeholders and objectives present for any construction project. For example, a construction project involves the stakeholders of the owner of the future facility, the contractor, the architect/engineer, and the end-users of the future facility. Each stakeholder is concerned with different objectives regarding the successful completion of the project, which may go beyond the basic "iron triangle" of cost, quality, and time. Furthermore, the construction industry can benefit from the use of decision analysis to improve the industry as whole, where first-hand experience is valued highly. "No quantitative analysis tool is a substitute for a construction project manager's experience and intuition … (however,) crisis decision analysis provides a rational framework for the manager to capture experience and test intuition" (Ashley, Uehara, & Robinson, 1983). Thus, decision analysis can be used to assist the project decision-maker by incorporating values and measures gained through experience in the decision. Decision analysis can thus be used to balance the multiple objectives to attain an optimal decision.

As identified in the process of executing Foreign Military Sales cases, many stakeholders with different perspectives are involved to achieve the common goal of improving security assistance and cooperation relationships between the purchasing nation and the United States government. A thorough literature review revealed a gap in research in terms of applying decision analysis principles to U.S. international construction programs, specifically international construction efforts supporting FMS cases in the Middle East region

Decision Analysis in Construction

The construction industry is greatly influenced by decision analysis methods. This industry relies heavily on metrics to determine project success as well as incorporating multiple stakeholder criteria. The "iron triangle" of cost, time, and quality are the initial measures of project success but project success criterion can also include soft metrics such as the business impact to organization. These metrics can be interpreted and weighted differently depending on the perspective of the stakeholder. One of the primary goals in decision analysis is to build stakeholder consensus (Keeney, 1992). Therefore, it is critical to identify which values impact all stakeholders.

One of the early decision analysis applications to the construction industry occurred in 1983 with the introduction of the Crisis Decision Analysis model. Researchers applied the Raiffa (1981) style decision analysis process to a hypothetical sewage tunnel construction example to incorporate risk as defined by the probability and impact of an event. The primary goal of the research was to develop a means to capture industry experience and provide a defensible approach for a publicly funded construction project (Ashley et al., 1983). The research led to further decision analysis applications for public infrastructure projects. For example, the construction of the Glen Canyon Dam utilized a multi-criteria decision analysis approach to build stakeholder consensus and support the Environmental Impact Statement (Flug, Seitz, & Scott, 2000).

More relevant and recent decision analysis undertakings have been applied to construction contracting acquisition selection. Researchers at Texas A&M University developed a decision support procedure for Project Delivery and Contract Strategy (PDCS) selection through the use of (1) analytic hierarchy process, (2) multi-attribute utility theory, and (3) simple multi-attribute rating technique with swing weights (SMARTS) (Anderson & Oyetunji, 2004). Twelve primary PDCS alternatives and 20 selection criteria factors were identified, with each alternative being scored using the additive aggregation model below.

$$U_j = \sum_{i=1}^{n} w_i * u_i(x_{ij}) \quad (1)$$

where U_j represents the aggregate utility of Alternative j, x_{ij} represents the level of attainment of Alternative j for measure i, u_i represents the single attribute utility function for measure i, and w_i represents the importance weight for measure i.

The user selects which selection factors, of the 20 identified, apply to their specific project and assigns a preference weight for each factor. The highest selection factor receives a score of 100, the second selection factor receives a score incrementally less than 100, and each successive factor receives a lower preference weight. The weights are then normalized by dividing the individual preference weight by the total score. The normalized weight for the selection factor is then applied to the PDCS value attainment for that specific selection factor. Finally, each selection factor score is aggregated for a total value. The PDCS model was then tested on 12 projects identified by the research team. Respondents to the validation portion of the research confirmed the result was appropriate to their normal business practices (Anderson & Oyetunji, 2004).

Critical Success Factors in Construction Contracting

One of the first steps to any decision analysis process is to identify what is trying to be achieved (Keeney, 2012). By identifying the fundamental objective, the decision-maker is then able to focus on identifying what constitutes success. A literature review of Critical Success Factors was analyzed to identify values specific to the construction industry and support the development of a decision analysis model.

Critical Success Factors in the construction industry focuses on identifying and isolating factors that result in project success. Chua (1999) utilized a neural networking technique and analytical hierarchy process to identify and assign the relative importance of each factor to project success. The research team surveyed subject matter experts in international construction to identify which factors they consider when determining the success of a project. Sixty-seven factors were identified and grouped in terms of budget performance, schedule performance, quality performance, and overall project success. Factors were then ranked using a Likert scale through a second round of surveys with the subject matter experts. Through a Chi squared analysis, schedule performance, or time, was identified as the most significant factor in determining project success as seen in Table 2 (Chua et al., 1999).

Table 2. Relative Importance of Different Project Objectives

Relative Importance of Different Project Objectives	
Success Objective	Relative Importance
Budge Performance	0.314
Schedule Performance	0.360
Quality Performance	0.325

Chua et al.'s (1999) CSF research was further expanded into several research initiatives. One of the first applications of the CSF research was the application of a decision framework to select a construction contracting strategy. The team utilized the case-based reasoning (CBR) method, which relies on previous decision instances and outcomes to influence decision selection. CBR was utilized because selecting a contracting strategy requires factoring a "large amount of unknowns and complex interrelationships" (Loh et al., 2000). The contracting strategy consists of the scope or work package, organization or functional grouping, contract type, and award method. Three primary categories they identified that influence the selection of a construction contract strategy include project characteristics, client objectives, and client comparative advantages. These three categories are further detailed in the 29 sub-factors summarized in Table 3.

Table 3. Factors Considered for Contract Strategy

Main Category	**Factors**
Project Characteristics	(1) political stability; (2) likelihood of exchange rate fluctuation; (3) efficiency and maturity of regulatory framework; (4) integrity and transparency of the system; (5) site location; (6) availability of appropriate contractors; (7) expected market competition among contractors; (8) project type; (9) technical complexity; (10) project size
Client's Objectives	(11) time economy; (12) time certainty; (13) cost economy; (14) cost certainty; (15) desired design quality; (16) desired construction quality; (17) design change flexibility; (18) client-consultants interaction; (19) design-construction integration; (20) checks and balances between design and construction; (21) appetite for conflict; (22) risk aversion
Client's Comparative Advantages	(23) budget talent; (24) design talent; (25) team-building talent; (26) monitoring talent; (27) labor; (28) material; (29) equipment

In follow-on research, Kog and Loh (2012) examined the critical success factors through the lenses of three different components of the construction process. Thirty-three industry professionals from the construction disciplines of architecture, civil/structural engineering, and mechanical/electrical engineering were surveyed. The two-survey Delphi method was used to rank and weight the responses of the subject matter experts. The responses were grouped by Project Characteristics, Contractual Arrangement, Project Participants, and Interactive Processes; the responses were further categorized into the values of Budget, Quality, and Schedule performance (Kog & Loh, 2012). The research resulted in 67 unique factors being identified, with the top-10 factors being shown in Table 4.

Table 4. Top-10 Critical Success Factors for Construction Components

Kog - Critical Success Factors			
Constructability	Adequacy of Plans	Project Manager Competency	Realistic Obligations
Project Manager Commitment	Contractual Motivation/Incentives	Adequacy of Funding	Economic Risks
Construction Control		Adequacy of Specifications	

The results of the critical success factors research can be used as a basis for the development of the applied decision analysis model. The critical success factors focus on the programmatic technical aspect of a construction project. However, the critical success factors neglect any intergovernmental relationship concerns. Therefore, a decision analysis model incorporating the factors standard to the construction industry and the factors unique to FMS construction needs to be established.

Value Focused Thinking

This research utilizes the Value-Focused Thinking process to create a decision analysis model. Alternative Focused Thinking and Value-Focused Thinking are the two primary decision models identified in the Raiffa, Keeney, and Howard style of decision analysis (Parnell et al., 2013). Both approaches have strengths and weaknesses to assist the decision-maker with a goal of creating a formalized process to select an optimal alternative for a given objective while providing defensible support for the decision. The VFT approach was selected due to its applicability across multiple scenarios while maintaining the fundamental objectives and core values of the organization (Keeney, 1992). VFT differs from other Multiple Objective Decision Analysis processes in that it establishes a value hierarchy first and then analyzes alternatives. VFT offers many other strengths to include the items found in Figure 1.

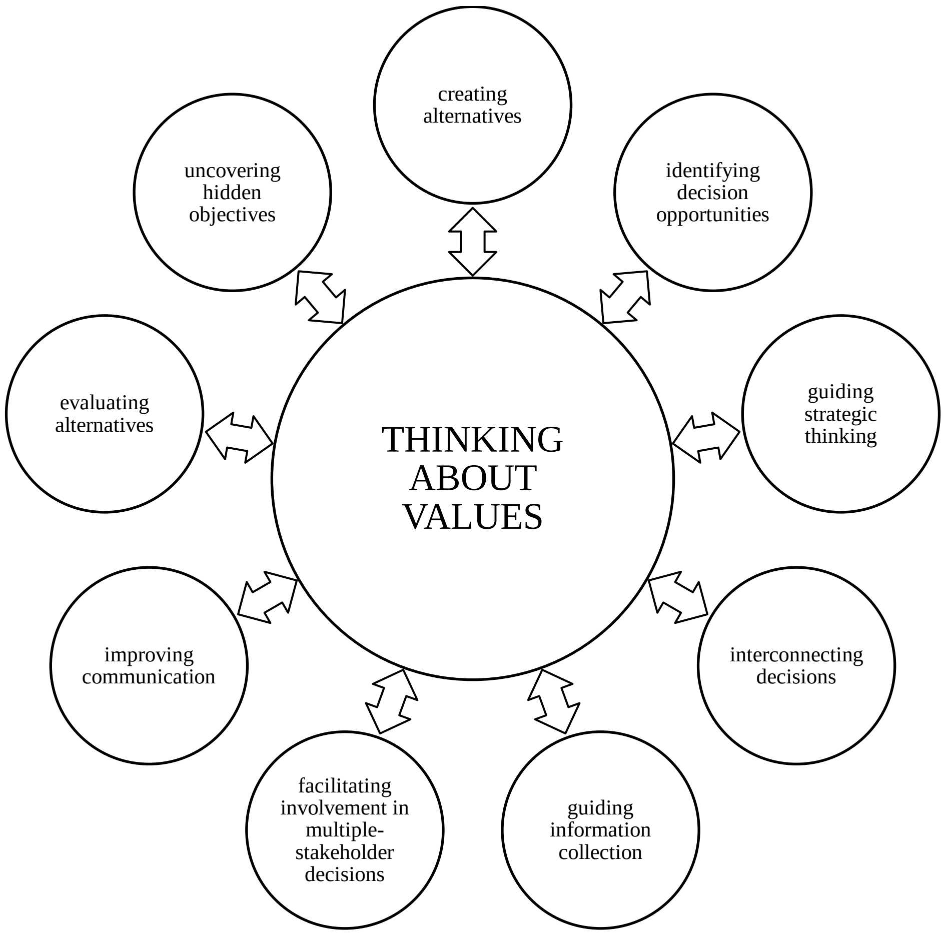

Figure 1. Benefits of Value-Focused Thinking

The VFT process can be represented by the 10-step process shown in Figure 2, which was derived by combining the primary processes identified by Keeney (1992) and Kirkwood (1998). The VFT process can be applied from validating the effectiveness of current initiatives to selecting the optimal alternative in constrained decision environments. Most notably, senior military strategic planners used VFT to create the *Air Force 2025 Strategic Plan* to identify which capabilities the U.S. Air Force needs to develop to maintain air superiority (Parnell et al., 1998). The VFT process was selected as the primary method for this research due to its applicability to multi-criteria decision analysis and the opportunity to discover new alternatives. Furthermore, the steps within the VFT process capture the decision analysis processes of AHP, additive aggregation model, and multi-attribute utility theory used in similar research.

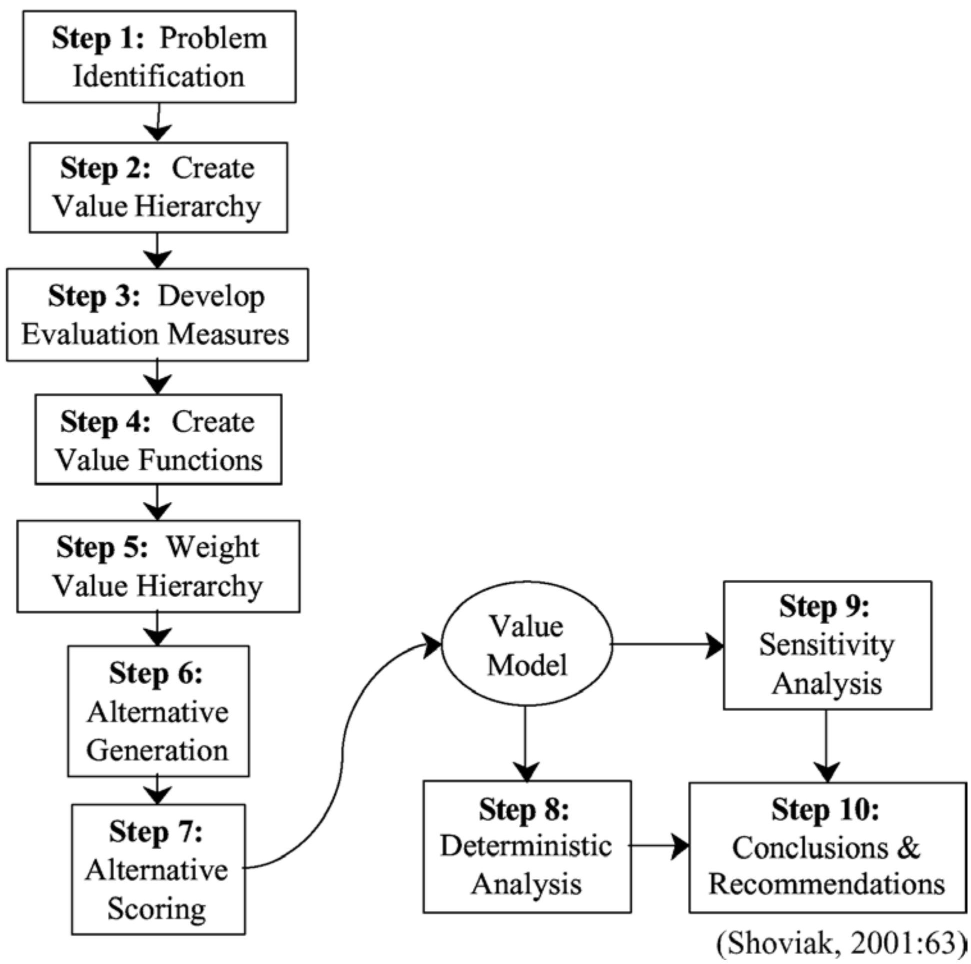

Figure 2. Value-Focused Thinking Process

Summary

This chapter is divided into three sections to establish foundational knowledge and background of this research. The first section provides background information on the United States Air Force Security Assistance and Cooperation Directorate Foreign Military Sales process, specifically examining the directorate's organizational structure and FMS case process. The second section examines existing research regarding decision analysis methods tailored to the construction industry and identify common variables of "success" to guide the development of a decision analysis model. The third section examines the decision analysis process using Value-Focused Thinking (VFT) and the validity of the VFT process to assist the FMS case decision-makers in selecting a construction execution method with minimal risk to cost and timeliness.

III. Methodology

This chapter details the methodology used to create the value model as part of the Value-Focused Thinking (VFT) process. The first section discusses the theory behind the VFT process and why it was selected as the decision analysis approach for this research. The second section details the first five steps of the VFT process which culminates with the creation of the value model. This model is then used to analyze construction contract acquisition strategies and results are discussed in Chapter IV.

Theory

Value-Focused Thinking is a decision analysis methodology that reverses the typical alternative-focused thinking approach by initially identifying the items that are important to the decision-maker. Instead of focusing on selecting the best alternative of what is currently and easily identifiable, VFT can remove any existing bias a decision-maker or stakeholder may have to a specific solution by focusing on the organizational objective and the values the organization would like to achieve (Keeney, 1992).

The VFT approach was selected as the decision analysis tool for this research for several reasons. First, the process forces the decision maker and stakeholders to clarify the problem. The likelihood the decision-maker can solve the problem increases significantly when the problem is clearly defined (Parnell, Bresnick, Tani, & Johnson, 2013). Next, VFT improves the likelihood of solving the problem by identifying value conflicts. These conflicts lead to discussions that "separate disagreements about possible consequences from disagreements about the relative desirability of those consequences" (Keeney, 1992). This discussion prompts the stakeholders and decision-makers to analyze how to reduce the conflicts or reexamine the value that is in conflict to determine if the value is relevant to solving the problem or objective. Finally, decision-makers should use the values found in the VFT approach in a consistent manner. By identifying the values and their respective weights before any alternatives or options are taken into consideration, bias towards a "preferred" alternative is reduced when the values are applied consistently among the solutions created. This pre-definition does not mean every value must be of the same weight; however, the values must be applied to every alternative in the same manner. In addition to reducing decision bias through this approach, VFT assists the decision-maker in selecting the optimal alternative using a defendable and repeatable process.

Procedures

The following sub-sections detail the first five steps of the Value-Focused Thinking process; steps six through nine are discussed in Chapter IV. The first five steps involve creating the decision analysis model and gathering pertinent data to be used in the model. The data used for creating the model was derived from a review of organizational mission statements and congressional policy documents. Additionally, the decision maker proxy and key stakeholders provided inputs to create the value model. For this research, the decision-maker proxy was considered to be the AFSAC Construction Branch located at Wright-Patterson AFB, OH.

Step One – Problem Identification

The first step of the VFT process is to guide the decision-maker in deconstructing the nature of the decision problem. The decision-maker proxy's objective for this research is to create a value hierarchy model that can be used on a case-by-case basis depending on the alternatives available for each facility construction project supporting FMS cases. Furthermore, the decision-maker proxy desires to create support for other alternatives to be used for specific cases based on independent research. Thus, the problem statement is “identify and select the optimal construction contract acquisition strategy for facility construction supporting the FMS program.” The problem statement thus establishes the baseline objective for the decision model (Keeney, 2012).

Step Two – Value Hierarchy Construction

After defining the problem, the next step is to create the value hierarchy. The fundamental objective was iteratively divided into specific values until the values can be quantitatively measured. These values were derived using the gold standard to construct the initial strawman hierarchy (Keeney, 1992). The gold standard involves the researcher initially developing the value hierarchy with values derived from doctrinal research and inputs from the stakeholders. The hierarchy is then verified by the decision-maker or the decision-maker proxy for accuracy.

For this research, the initial strawman was developed using the DSCA mission and policy memorandums, as well as AFSAC internal mission and policy memorandums. An affinity grouping exercise was used to logically determine the values and sub-values of the hierarchy. The first iteration of this process yielded the Tier 1 values of Cost, Risk, Timeliness, and Transparency as seen in Figure 3.

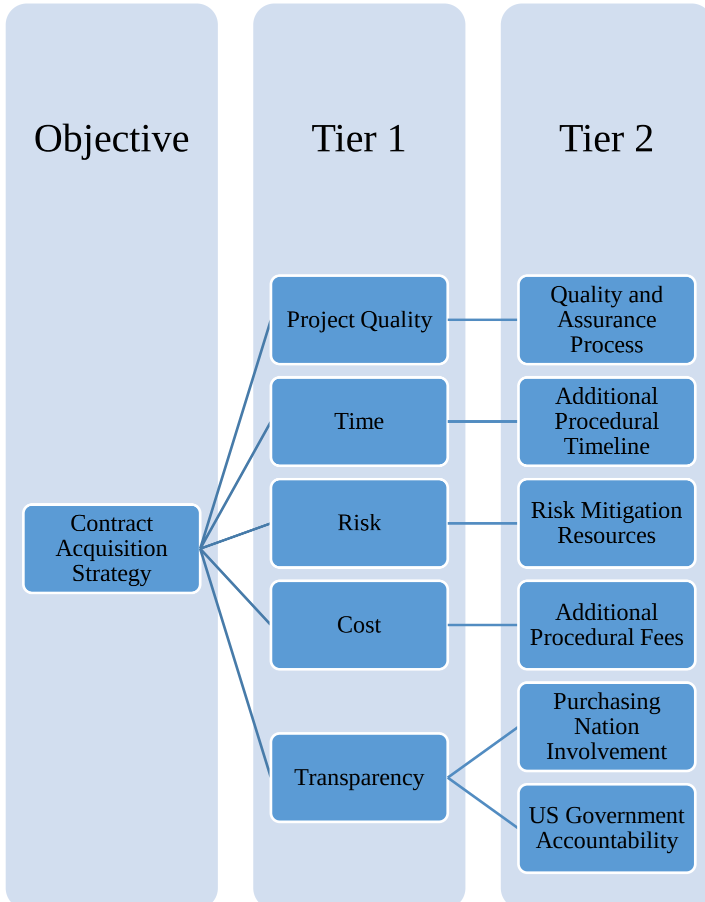

Figure 3. Initial Strawman Hierarchy

The hierarchy was further refined with inputs from the AFSAC construction branch. Eight responses from stakeholders within the AFSAC construction branch were received. The responses were consolidated and common themes were identified. The values that were not accounted for in the initial strawman hierarchy included "soft" metrics such as flexibility, purchasing nation partnership, organizational interrelationship impacts, product quality, and responsiveness.

A second affinity grouping exercise was used to categorize the complete list of values that were identified. This led to changing the Tier 1 values to Impact and Programmatic. The Impact branch captures the qualitative values that affect organizations outside of the construction and contracting agencies involved with the facility construction scope of the FMS case. The Programmatic branch captures the procedural values associated with the direct selection of the contract acquisition strategy. The programmatic branch is more closely aligned with values and critical success factors identified in Chapter II that are typical in the construction industry. The Tier 1 grouping highlights the importance of partnership building to the decision-maker. The final hierarchy, shown in Figure 4, was then validated by the AFSAC construction branch. The definitions for the objectives in each of the three tiers in the hierarchy are shown in Table 5 through Table 7.

Table 5. Tier 1 Objectives and Definitions

Objective Name	**Definition**
Impact	This category consists of the values associated with business impact to organizations, other than AFSAC construction branch, that lead to the strategic objectives outlined by DoD, Purchasing Nation, and the U.S. Government. Specifically, the selection of the acquisition contract strategy influences the building of defense partnerships.
Programmatic	This category consists of values pertaining to the success factors and metrics of the acquisition contract strategy. These values reflect what the decision maker values in terms of the construction process and inter-agency operations.

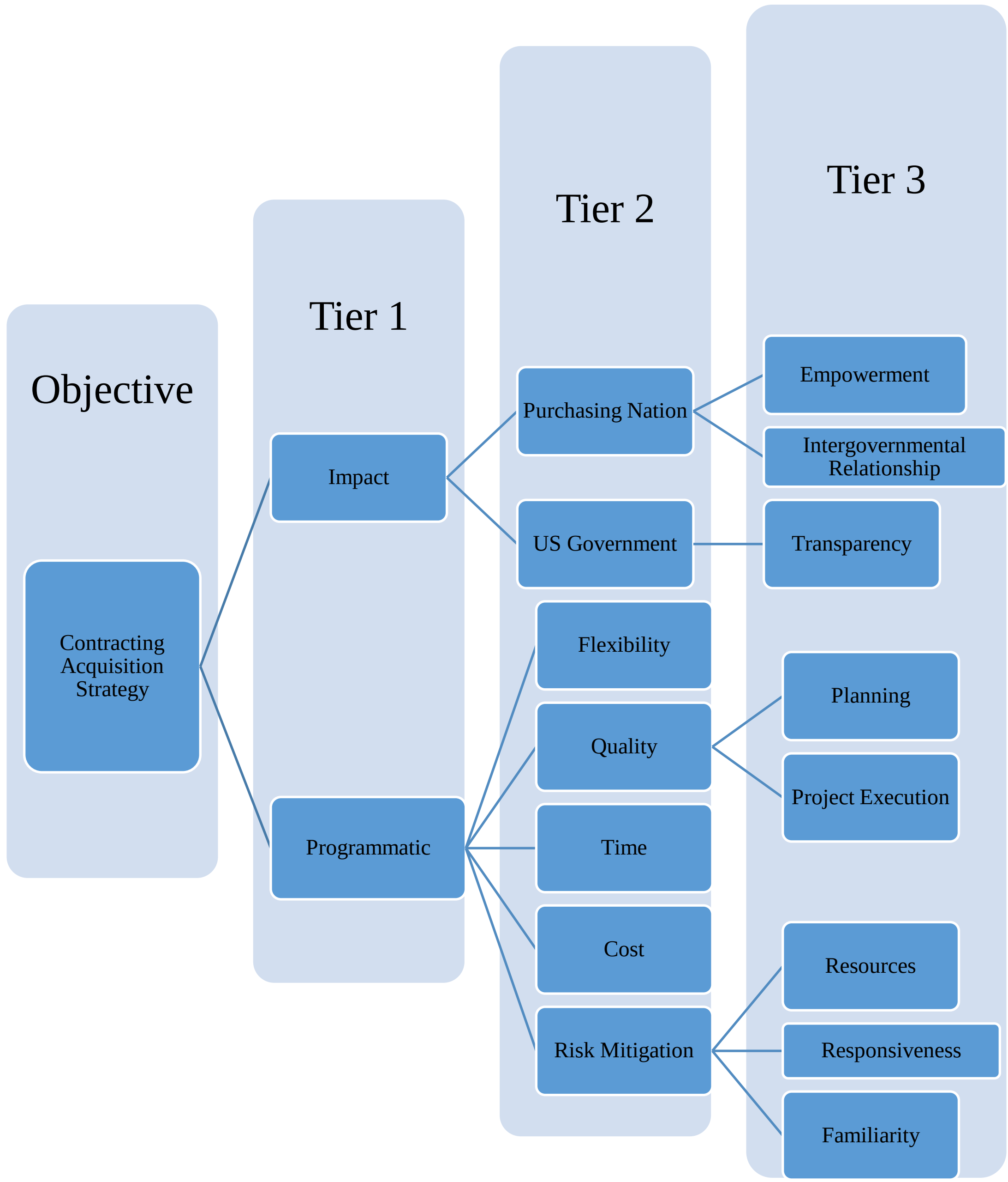

Figure 4. Final Value Hierarchy

Table 6. Tier 2 Objectives and Definitions

Objective Name	**Definition**
Improve Purchasing Nation Relationship	Acquisition contracting strategy selection should improve AFSAC's relationship with purchasing nation counterparts to ensure a successful facility completion. This value was derived from National Defense Strategy, DSCA, AFLCMC, and AFSAC doctrine.
Improve U.S. Government Relationship	Acquisition contracting strategy selection should improve AFSAC and DSCA relationship with Congress and other governmental agencies. This value was derived from National Defense Strategy, DSCA, AFLCMC, and AFSAC doctrine.
Maximize Flexibility	Acquisition contracting strategy selection should maximize flexibility in order to address unforeseen circumstances or changes without impacting the completion of the facility. This value was derived from the literature review on critical success factors and the AFSAC value survey.
Maximize Quality	Acquisition contracting strategy selection should maximize the quality of the project through the Tier 3 values of capitalizing on planning efforts and established Quality and Assurance project execution procedures. This value was derived from the literature review on critical success factors and the AFSAC value survey.
Maximize Risk Mitigation	Acquisition contracting strategy selection should maximize risk mitigation procedures through the Tier 3 values of maximizing resources available for risk mitigation, capitalizing on responsiveness, and capitalizing on agency experience with similar projects. This value was derived from the literature review on critical success factors and the AFSAC value survey.
Minimize Cost	Acquisition contracting strategy selection should minimize additional costs to the construction project associated with agency project management fees. This value was derived from the literature review on critical success factors and the AFSAC value survey.
Minimize Time	Acquisition contracting strategy selection should minimize additional timeline growth to the construction project associated with established procedural timelines for awarding the construction contract and project execution. This value was derived from the literature review on critical success factors and the AFSAC value survey.

Table 7. Tier 3 Objectives and Definitions

Objective Name	**Definition**
Maximize Purchasing Nation Empowerment	Acquisition contracting strategy should empower and involve the purchasing nation. This value was derived from National Defense Strategy, DSCA, AFLCMC, and AFSAC doctrine.
Improve Intergovernmental Relationship	Acquisition contracting strategy should improve U.S. and purchasing nation intergovernmental relationship through the cooperation of both governmental entities. This value was derived from National Defense Strategy, DSCA, AFLCMC, and AFSAC doctrine.
Maximize Transparency	Acquisition contracting strategy selection should maximize transparency of the construction process in order to ensure proper stewardship of FMS case finances and Congressional oversight mandates are being met. This value was derived from National Defense Strategy, DSCA, AFLCMC, and AFSAC doctrine.
Maximize Planning Efforts	Acquisition contracting strategy selection should maximize planning efforts by incorporating established project planning processes that encourage contractor competition and proper scope development. This value was derived from the literature review on critical success factors and the AFSAC value survey.
Maximize Project Execution Process Quality	Acquisition contracting strategy selection should maximize the project execution process by incorporating established Quality and Assurance procedures. This value was derived from the literature review on critical success factors and the AFSAC value survey.
Maximize Resources for Risk Mitigation	Acquisition contracting strategy selection should maximize resources available for risk mitigation in response to the complexity of the project. This value was derived from the literature review on critical success factors and the AFSAC value survey.
Capitalize on Responsiveness	Acquisition contracting strategy selection should maximize responsiveness regarding the information flow between the construction contractor, construction management agency, AFSAC, and the end user. This value was derived from the literature review on critical success factors and the AFSAC value survey.
Capitalize on Agency Project Familiarity	Acquisition contracting strategy selection should capitalize on the agency’s experience with projects of similar scope, time, and location. This value was derived from the literature review on critical success factors and the AFSAC value survey.

Step Three – Evaluate Measures

Developing evaluation measurements is the next step in constructing the hierarchy. The evaluation measures are used to communicate the degree of completion for values in the hierarchy. The decision-maker also uses these evaluation measurements to convert subjective values to objective or quantitative values. Initial measures were developed through discussions with subject matter experts with a focus on keeping the evaluation measurements as easily understood as possible to measure value attainment.

There are three types of measures associated with the VFT process. The first and most desired type is the natural measure (Keeney, 1992), which is a quantitative measure in which attainment of the measure directly equates to the attainment of the value in the hierarchy. For example, the procedural fee for construction management services would be a natural measure based on cost. The second type of measure is the constructed measure, which indirectly evaluates the level of attainment of the desired value from qualitative data gained from the decision-maker or subject matter expert (Keeney, 1992). For example, the perceived impact on intergovernmental relationships as a result of the decision would be a constructed measure. The subject matter expert would provide a qualitative response for the level of attainment of the measure based on experience. The final and least desirable measure is the proxy measure, which utilizes quantitative data to indirectly evaluate the level of attainment of the value (Keeney, 1992). For example, the procedural timeline associated with a change order would be an indirect way to measure flexibility. Although the procedural time to process a change order is quantifiable, a long lead-time would reflect the flexibility of the contracting or construction management agency. The measures in Table 8 were derived from a review of construction-related critical success factors in the literature and inputs from the AFSAC construction branch.

Table 8. Model Evaluation Measures

	Objective	**Measure**	**Type**
1	Improve Purchasing Nation Empowerment	Level of Purchasing Nation Involvement with Construction Process.	Constructed
2	Improve Intergovernmental Relationship	Perceived Impact on Purchasing Nation and U.S. relationship.	Constructed
3	Maximize Transparency	Level of Transparency to U.S. government of construction process.	Constructed
4	Minimize Cost	Additional Fee required by construction agency to perform contracting and construction oversight functions.	Natural
5	Minimize Time	Additional Procedural Time required by construction/contracting agency to award project from receipt of requirement.	Proxy
6	Minimize Time	Additional Procedural Time required by construction/contracting agency to execute construction project.	Proxy
7	Maximize Resources for Risk Mitigation	Level of resources organic to the construction/contracting agency for project oversight.	Constructed
8	Maximize Resources for Risk Mitigation	Level of additional resources AFSAC must provide to ensure project oversight with AFSAC standards.	Constructed
9	Maximize Responsiveness	Frequency of regularly scheduled project updates and communication with project team.	Natural
10	Capitalize on Agency Experience	Number of projects agency has completed with similar scope, timeline, and location.	Natural
11	Maximize Flexibility	Additional Procedural Timeline associated with processing change orders.	Proxy
12	Maximize Flexibility	Additional Procedural Cost associated with processing change orders.	Proxy
13	Maximize Planning Efforts	Availability of site-survey	Proxy
14	Maximize Planning Efforts	Availability of Two-Phase bid process with potential construction contractors.	Proxy
15	Maximize Planning Efforts	Number of qualified contractors available to bid with established processes	Proxy
16	Maximize Project Execution Process Quality	Level of Defined Quality and Assurance processes during construction and close-out of project.	Constructed

Step Four – Create Value Functions

The next step in the VFT process is to define the value function for each evaluation measure identified in Step 3. The value function, known as the Single Dimension Value Function (SDVF), is developed by converting differing units and scales of evaluation measures for a hierarchy into a common value. Each scale is bounded by upper and lower limits where the value for each evaluation measure is between 0.0 (least value attainment) and 1.0 (full value attainment). An SDVF was created for each measurement. SDVFs for the model are located in Appendix B.

The first step in creating an SDVF is to establish the lower and upper bounds for the measurement. Each measurement was analyzed to determine the minimum and maximum possible values each alternative may score. These measurement limits were determined through the literature review and discussions with the AFSAC construction branch. Table 9 shows a consolidated listing of the upper and lower bounds used for each SDVF.

Once the upper and lower bounds are identified, an SDVF is created. Two primary types of SDVFs were used in this research: categorical and linear. A categorical SDVF is used when the data for alternatives is non-specific. For example, the SDVF for a procedural timeline associated with processing a change order, shown in Figure 5, is scaled to weekly categories. An alternative with an established and expedient change order process will score high on the SDVF scale. An advertised change order process of less than a week would receive a maximum score of 1 for the measure. An advertised change order process of more than three weeks would receive the lowest score of 0.25.

Table 9. Measurement Upper and Lower Bound Limit Summary

	Objective	Measure	Lower Limit	Upper Limit
1	Improve Purchasing Nation Empowerment	Level of Purchasing Nation Involvement with Construction Process.	0%	100%
2	Improve Intergovernmental Relationship	Perceived Impact on Purchasing Nation and U.S. relationship.	0%	100%
3	Maximize Transparency	Level of Transparency to U.S. Gov of construction process.	Does Not Meet Requirements	Meets All Requirements
4	Minimize Cost	Additional Fee required by construction agency to perform contracting and construction oversight functions.	0%	20%
5	Minimize Time	Additional Procedural Time required by construction/contracting agency to award project from receipt of requirement.	120+ Days	<30 Days
6	Minimize Time	Additional Procedural Time required by construction/contracting agency to execute construction project.	3+ Years	<180 Days
7	Maximize Resources for Risk Mitigation	Level of resources organic to the construction/contracting agency for project oversight.	0	10
8	Maximize Resources for Risk Mitigation	Level of additional resources AFSAC must provide to ensure project oversight with AFSAC standards.	10	0
9	Maximize Responsiveness	Frequency of regularly scheduled project updates and communication with project team.	Quarterly	Bi-Weekly
10	Capitalize on Agency Experience	Number of projects agency has completed with similar scope, timeline, and location.	0 Projects	>20 Projects
11	Maximize Flexibility	Additional Procedural Timeline associated with processing change orders.	>3 Weeks	<1 Week
12	Maximize Flexibility	Additional Procedural Cost associated with processing change orders.	0	10
13	Maximize Planning Efforts	Availability of site-survey	No	Yes
14	Maximize Planning Efforts	Availability of Two-Phase bid process with potential construction contractors.	No	Yes
15	Maximize Planning Efforts	Number of qualified contractors available to bid with established processes	0	10
16	Maximize Project Execution Process Quality	Level of Defined Quality and Assurance processes during construction and close-out of project.	0%	100%

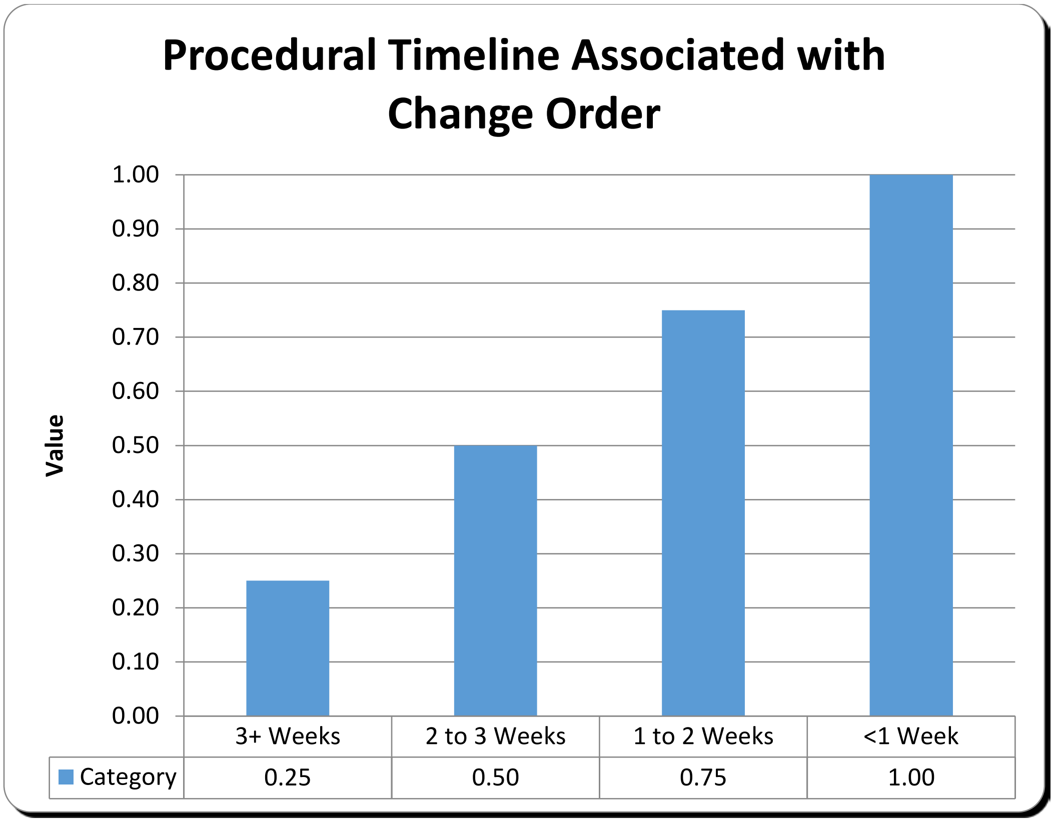

Figure 5. Categorical SDVF Example

A linear SDVF is used when there is a direct relationship between the value and the measure. For example, the programmatic fee associated with construction oversight, shown in Figure 6, is a direct measure to the value attainment. The project cost can increase as a result of fees included by different agencies involved in the process. The use of a DoD Construction Agent such as the U.S. Army Corps of Engineers adds a percentage fee to the project cost for construction and contracting oversight services. If the fee was not included in the Letter of Acceptance estimate, the AFSAC Construction Branch will need to request additional funds from the purchasing nation to execute the project. A SDVF score of 1 represents a 0% additional incurred cost as a result of a programmatic fee, while a SDVF score of 0 represents the negative limit of a 20% programmatic fee.

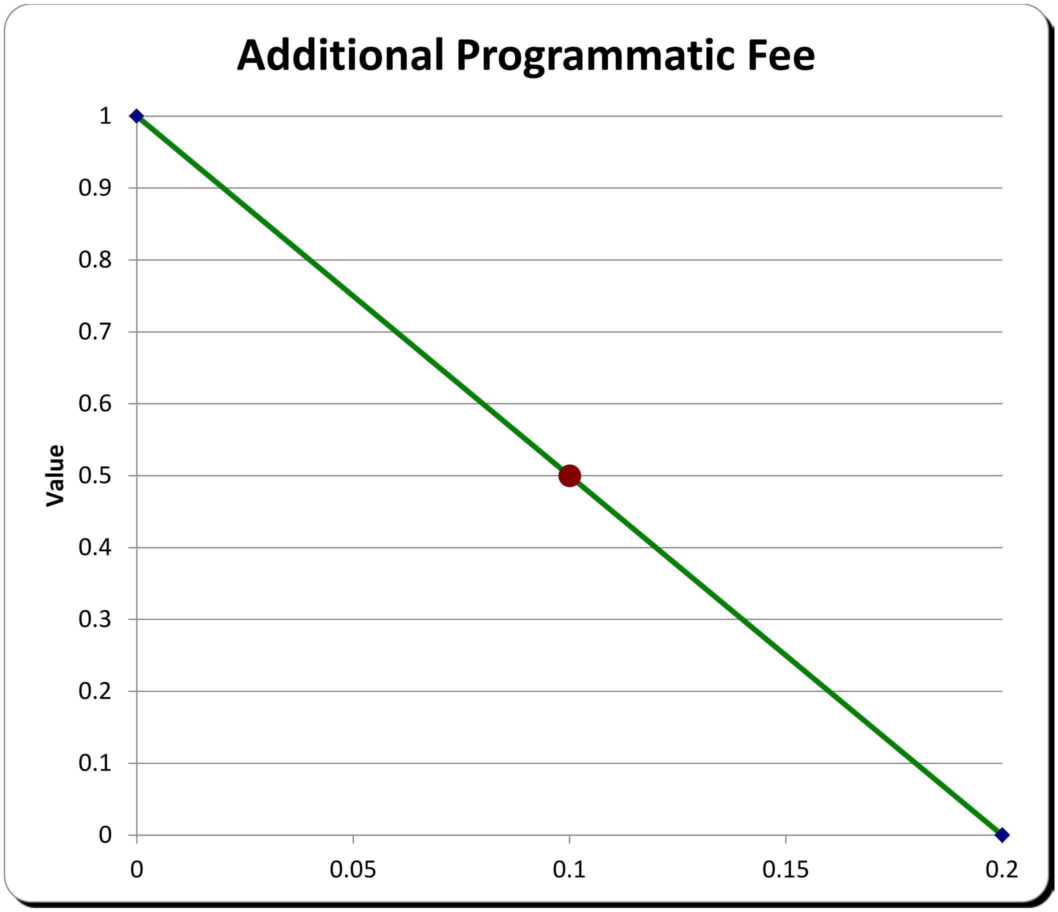

Figure 6. Linear SDVF Example

Step Five – Weighting the Value Hierarchy

The next step to the VFT process is weighting the value hierarchy. This step is performed independently from alternative generation to remove any decision bias towards a pre-conceived optimal solution. The values within each tier are weighted such that the total in any tier within a single branch equals 1. For example, the Tier 1 values of Impact and Programmatic branches are weighted 0.3 and 0.7, respectively, as seen in Figure 7. The "100-marble" method was utilized to assign the weights; the weights were then validated by the AFSAC construction branch.

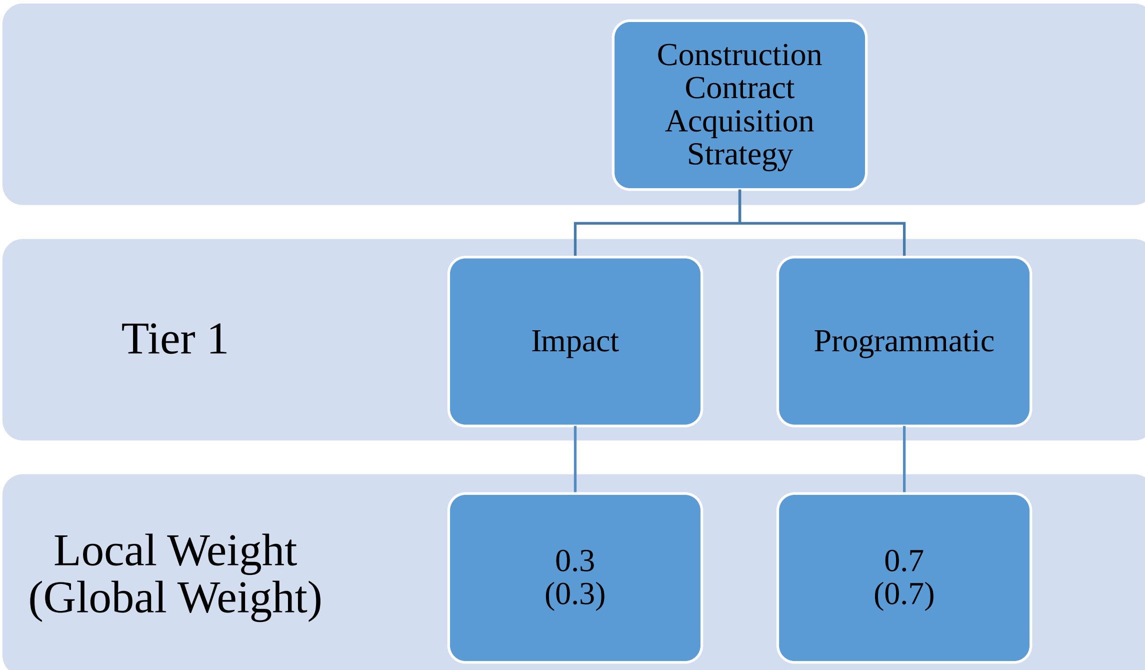

Figure 7. Tier 1 Weights

Additionally, the sub-values are weighted locally such that the sub-values of the primary value in the higher tier equal to 1. This weighting strategy produces two weights: global weight and local weight. The local weight corresponds to the weighting within the primary or higher tier value. The global weight corresponds to the weighting of the entire model. The weightings of the Impact and Programmatic Branch are seen in Figure 8 and Figure 9, respectively.

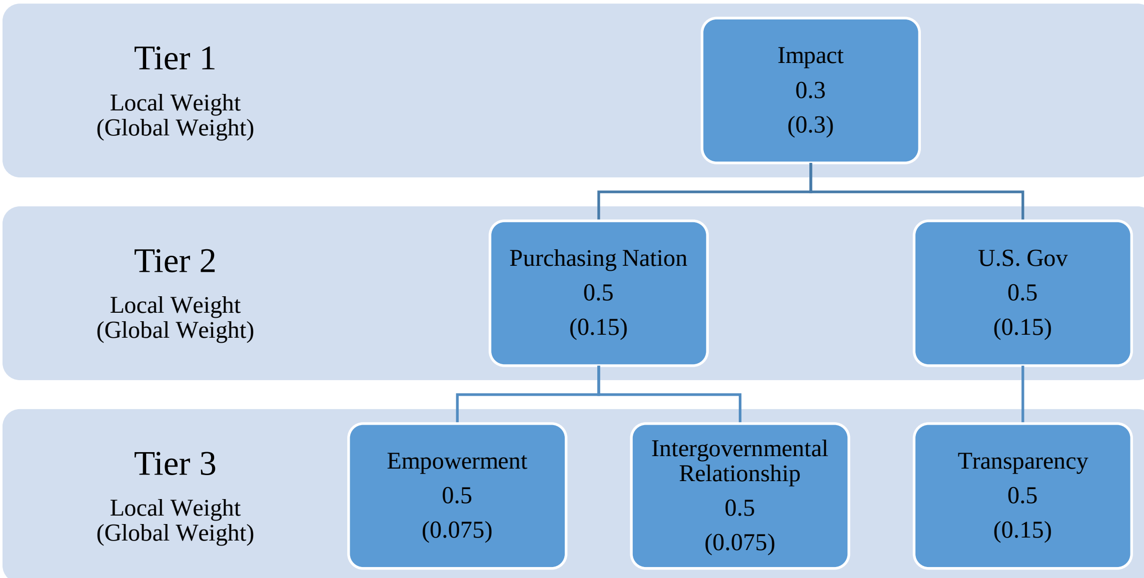

Figure 8. Impact Branch Weighting

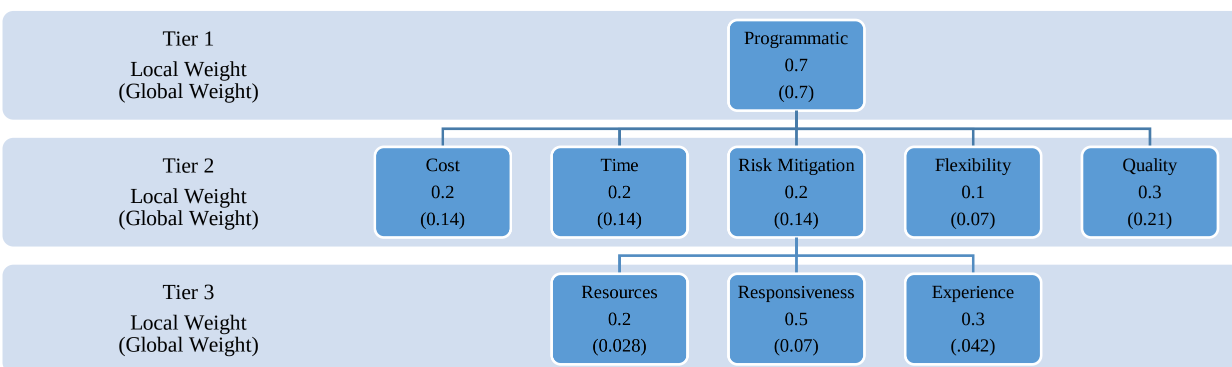

Figure 9. Programmatic Branch Weighting

Summary

This chapter provides a brief description of the theory behind the VFT process and applies the first five steps of the VFT process for the creation of the VFT model. The first step is to identify and define the problem statement. For this research, the problem statement is selecting the optimal construction contracting acquisition strategy to include selecting contracting agent, construction agent, and project delivery method. The second step is to create the value hierarchy without weights or measures assigned. The values were attained through a review of published organizational guidance from the DSCA, U.S. Air Force, and AFSAC levels, as well as input from the construction branch organization. The third step is to identify measures that reflect attainment of the values in the hierarchy. The fourth step is to scale or normalize the measurements through the Single Dimension Value Function. The final step in creating the value model is to weight the values within the model. With the creation of the VFT model, alternatives can be generated and analyzed to select the optimal construction contracting acquisition strategy.

IV. Analysis and Results

This chapter details the next four steps of the Value-Focused Thinking (VFT) process and provides the results of the VFT model selecting the optimal construction contract acquisition strategy. Step six details the identification of possible alternatives based on the values identified in the hierarchy. Step seven details the alternative scoring through the use of Excel-based software. Step eight provides the deterministic results of the model. Step nine provides the sensitivity analysis of the measures of the model.

VFT Process Six through Nine

Step Six – Alternative Generation

There are four primary variables to selecting a construction contract acquisition strategy analyzed in this research. First, the contracting agent is selected. The agent must have the resources and authority in the form of a large enough warrant to award major construction projects. This currently limits the DoD's options to USACE, NAVFAC, and AFICA. As identified in the literature review, other governmental agencies such as the Department of Justice and the Department of State also have the capability to award construction projects on behalf of the U.S. government. Second, the Design and Construction Agent (DCA) is selected. AFSAC does not have design or construction oversight services organic to the Construction Branch. USACE and NAVFAC include design and construction services within their organizations. AFICA must rely on USACE, NAVFAC, and in limited cases AFCEC to execute design and construction oversight services. Third, the project delivery method is selected. For this research, the alternatives for the contract structure are limited to Design-Bid-Build and Bid-Build contracts which encompasses most of the current construction program. Due to the time and quality values identified in the hierarchy, a fourth variable was identified addressing the contractor competition environment. Full competition and limited invitation for bid processes define this variable of the project delivery method.   Table 10 shows a consolidated example of the variables included in the Construction Contracting Acquisition Strategy. Through inputs from the AFSAC Construction Branch and published DoD guidance, the 17 alternatives shown in Table 11 were generated. Each alternative represents an independent construction contract acquisition strategy selection.

Table 10. Construction Contracting Acquisition Strategy Components

	Construction Acquisition Strategy Components			
Example Alternative	**Contracting Agent**	**Construction/Oversight Agent**	**Project Delivery Method**	**Competition**
USACE-USACE-DBB-Limited Invite for Bid	U.S. Army Corps of Engineers	U.S. Army Corps of Engineers	Design-Bid-Build	Limited Invite for Bid
AFICA-USACE-DB-Full Competition	Air Force Installation Contracting Agency	U.S. Army Corps of Engineers	Design-Build	Full Competition

Table 11. Acquisition Strategy Alternatives

Construction Contract Acquisition Strategy Alternatives	
U.S. Army Corps of Engineers & Bid-Build Full Competition	Air Force Installation Contracting Agency & Bid-Build Full Competition
U.S. Army Corps of Engineers & Design-Bid-Build Full Competition	Air Force Installation Contracting Agency & Bid-Build Limited Invite for Bid
U.S. Army Corps of Engineers & Bid-Build Limited Invite for Bid	Air Force Installation Contracting Agency & Design-Bid-Build Full Competition
U.S. Army Corps of Engineers & Design-Bid-Build Limited Invite for Bid	Air Force Installation Contracting Agency & Design-Bid-Build Limited Invite for Bid
Naval Facilities Engineering Command & Bid-Build Full Competition	Other U.S. Governmental Agency & Bid-Build Full Competition
Naval Facilities Engineering Command & Bid-Build Limited Invite for Bid	Other U.S. Governmental Agency & Bid-Build Limited Invite for Bid
Naval Facilities Engineering Command & Design-Bid-Build Full Competition	Other U.S. Governmental Agency & Design-Bid-Build Limited Invite for Bid
Direct Commercial Sale	

New Alternative Identification

One of the benefits of utilizing the VFT process as a decision analysis model is that the process allows for the discovery of new alternatives that currently may not exist or are not part of the standard practices. Through the VFT process, the alternative of establishing an organic construction contracting capability within the AFSAC organization was identified. Two of the primary values identified during the VFT process focused on project critical success factors, specifically responsiveness and experience. AFSAC currently relies on external contracting agencies to perform construction contracting functions. Depending on the location of the FMS case, a DoD contracting organization may not have active or recent construction experience. Therefore, having the construction contracting authority organic to the AFSAC organization would curtail the time associated with utilizing a new organization and capitalize on the experience gained from previous cases.

However, the new alternative of a construction contracting authority organic to AFSAC construction branch was not included in the alternative analysis due to the unavailability of data. This alternative is identified as the optimal solution without considering the additional resources and operating agreements needed to establish it as a viable alternative. If the alternative was scored in the value model, the contracting agent organic to AFSAC would attain maximum value for measures of responsiveness and flexibility. Both measurements account for 14% of the global weighting in the model. Furthermore, this alternative would attain maximum value for the familiarity measurement which accounts for 4.2% of the value model. The organic contracting capability would thus attain maximum value on almost 20% of the entire model. The organic contracting capability would reflect value attainment on other measures similar to the AFICA alternatives. Thus, the organic contracting capability would show the highest value attainment of the alternatives identified.

Step Seven – Alternative Scoring

This section reviews the process of populating the values for the measures of each alternative. Each measure was scored based on inputs from the AFSAC construction branch, as well as published policies from the various DoD Construction and Contracting agents. The 17 alternatives were analyzed individually where all measures were populated for a single alternative prior to populating the values for the next alternative. This process reduces any potential scoring bias. It is difficult to remove comparison bias between alternatives when a measure is calculated for each alternative before advancing to the next measure (Kirkwood, 1998).

Impact Branch measurements were obtained from qualitative assessments by the AFSAC construction branch except for the Level of Transparency measurement, which reflects the attainment of compliance mandates set forth by Congress, the DoD, and DSCA. Programmatic Branch measurements were attained from DSCA/AFICA/USACE/NAVFAC published guidance regarding Supervision Overhead and Inspection (SOIP) and Supervision and Administration (S&A) rates, as well as policy guidance when available on responsive rates. Negotiations on services and rates occur during the selection process. However, reduced rates for hybrid services are not guaranteed for every project. Therefore, established policy standards for Other than Continental United States (OCONUS) construction were used to populate the values associated with the programmatic branch. Appendix B provides a detailed listing of the raw data values used for each alternative. Appendix C provides a detailed listing of the value scores obtained from the respective Single Dimension Value Function for each measure.

Step Eight – Deterministic Analysis

Deterministic analysis, the next step in the VFT process, represents the results obtained from VFT model after all the alternatives and measurements were populated with their appropriate data. This step helps the decision-maker see which values have a significant impact on the attainment of the fundamental objective. The overall results are shown in Figure 10.

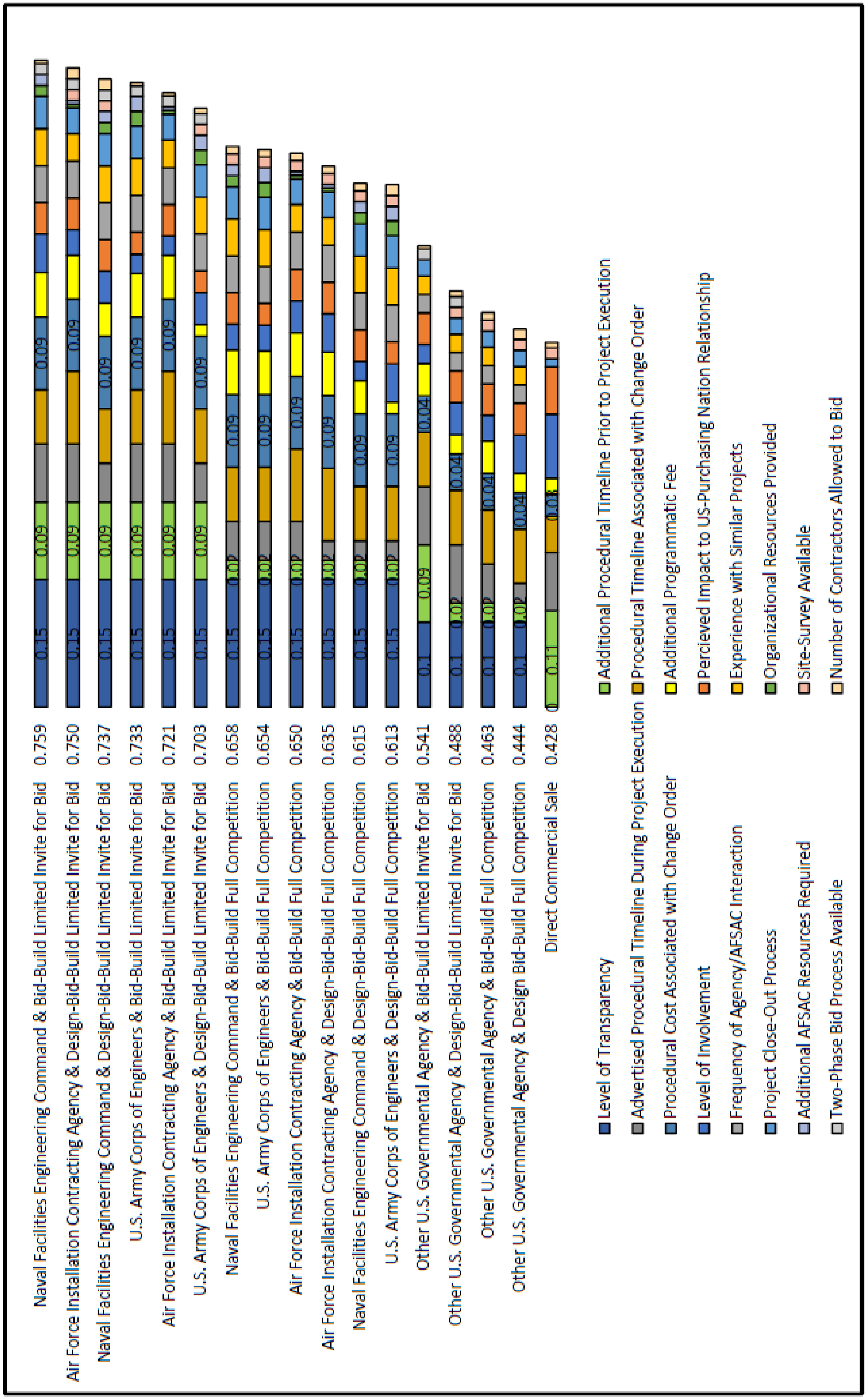

Figure 10. Deterministic Analysis Results

As shown in Figure 10, the transparency and change order measurements accounted for a significant portion of the value scores. The three measurements accounted for 43% (0.33/0.759) of the value for the top scoring alternative, which was NAVFAC Contracting and Construction Execution with Limited Invite for Bid. This value attainment reflects how the oversight mandate dictates the initial selection. If a method does not meet the initial pass of the oversight mandate, the alternative must score significantly better on other measures to be considered. The overall deterministic analysis also highlighted how similar the DoD Construction and Contracting Agent alternatives scored. This finding is consistent with other DoD literature analyzing construction agents and found that there is not a significant difference between the processes and fees of USACE, NAVFAC, and AFICA (Kalish & Tarescavage, 2015).

The deterministic results were further analyzed at the Tier 1 value level to show how the model incorporates different measures. Some of the measures are in direct competition with each other. One alternative will score high on one set of measures while scoring lower on others due to advantages and disadvantages of the alternative. Additionally, the Tier 1 analysis shows how the alternative rankings can drastically change when another set of values and weights are included.

Figure 11 displays the deterministic analysis of the Programmatic Branch. As identified in the overall results, there is minimal difference between DoD Construction and Contracting agents. However, the project delivery method valued Limited Invite for Bid favorably. A greater weighting on the Time value (local weight of 0.324) compared to the local weights of 0.108 for Cost and Quality values each greatly influenced the outcome of the alternative rankings. Time was weighted with the utmost importance. Additionally, the Limited Invite for Bid process limits the award to contractors who have experience working similar projects and are vetted as being able to complete the work. This focus on quality comes at a cost though; potential bidders know the pool of applicants is smaller and can command a premium for their services. The model shows a preference for selecting a project delivery strategy with a fast bidding and procedural process while ensuring the quality of the project. The top six alternatives in the Programmatic Branch were variations of DoD Construction & Contracting agents with a Limited Invite for Bid.

Figure 12 displays the deterministic analysis for the Impact Branch. As identified in the deterministic analysis, the weighting on the Level of Transparency measure does not allow an alternative that does not meet the oversight requirements to be competitive. A direct commercial sale alternative as well as single source contracting is available but the AFSAC Construction Branch will not retain primary responsibility of the project execution. Using these alternatives require coordination with the SCO and AFSAC FMS case manager to ensure the support facilities meet standards set forth by the U.S. government and the end-item supplier.

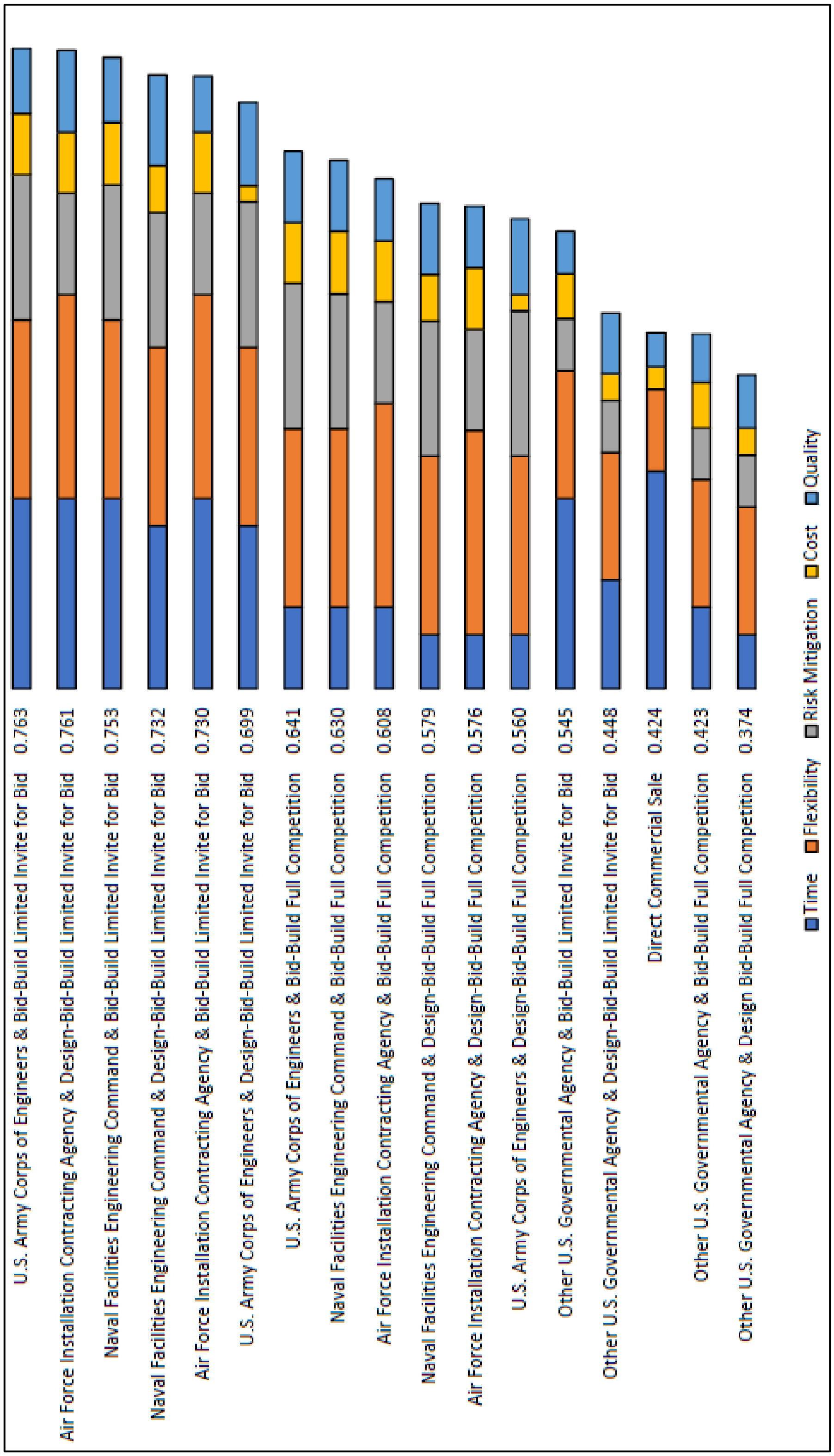

Figure 11. Programmatic Branch Results

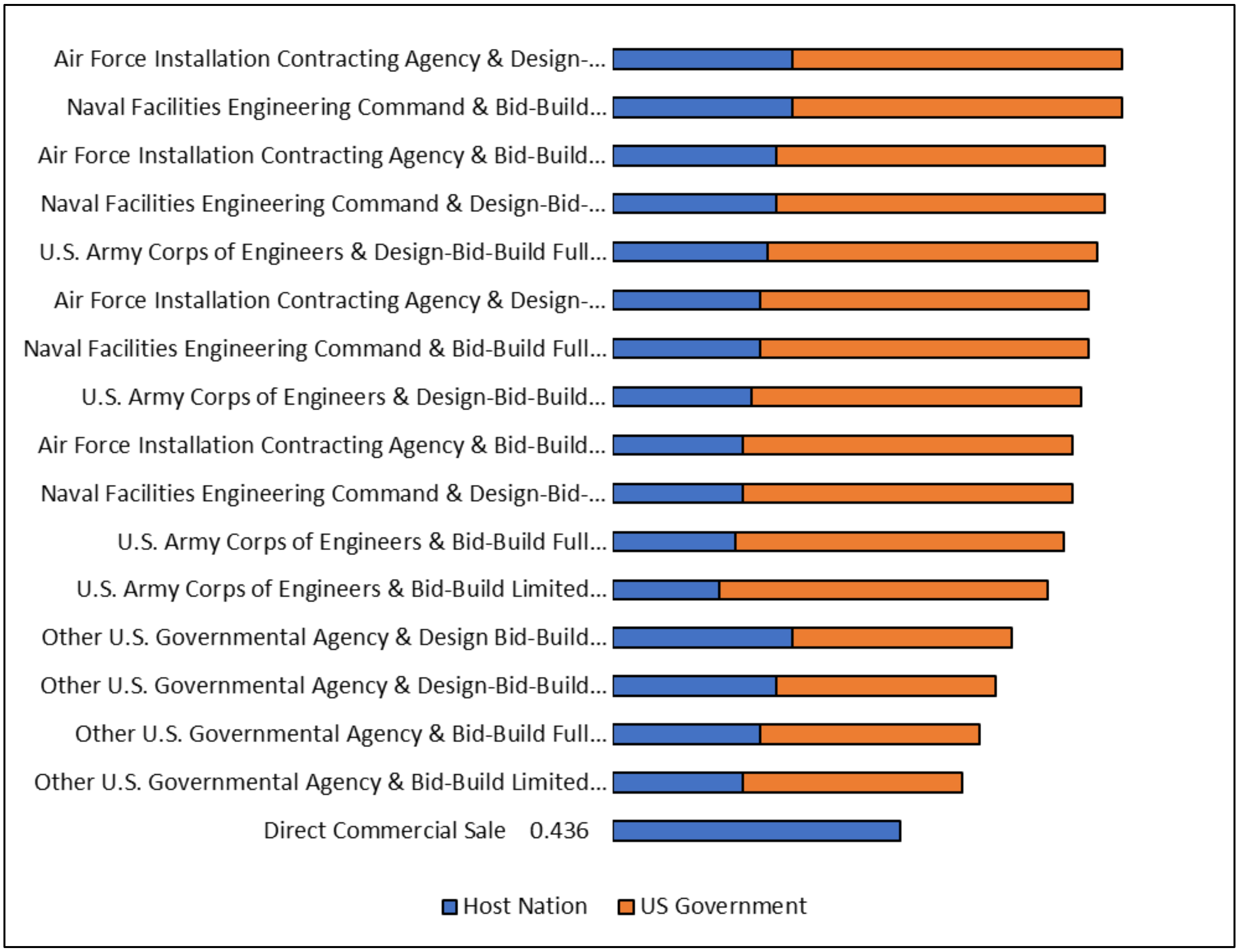

Figure 12. Impact Branch Deterministic Analysis

Step Nine – Sensitivity Analysis

The next step in the VFT process is the sensitivity analysis, which is performed to show the decision-maker how the ranking of alternatives can change with a change in the hierarchy weights. This analysis provides an opportunity to isolate a single value of the model and see the impact it has on the alternative ranking outcome. For example, if the model is used for a future project selection and Time is not primary concern, the sensitivity analysis on the Time value will graphically show the change in alternative rankings based on the lesser weight for that value. This analysis can be done without having to re-run the model in its entirety.

The sensitivity analysis for the Tier 1 values (Impact and Programmatic) are displayed in Figure 13 and Figure 14, respectively. The Impact Branch sensitivity analysis shows a grouping of DoD Construction and Contracting agents towards the higher scores. Of note, there is one alternative that is not on a positive slope, which means that a higher value weight will result in a higher alternative score. The USACE Bid-Build Limited Invite for Bid alternative would decrease in ranking as the Relationship Impact value increases in weight. This decrease is due to the combination of the prior project relationship with the purchasing nation and the purchasing nation's empowerment measure using the Limited Invitation for Bid project delivery method. Additionally, the Direct Commercial Sale alternative does not score high on the Impact branch due to the low score associated with the Transparency measure.

The Programmatic Branch sensitivity analysis displays two groupings. For the first grouping, the DoD Construction and Contracting Agents score higher on the model regardless of the project delivery method. This grouping is due to the values associated with experience with similar projects and having well defined processes and procedures for construction. The second grouping occurs with the project delivery method where Limited Invite for Bid projects scored higher in the model. This grouping is due to the values associated with time and quality. As identified earlier, the model is weighted towards providing a timely product to meet the delivery deadline of the end-item.

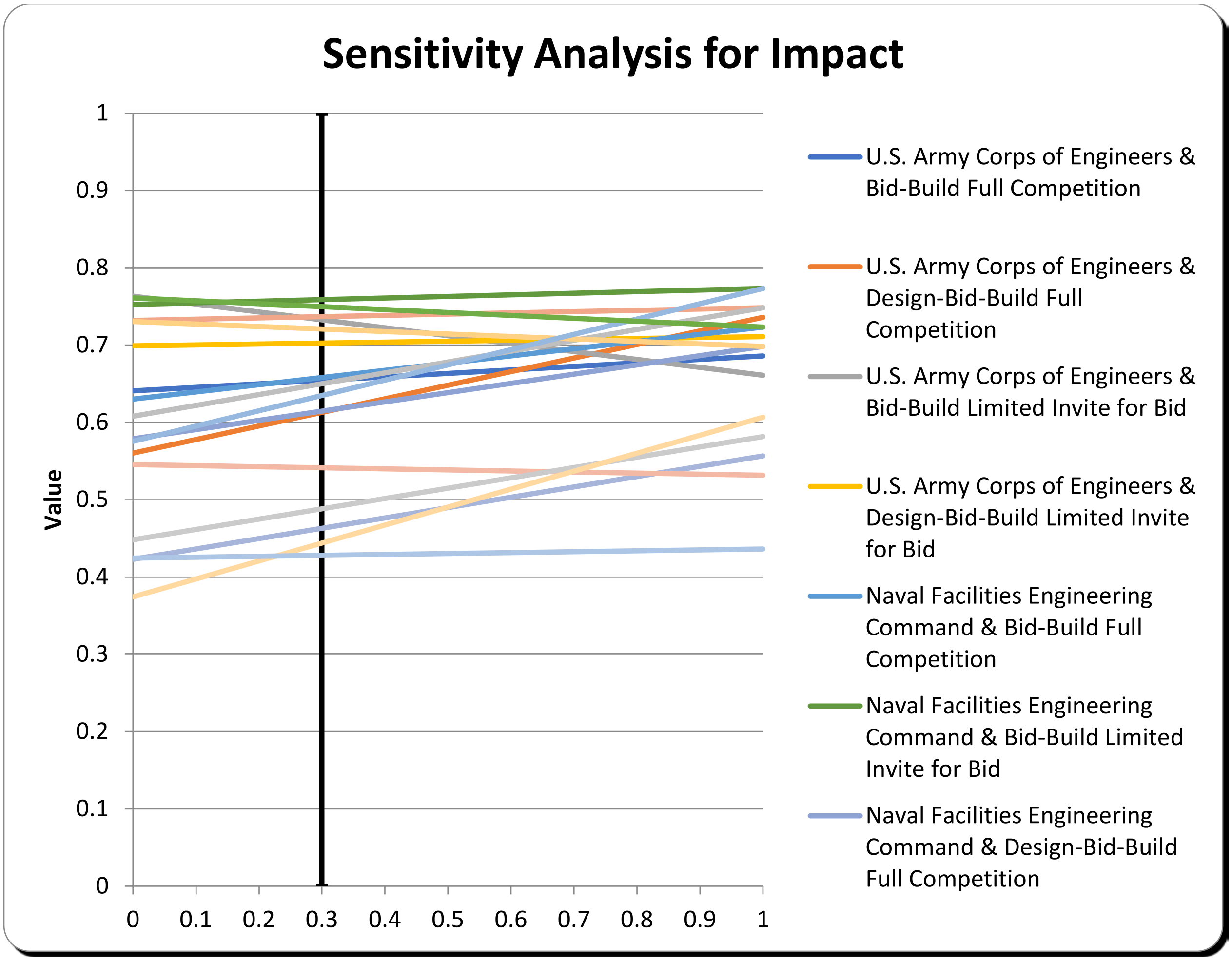

Figure 13. Sensitivity Analysis for Impact Branch

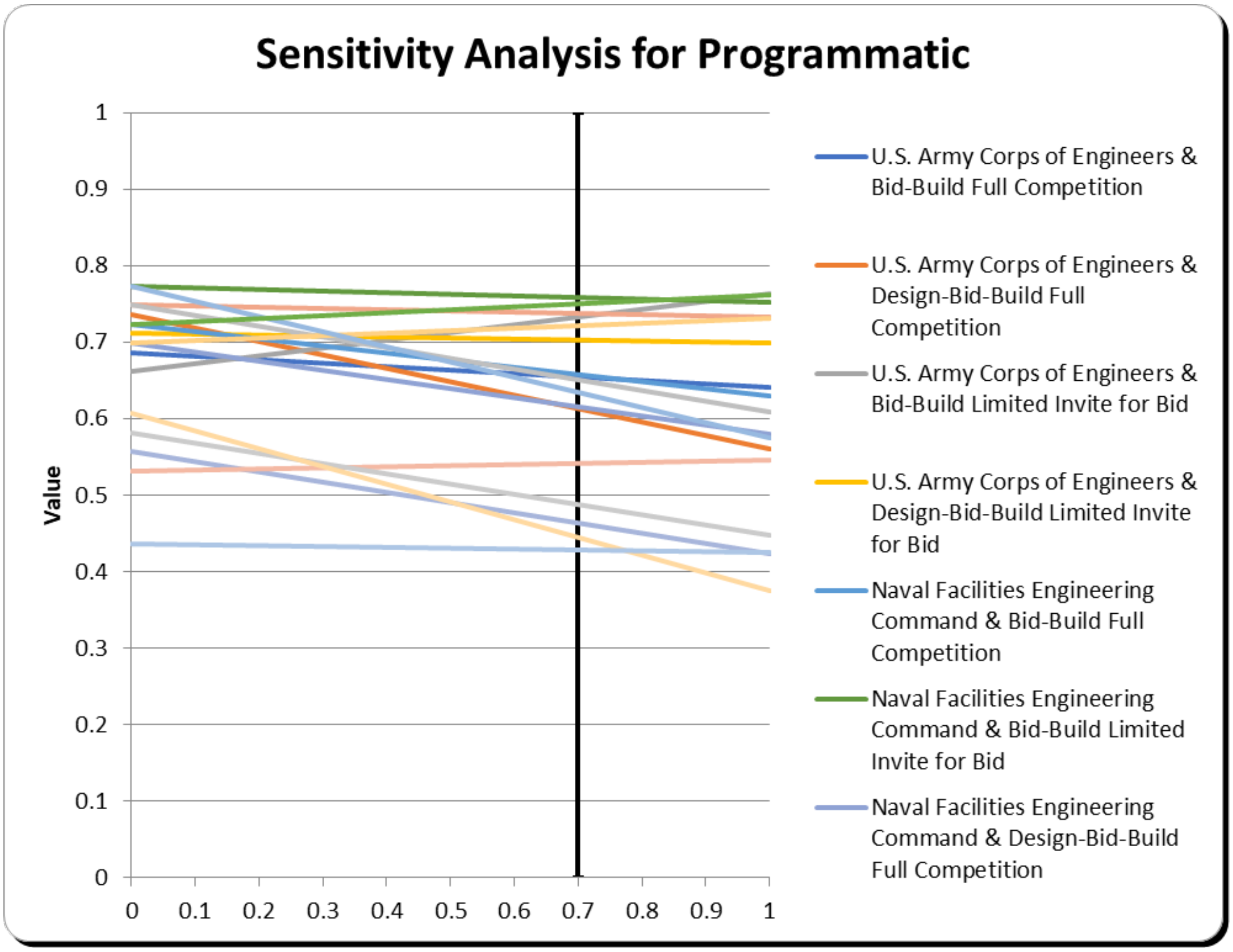

Figure 14. Sensitivity Analysis for Programmatic Branch

Within the Programmatic Branch, sensitivity analyses were conducted as displayed in Figure 15 through Figure 17. Of note, there is an increased variability between alternatives within the Time and Risk Mitigation values as the weights are changed. If the Time value was the only factor in the decision, a Direct Commercial Sale would be recommended. However, this alternative fails to account for Risk Mitigation strategies on behalf of the U.S. government. This comparison shows the utility of the VFT model and how it balances alternative score extremes.

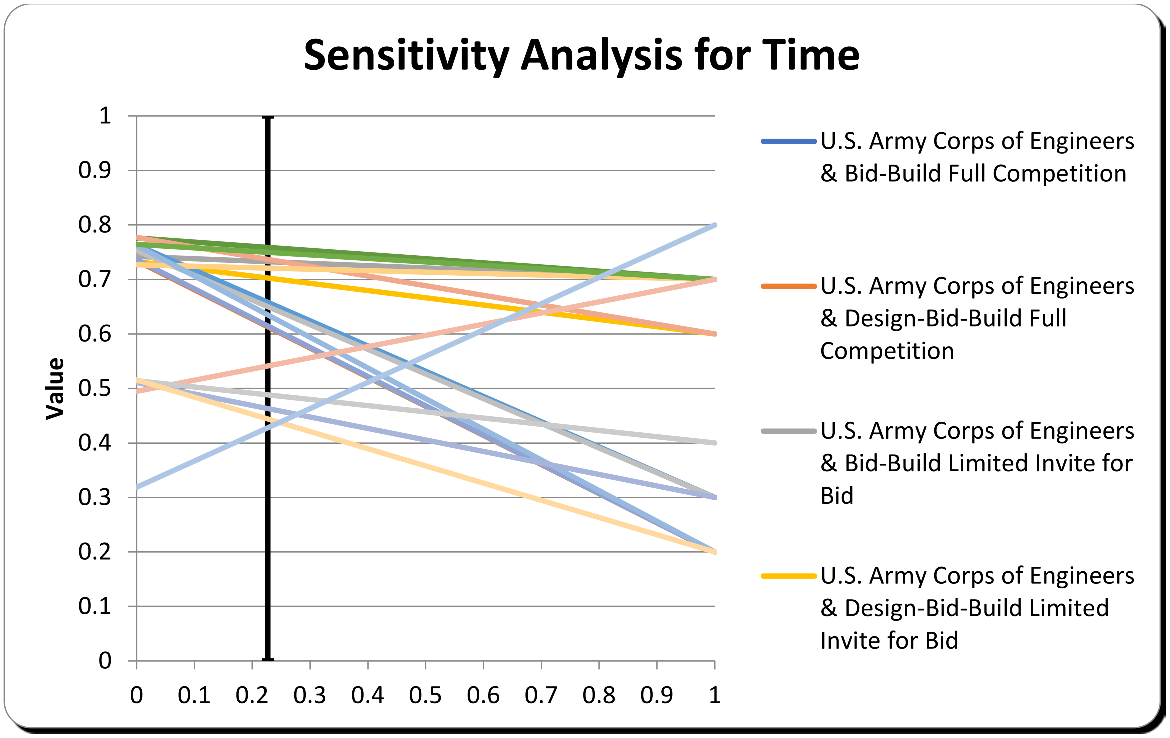

Figure 15. Sensitivity Analysis for Time

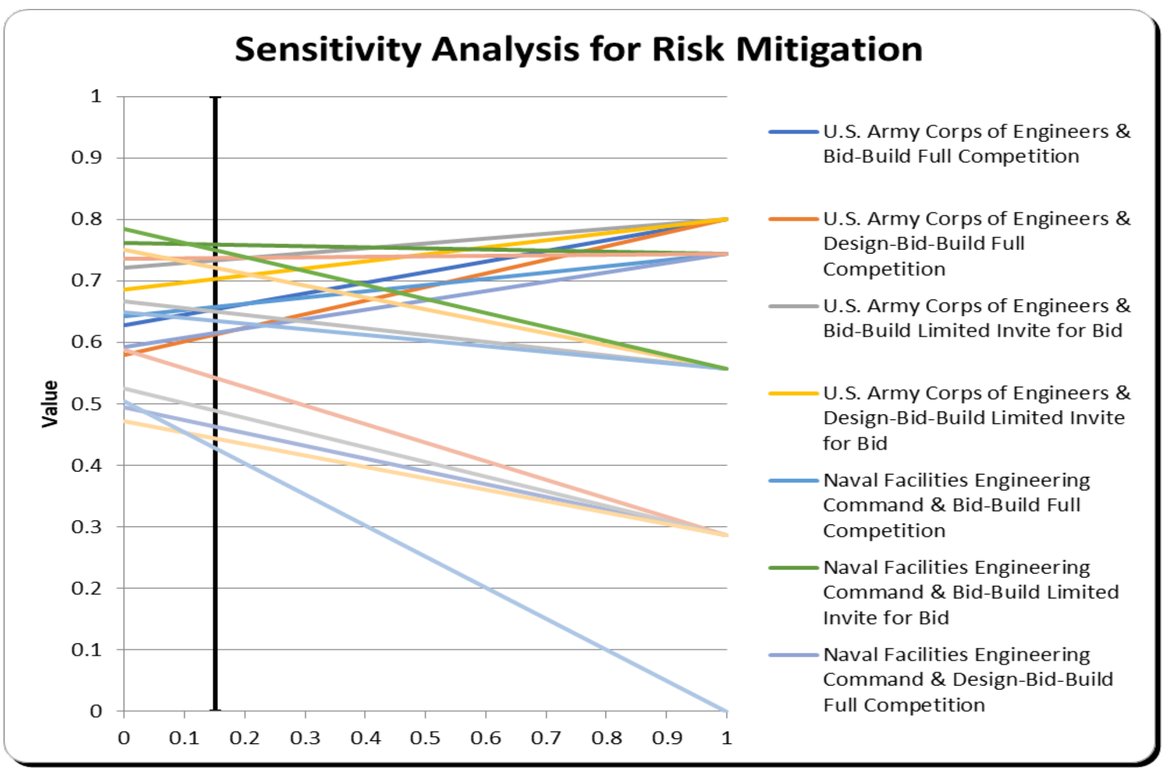

Figure 16. Sensitivity Analysis for Risk Mitigation

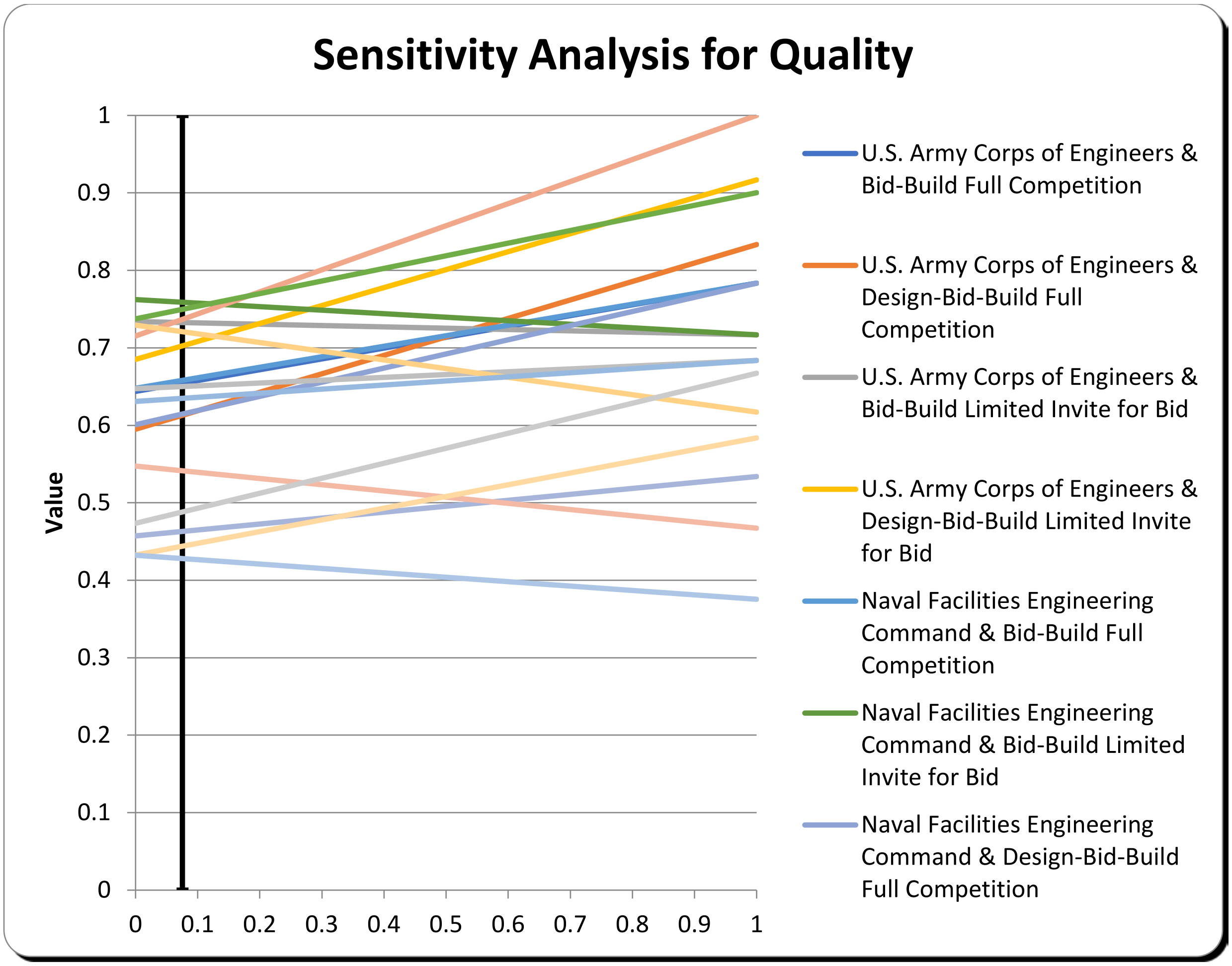

Figure 17. Sensitivity Analysis for Quality

Summary

This chapter detailed the next four steps of the VFT process and provided results of the VFT model in selecting the optimal construction contract acquisition strategy. Step six identifies possible alternatives based on the values identified in the hierarchy. Step seven scores the alternatives using Excel-based software. Step eight provides the deterministic results, and step nine provides the sensitivity analysis. Alternatives that focused on providing a timely product and meeting transparency requirements scored well, as reflected by the DoD Construction and Contracting Agents utilizing a Limited Invite for Bid Design-Build project delivery method.

V. Conclusions and Recommendations

The purpose of this chapter is to summarize the results of the VFT model and its impact on assisting the AFSAC Construction Branch select a construction contracting acquisition delivery strategy. The final step of the VFT process is to provide conclusions and recommendations. The initial research questions and objectives are revisited. A summary of limitations is included as well as a recommendation for future research opportunities.

Step Ten – Conclusion/Review of Results

As identified in Chapter I, the primary objective of this research is to develop a decision tool to assist the AFSAC International Construction Branch select an optimal construction acquisition contract strategy and provide a defensible process to garner stakeholder support. The VFT model utilizes value equations derived from a hierarchy that reflect the values decision-makers account for when selecting and advocating for a construction acquisition contract strategy. To guide this research, the following research questions were developed.

1. What value hierarchy applies to facility construction in an international environment?
2. How can the Value Focused Thinking approach assist the AFSAC Construction Branch execute their mission?
3. How sensitive is the model to changes in weightings of measurements?

The Value-Focused Thinking process, to include the value hierarchy, was selected as the primary method of research due to its applicability across multiple scenarios while maintaining the fundamental objectives and core values of the organization. The hierarchy was developed in three stages. First, the "iron triangle" of Cost, Time, and Quality associated with project management was used as the baseline starting point for creating the hierarchy. Second, a review of current policy regarding the Security Cooperation Officer Program, as well as Defense Security Cooperation Agency guidance, revealed the importance of building security partnerships with U.S. allies. This focus on relationship building was included in the hierarchy. Third, input from the AFSAC Construction Branch was used to identify additional decision-maker values. These values reflected qualities such as responsiveness, experience, and procedural flexibility in addition to the values identified in the first two iterations. This process led to a three-tier VFT model with 17 Values and 16 measurements. The weights were derived from construction critical success factors and input from the AFSAC construction branch. The value hierarchy was created, thereby satisfying the first research question.

The second investigative question involves the implementation of the VFT model in the AFSAC decision-making process. Due to the complexity the FMS program to include intergovernmental sensitivities and oversight mandates, the AFSAC Construction Branch must brief their selected construction contract acquisition strategy for approval by the FMS case manager, purchasing nation, and AFSAC leadership. The VFT model provides a repeatable and defensible data-driven approach that can alleviate decision bias. Furthermore, the VFT can display value trade-offs between alternatives and guide stakeholders to an alternative selection that is agreeable for all parties involved. Therefore, the model can be incorporated into the decision approval briefs as additional support for the alternative selected.

The third investigative question involves analyzing how sensitive the model is to changes in weighting. A sensitivity analysis was performed on the Tier 1 values of Impact and Programmatic branches. The analysis was performed at this level of the hierarchy due to one branch focusing on the qualitative factors associated with intergovernmental relationships and the other branch focusing on quantitative measures associated with project success. The top six ranking alternatives would not change significantly as the weighting changed between the two branches. However, the remaining alternatives increased in value attainment as the weighting on the impact branch increased.

Limitations

Despite the utility of the VFT model developed in this research, there are limitations to its effectiveness. The quality of the data used in the model must be accurate. International construction metrics on cost and responsiveness, specifically within the DoD, can vary from project to project, as well as within the operating theater. The alternative scoring process used data from published USACE, AFICA, and NAVFAC policies and processes. For example, AFICA strives to respond and execute a change order within five days (AFICA 2017). However, the timeline for a change order depends on many factors and a complex change order may not be as quick to resolve. Furthermore, fee and service negotiations occur between the AFSAC construction branch and the respective contracting or construction agent. This negotiation may differ from established policy due to risk mitigation resources that are available and the risk associated with the project. Published guidance was utilized as a starting point for the model.

Another limitation to this research is the large scope of the VFT model. Initially, the research was confined to the programmatic aspects of an international construction project. However, during the research, more measures and values were discovered. While this model is now tailored to the AFSAC Construction Branch process, a model too large will not identify a statistically differentiated alternative. The impact of a weighted measure will not be significant to the overall model if it must compete with multiple measures.

Future Research Opportunities

As identified in the limitations section, future research opportunities exist to build on this research. The Tier 1 values can be separated and analyzed as individual hierarchies. This analysis will allow the researcher to refine a portion of the overall model with detailed data and incorporate new alternatives. Additionally, the VFT model can be re-weighted to reflect a generic standard project for other military construction entities. Specifically, the same process and construct can be applied to U.S. Navy and U.S. Army FMS facility construction initiatives.

Appendix A. Value Discovery Guide

Problem Statement Question:

What is important to me in terms of selecting a construction delivery strategy?

What do I value in the strategy selection?

Value Identification:

1. In an optimal environment with no constraints:
    a. What do you (from an organizational and project manager perspective) want?
    b. What do you value?
    c. What should you want or try to achieve?

How to get there:

2. What is the optimal way to achieve those desired effects? (Perfect Alternative)
3. What is the worst way? (Negative Alternative)
4. What is an acceptable way? (Goldilocks)

Problems/Shortcomings:

5. What are the negatives to each alternative?

Goals and Constraints:

6. What are you trying to achieve with the alternative?
7. What limitations are in place?

Different Lens:

8. What are the concerns from other organizations regarding your desired alternative?

Strategic Objectives:

9. What values are non-negotiable to achieve the ultimate objective?

Appendix B. Single Dimension Value Functions

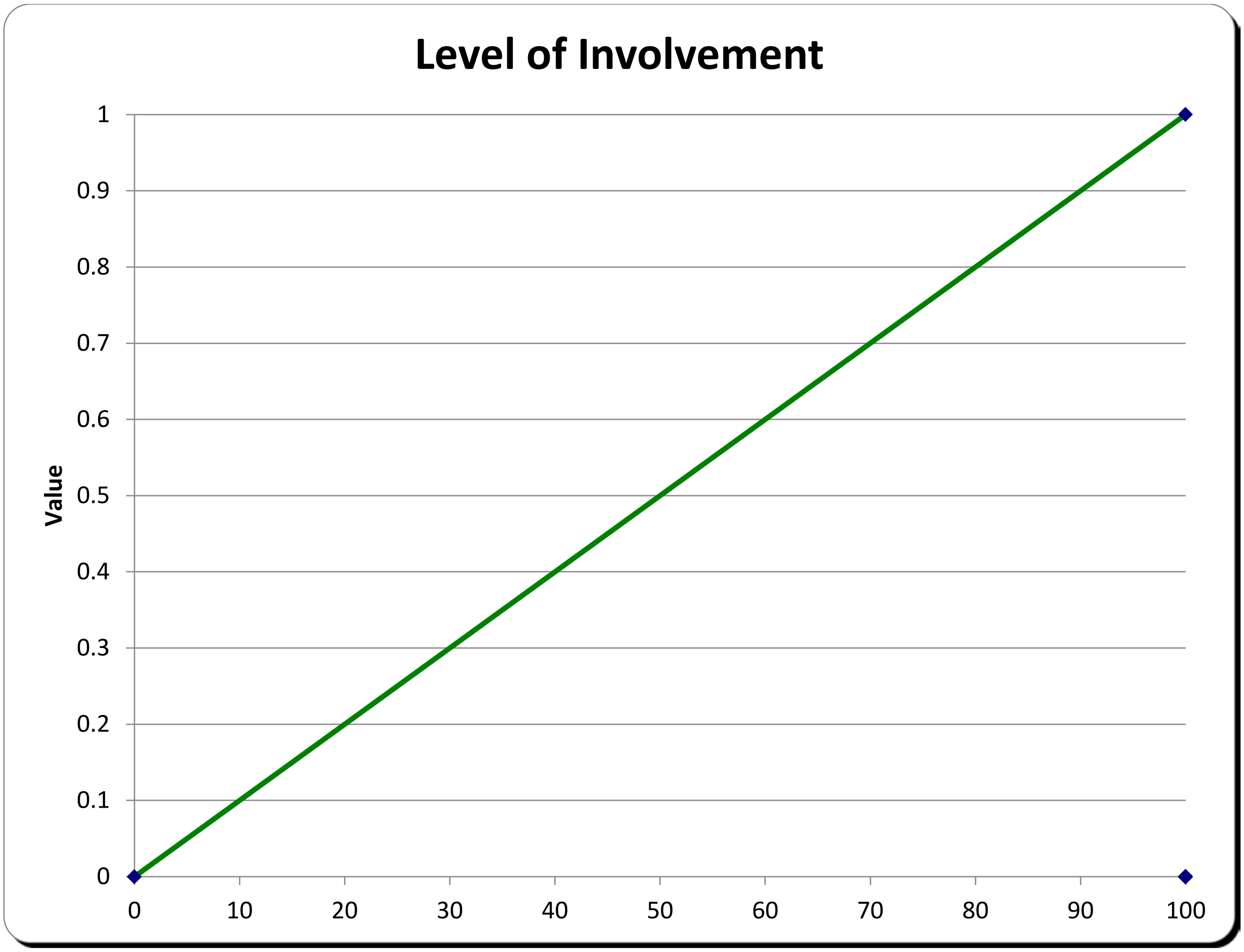

Figure 18. Level of Involvement SDVF

The level of involvement measurement reflects the attainment of the purchasing-nation empowerment value. The more autonomy and responsibility the purchasing nation has over the construction process, the higher the value of empowerment the purchasing nation has. The empowerment measure reflects the building strategic partnership ties by giving control of the process to the purchasing nation to meet their own need for the construction project. A direct commercial sale represents the upper bound maximum where the purchasing nation has requested to not use the services of the AFSAC construction branch and elects to have full control of the construction process. A request by the purchasing nation to relinquish full control of the construction process to the AFSAC construction branch represents the lower bound limit of the SDVF.

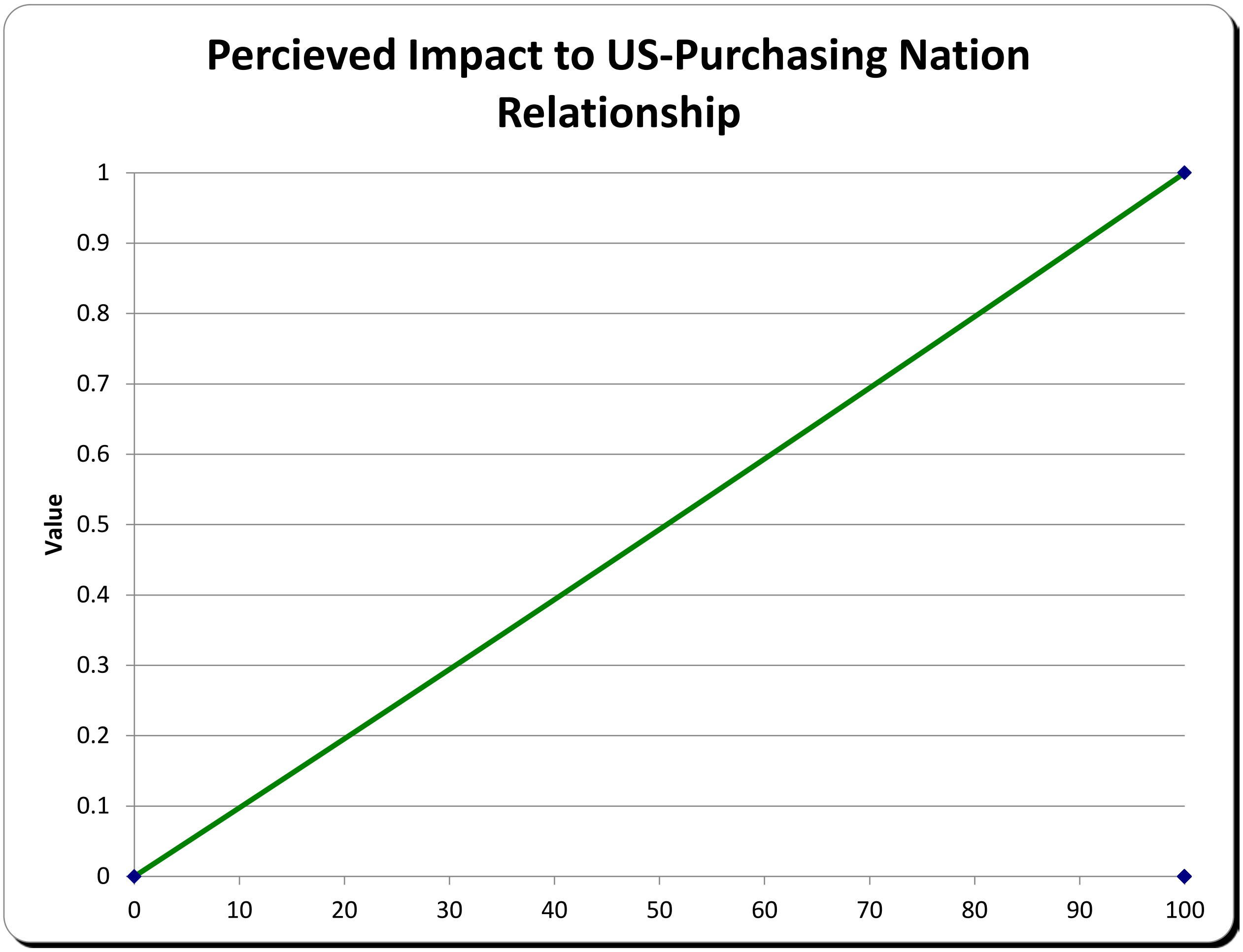

Figure 19. Perceived Impact to US-Purchasing Nation Relationship SDVF

The perceived impact to US-Purchasing Nation relationship measurement reflects the attainment level of the intergovernmental relationship value. In some FMS cases, the purchasing nation has requested the use or dis-use of certain construction agents due to prior performance. The selection of one of these agents may impact the operational relationship between intergovernmental stakeholders of the project. The SDVF is scaled on a 0% to 100% based on the constructed value of the impact on stakeholder relationships. A zero value represents the selection of a construction contracting agent that results in a strained relationship between intergovernmental organizations to the point of impacting the project. A 100% attainment value represents a selection of a construction contracting agent that is has a positive impact on the project due to existing strong relationship ties.

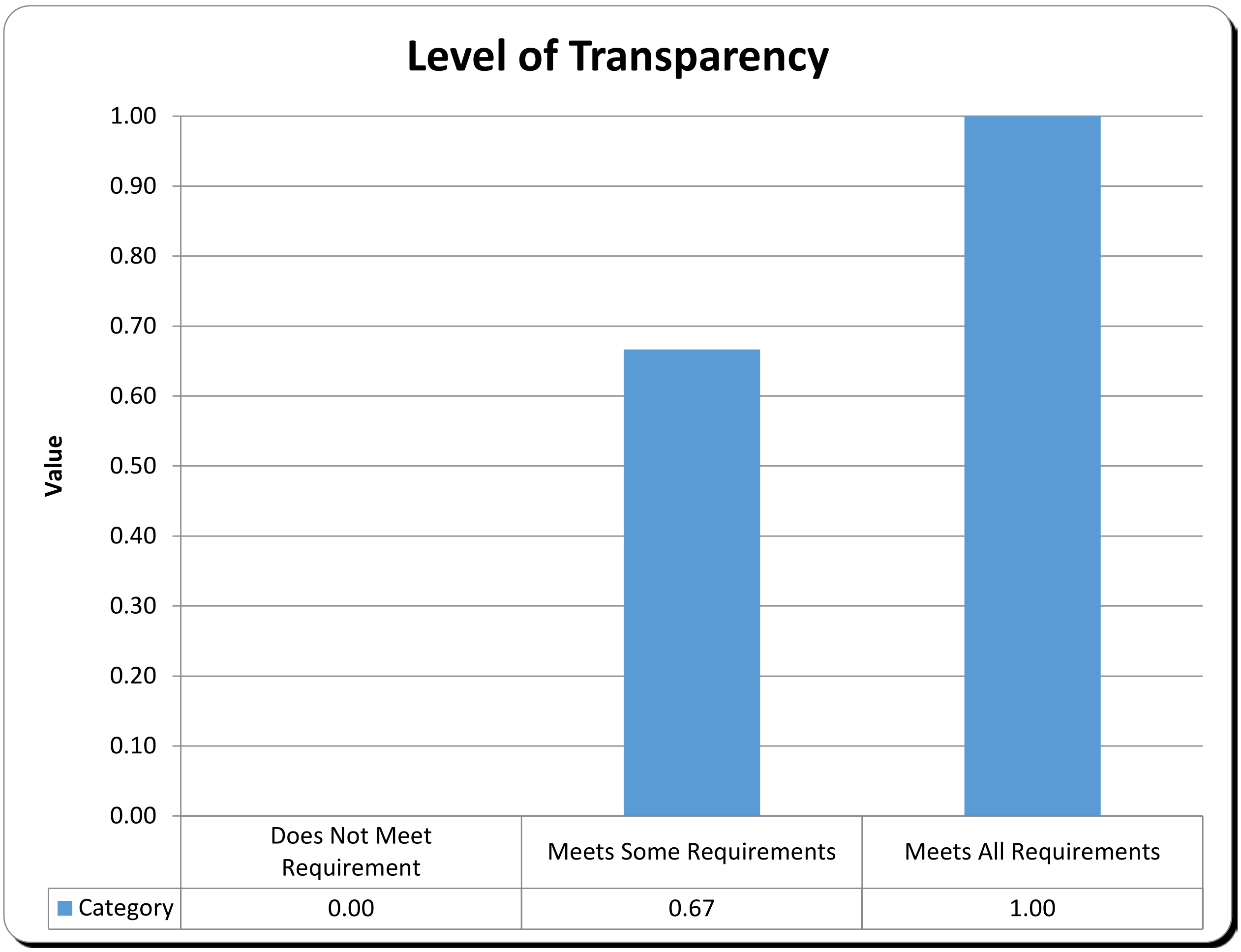

Figure 20. Level of Transparency to U.S. Government Entities SDVF

The level of transparency to U.S. Government entities measurement reflects the attainment level of the transparency value. As identified in the literature review, AFSAC must meet Congressional and DSCA mandates for transparency and accountability for the entire FMS case. The construction of supporting facilities must abide by this call for transparency and accountability as well. However, the option of direct commercial sale allows the purchasing nation to own the supporting facility construction process if the facility meets the specifications as required by the FMS case. The direct commercial sale alternative represents a Does Not Meet Requirement lower limit while the use of a DoD Construction Agency represents a Meets All Requirements upper limit.

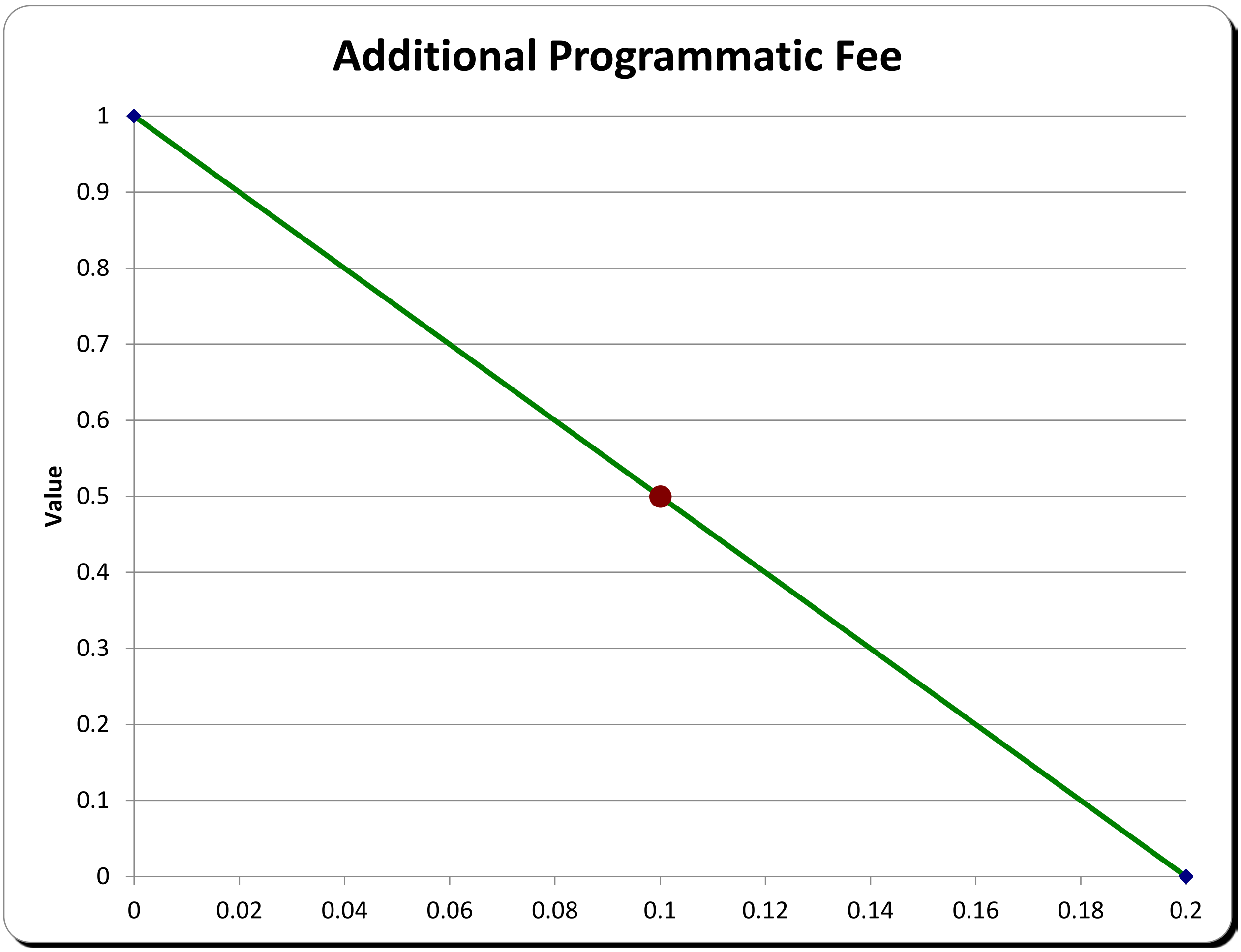

Figure 21. Additional Construction Contracting Agent Programmatic Fee SDVF

The programmatic fee measurement reflects the attainment level of the minimizing additional cost value. The cost of the overall project can increase as a result of fees included by different agencies involved in the process. For example, the use of a DoD Construction Agent such as the U.S. Army Corps of Engineers adds a percentage fee of the total cost of the project for construction and contraction oversight services. If the fee was not included in the Letter of

Acceptance estimate, the AFSAC Construction Branch will need to request additional funds from the purchasing nation to execute the project. A SDVF score of 1 represents a 0% additional incurred cost as a result of a programmatic fee. A SDVF score of 0 represents the negative limit of a 20% programmatic fee.

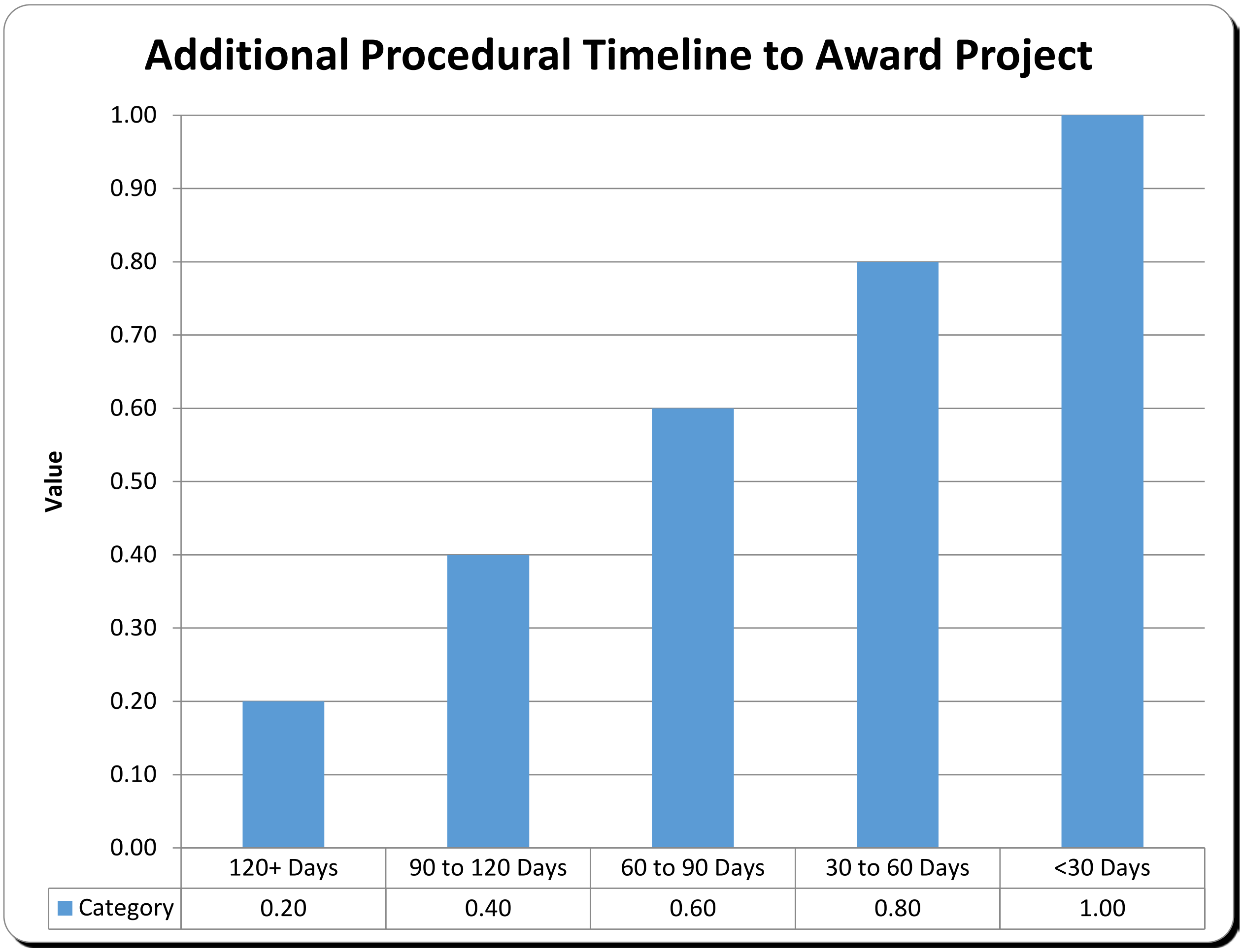

Figure 22. Additional Timeline to Award SDVF

The additional procedural timeline to award measurement reflects the attainment level of the minimize time value. Each alternative offers a different procedural time to award a project. A fast-track project award can be accomplished within 30 days. This value represents the upper limit of an SDVF score of 1. However, a fast-track method often results in tradeoffs with other values in the hierarchy. A longer project award timeline consists of an award that takes over 120 days. This value represents the lower limit of an SDVF score of .2.

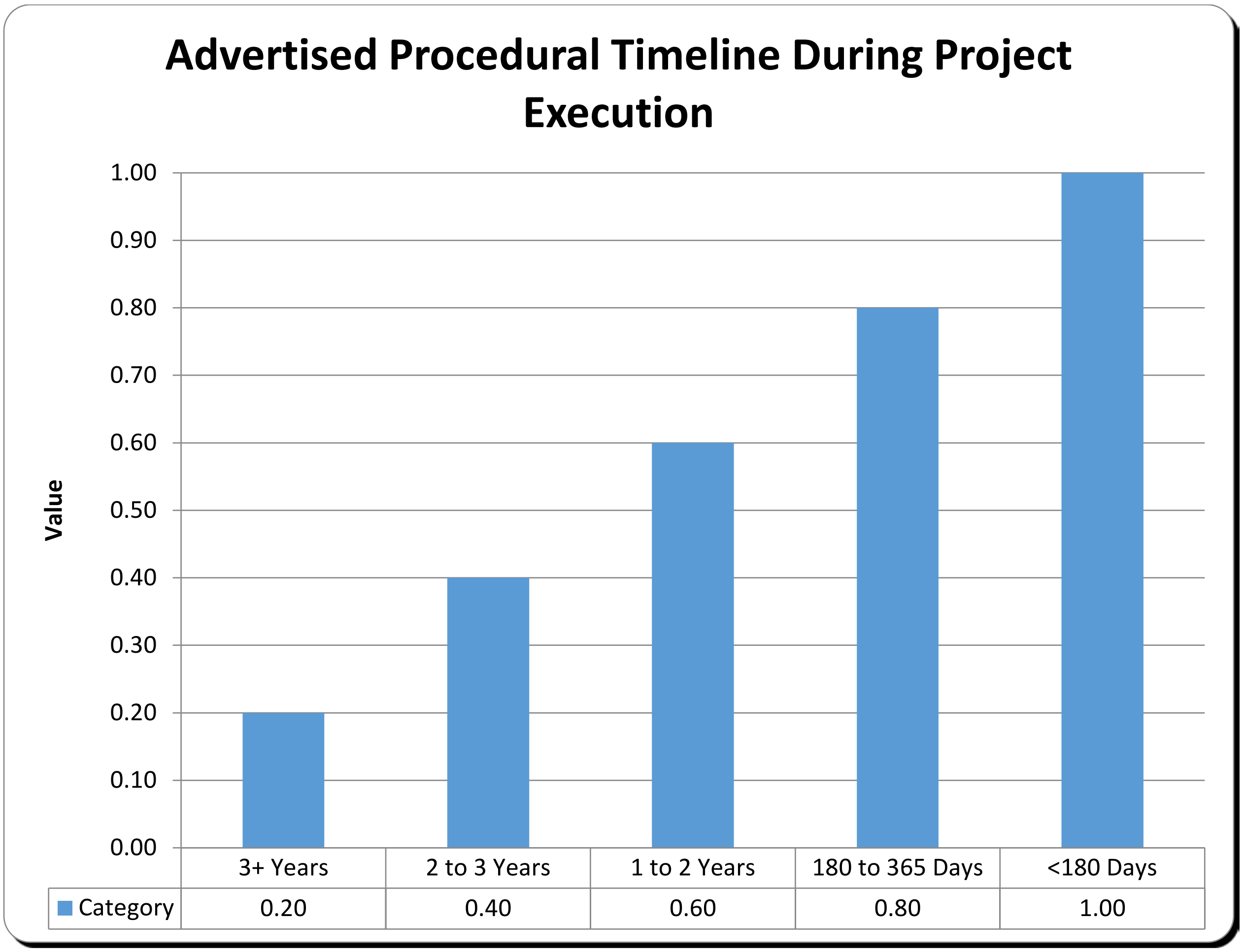

Figure 23. Advertised Project Execution Timeline SDVF

The advertised procedural timeline for project execution measurement reflects the attainment level of the minimize time value. Each alternative advertises an estimate for project completion. A small project can be completed very quickly with the use of a minimal oversight. This value represents the upper limit of an SDVF score of 1. However, an expedient method often results in tradeoffs with other values in the hierarchy such as quality. A longer project execution timeline consists of an advertised construction completion timeline that takes over three years. This value represents the lower limit with an SDVF score of .2.

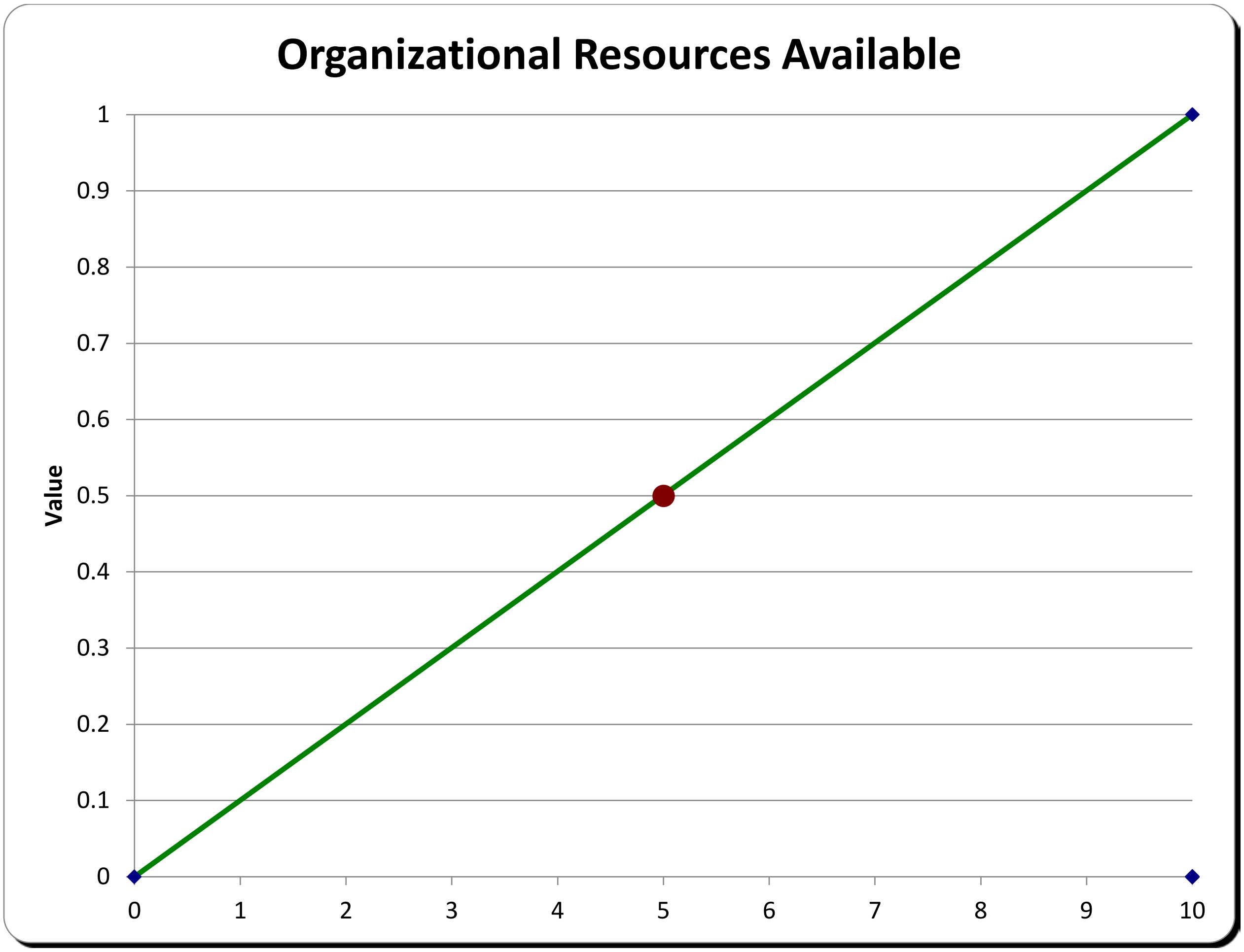

Figure 24. Organizational Resources Available SDVF

The organizational resources available measurement captures the attainment of the risk mitigation value. Resources are defined as project managers and other organizational overhead entities that can identify and correct project deficiencies. Each alternative will differ with the contracting and construction oversight services they provide. The SDVF is on a scale of zero to ten. A minimalist alternative will provide minimal risk mitigation resources and represent the lower bound limit of zero. A large oversight organization will provide dedicated project managers and other resources to respond to risk mitigation issues. The upper bound limit of ten represents the alternative with the most resources offered as per the services provided.

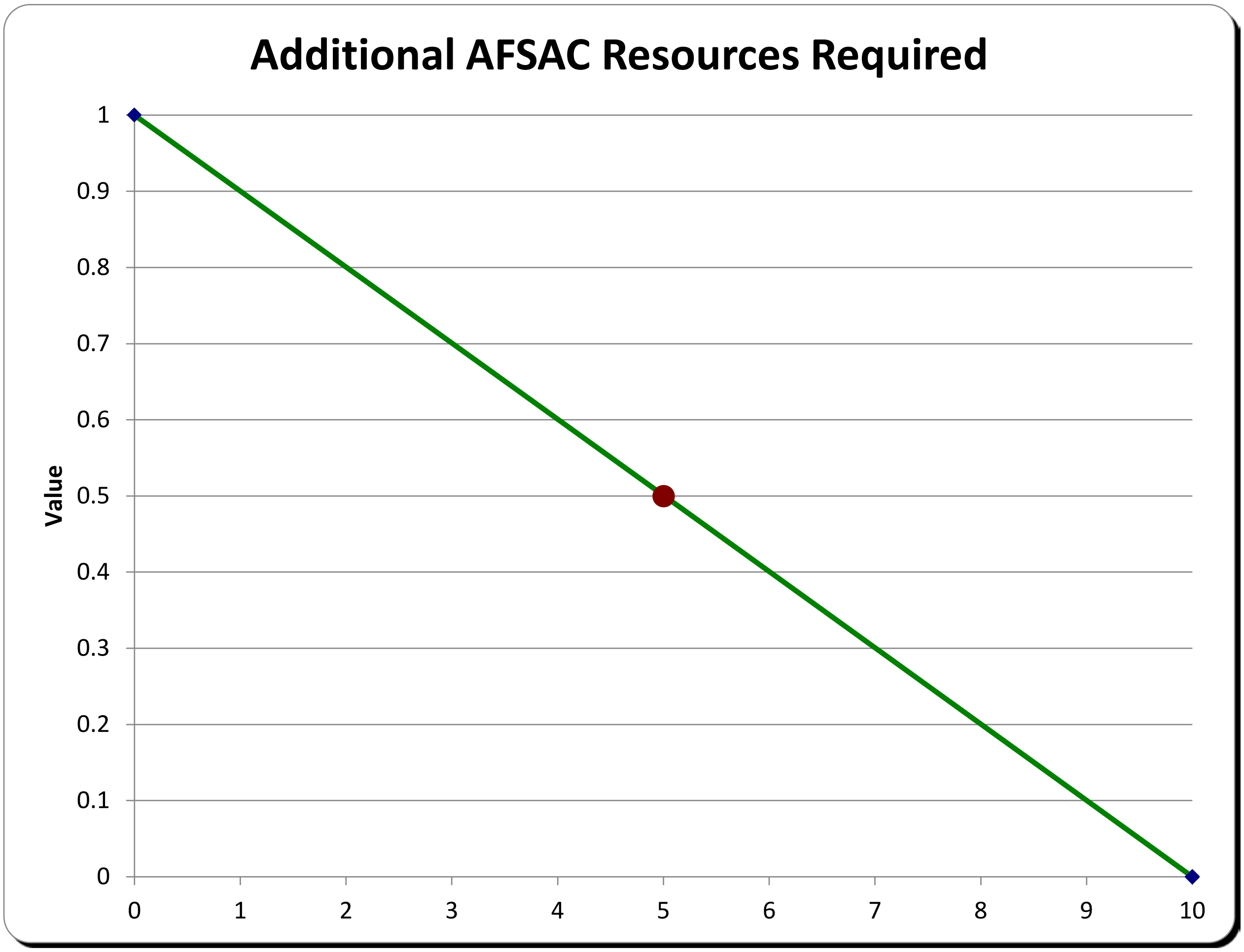

Figure 25. Additional AFSAC Resources Required SDVF

The additional AFSAC resources required measurement captures the attainment of the risk mitigation value. Resources are defined as project managers and other organizational overhead entities that can identify and correct project deficiencies. Each alternative will differ with the contracting and construction oversight services provided by the agency selected. The SDVF is on a scale of zero to ten. An alternative that requires minimal additional resources (zero) from AFSAC to provide oversight services reflects an SDVF score of 1. An alternative that requires the most additional resources (ten) from AFSAC to provide effective oversight services reflects an SDVF score of 0.

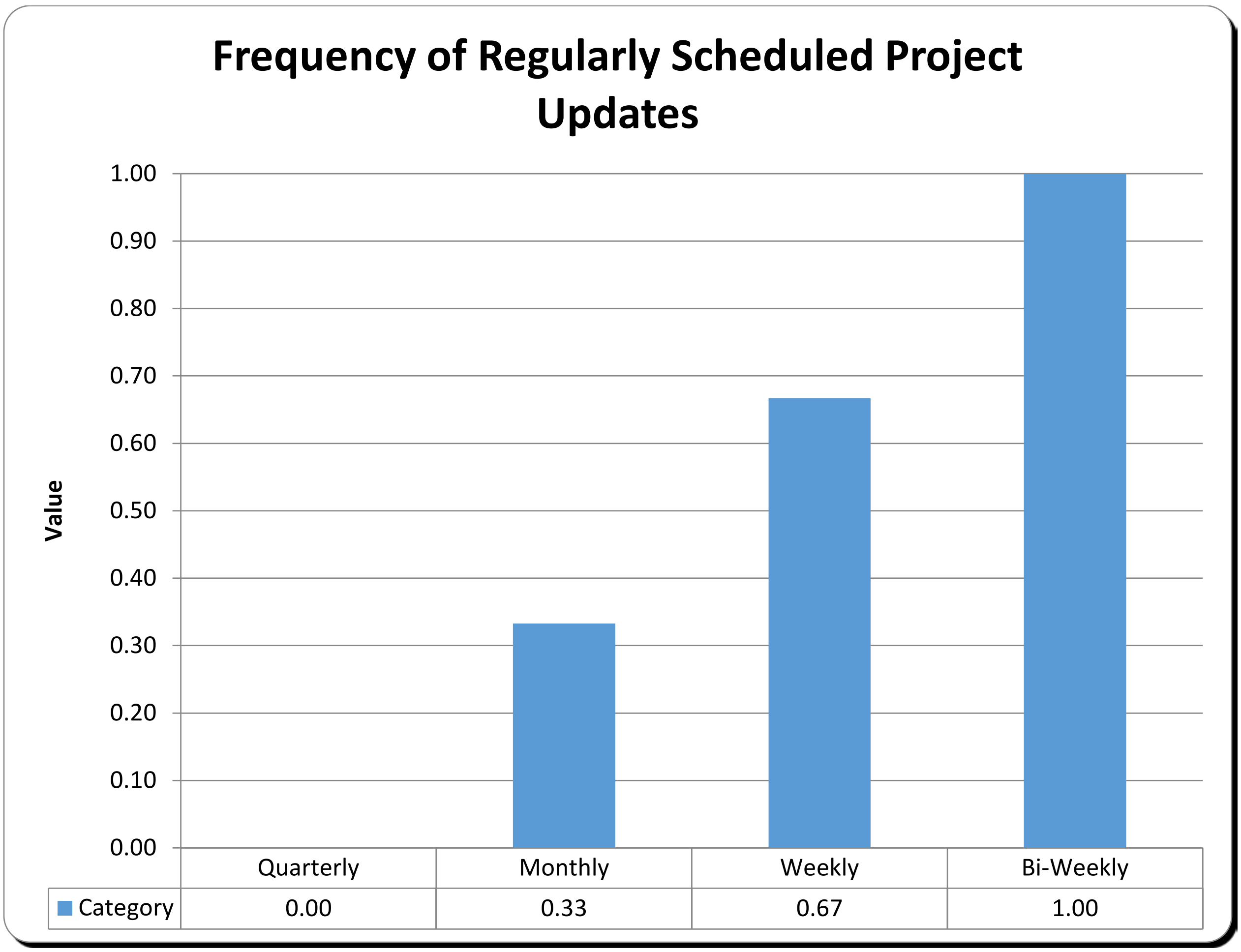

Figure 26. Frequency of Regularly Scheduled Project Updates SDVF

The frequency of regularly scheduled project updates is a proxy measure for the attainment of the responsiveness value. The frequency of regularly scheduled updates to project stakeholders of the project is critical to project success, especially for geographically separated organizations common to international construction. (Loh et al., 2000). Alternatives will vary by how often the assigned construction manager provides updates. A bi-weekly standard practice of project updates is the most responsive procedure and is seen as the upper-limit boundary. A bi-weekly update reflects an SDVF score of 1. A quarterly project update may be a standard practice for some organizations, but this frequency does not satisfy the requirements of the AFSAC construction branch. Therefore, a quarterly project update frequency would receive an SDVF score of 0.

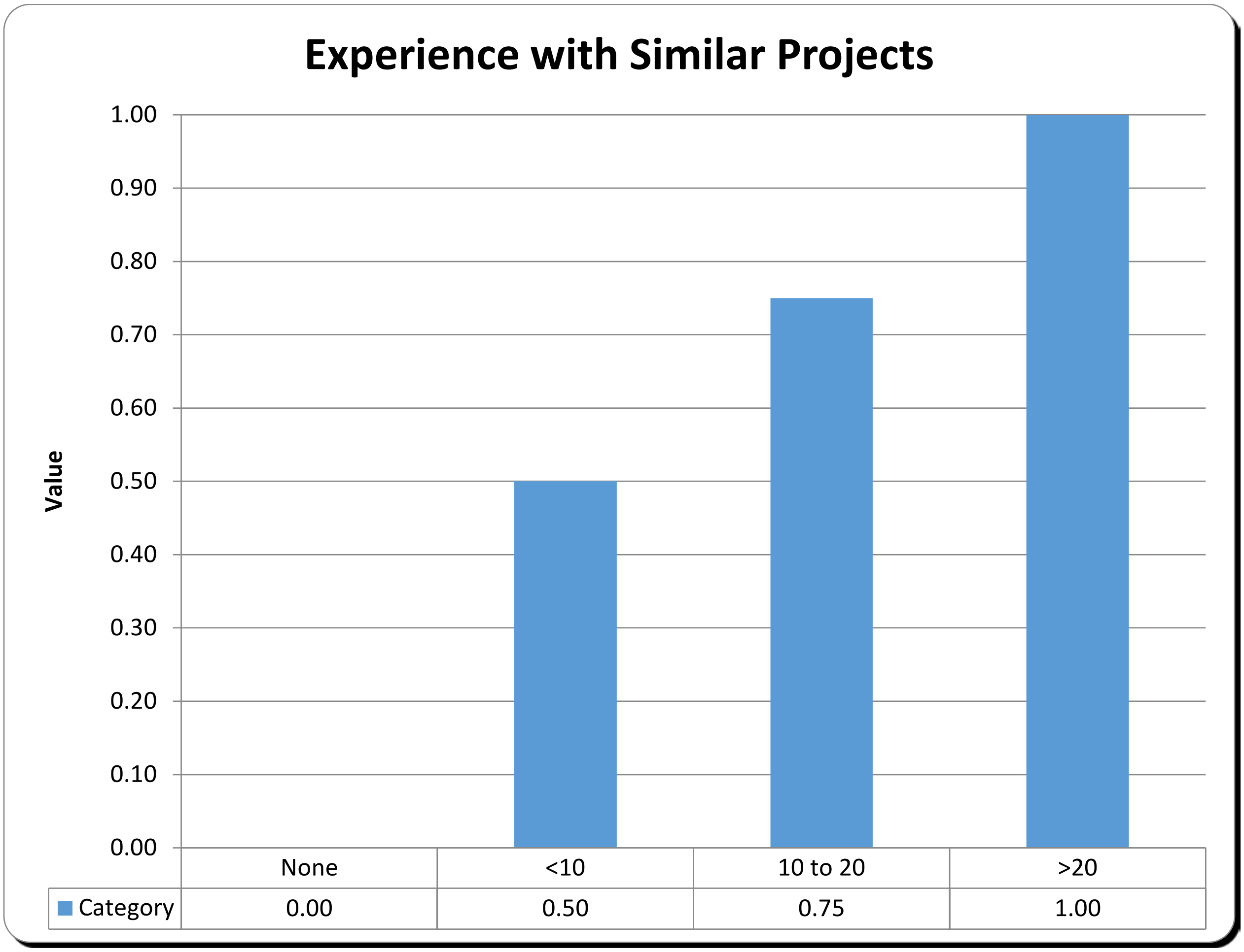

Figure 27. Experience with Similar Projects SDVF

The number of similar projects a construction and contracting agency has completed is a natural measurement reflecting the value of capitalizing on experience. Capturing the corporate knowledge gained from experience is one of the benefits of using a formalized decision support system or multi-criteria decision analysis.(Loh et al., 2000) An alternative that is established in the region and performs military type construction on a regular basis would score a high value.

The SDVF is scaled where an alternative that has worked with 20 or more similar projects would receive a score of 1. An alternative that is new to the market or industry would not have experience with working similar projects in scope, size, or region and would therefore receive a score of 0.

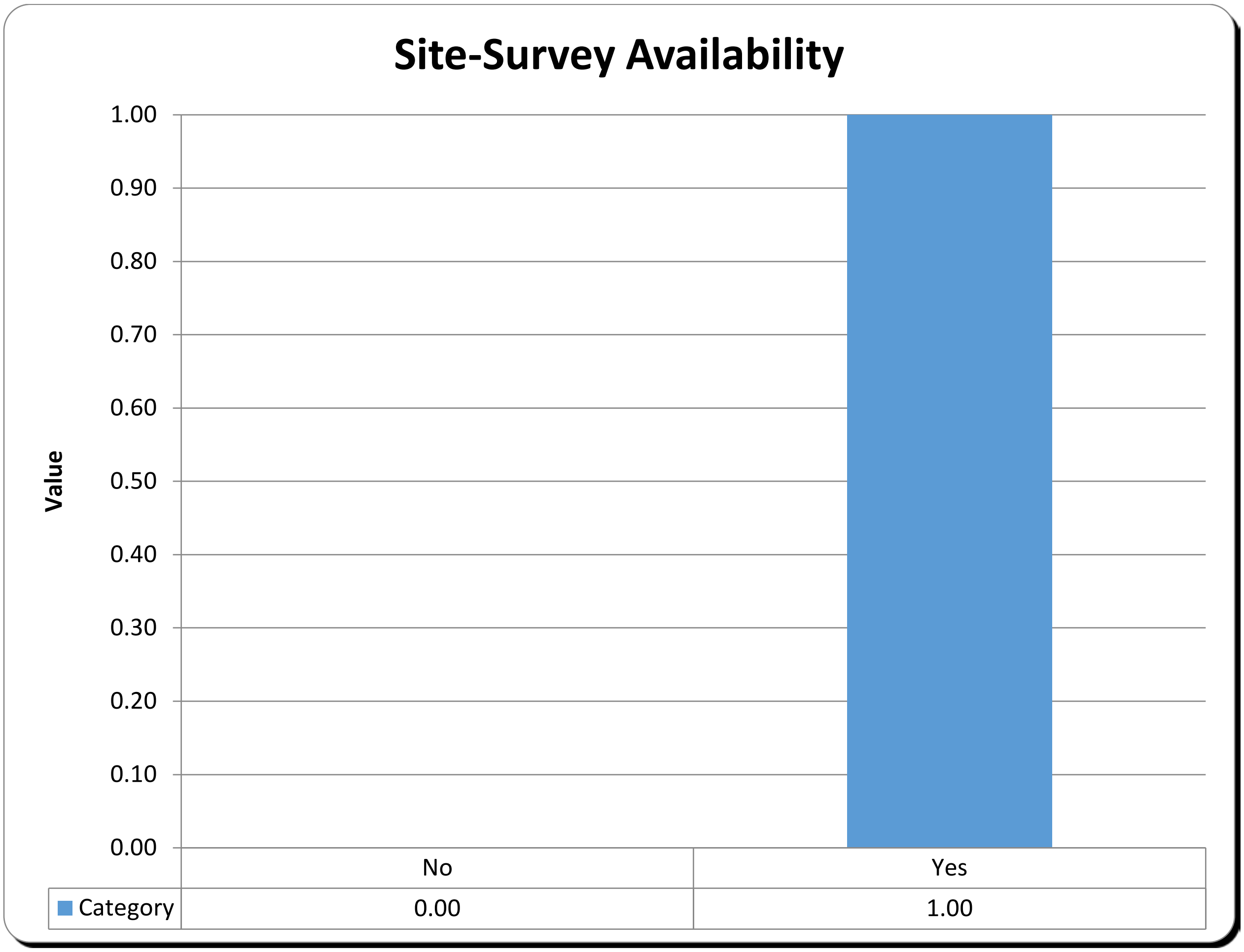

Figure 28. Site Survey Availability SDVF

The site survey availability is a proxy measure for quality of the construction project process and the facility. The AFSAC construction branch input showed an affinity towards planning and thorough requirement definition. Additionally, the literature review highlighted a critical success factor of the importance of initial planning and the impact it has on project time and cost growth.(Loh et al., 2000) If the alternative utilizes site-survey planning prior to project execution, the SDVF reflects a score of 1. In the absence of the site-survey due to expediency or resource availability, the alternative receives a zero score.

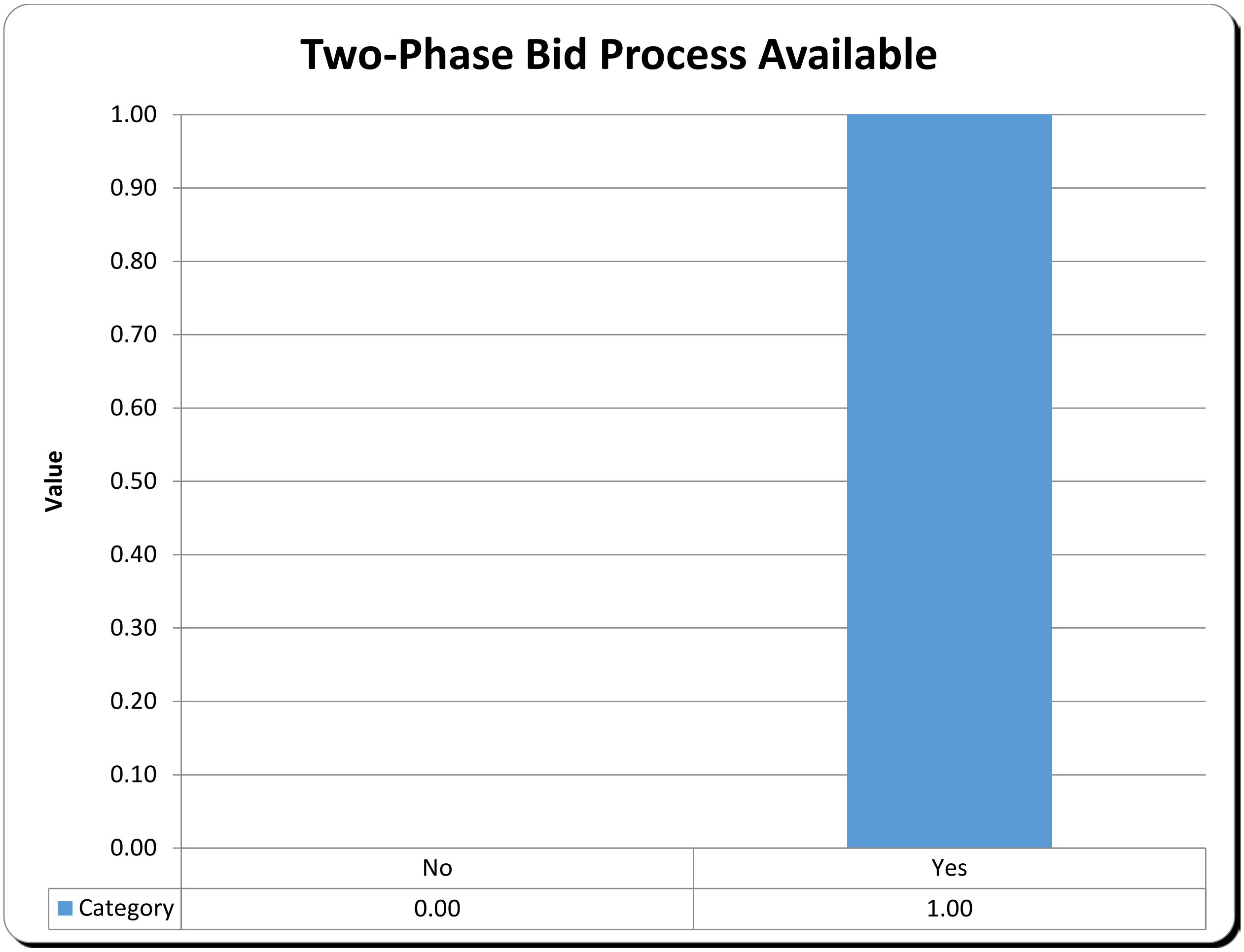

Figure 29. Two-Phase Bid Process SDVF

The two-phase bid process availability is a proxy measure for quality of the construction project process and the facility. The AFSAC construction branch input showed an affinity towards planning and thorough requirement definition. Additionally, the literature review highlighted a critical success factor of the importance of initial planning and the impact it has on project time and cost growth.(Loh et al., 2000) The two-phase bid process invites a pool of pre-approved contractors capable of completing the construction project. While this process may limit the number of contractors available to bid, the process increases the quality of the bid and mitigates the risk on behalf of the project owner. If the alternative utilizes the two-phase bid process, the SDVF reflects a score of 1. In the absence of the two-phase bid process due to expediency or resource availability, the alternative receives a zero score.

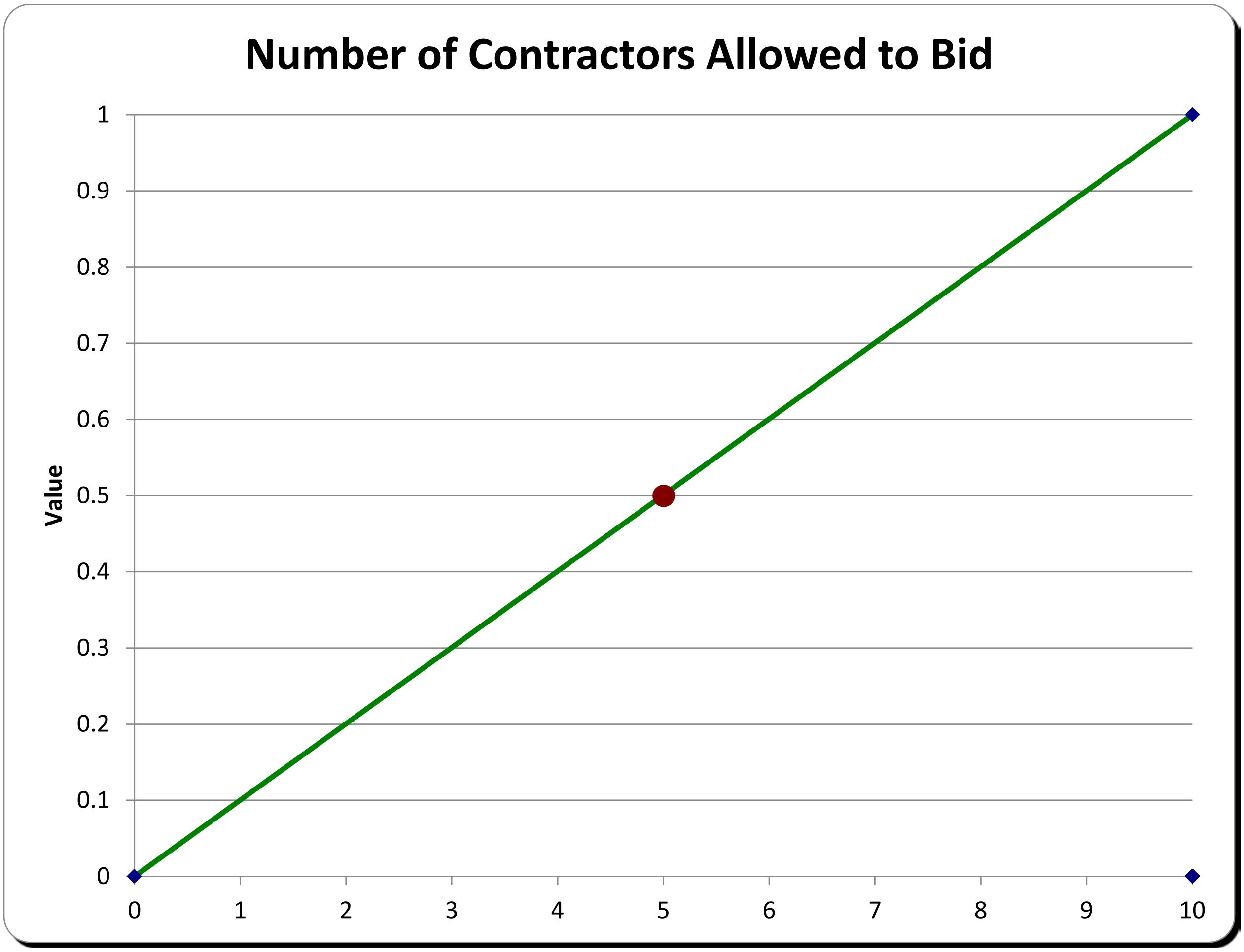

Figure 30. Number of Contractors Able to Bid SDVF

The number of contractors involved in the bidding process is a proxy measure for quality of the construction project process. Literature review revealed that the quality of the construction process and quality of the bids received is correlated with the number of contractors bidding on the project.(Loh et al., 2000) The SDVF is scaled from 0 to 10 where the more contractors bidding on the project equates to a higher score.

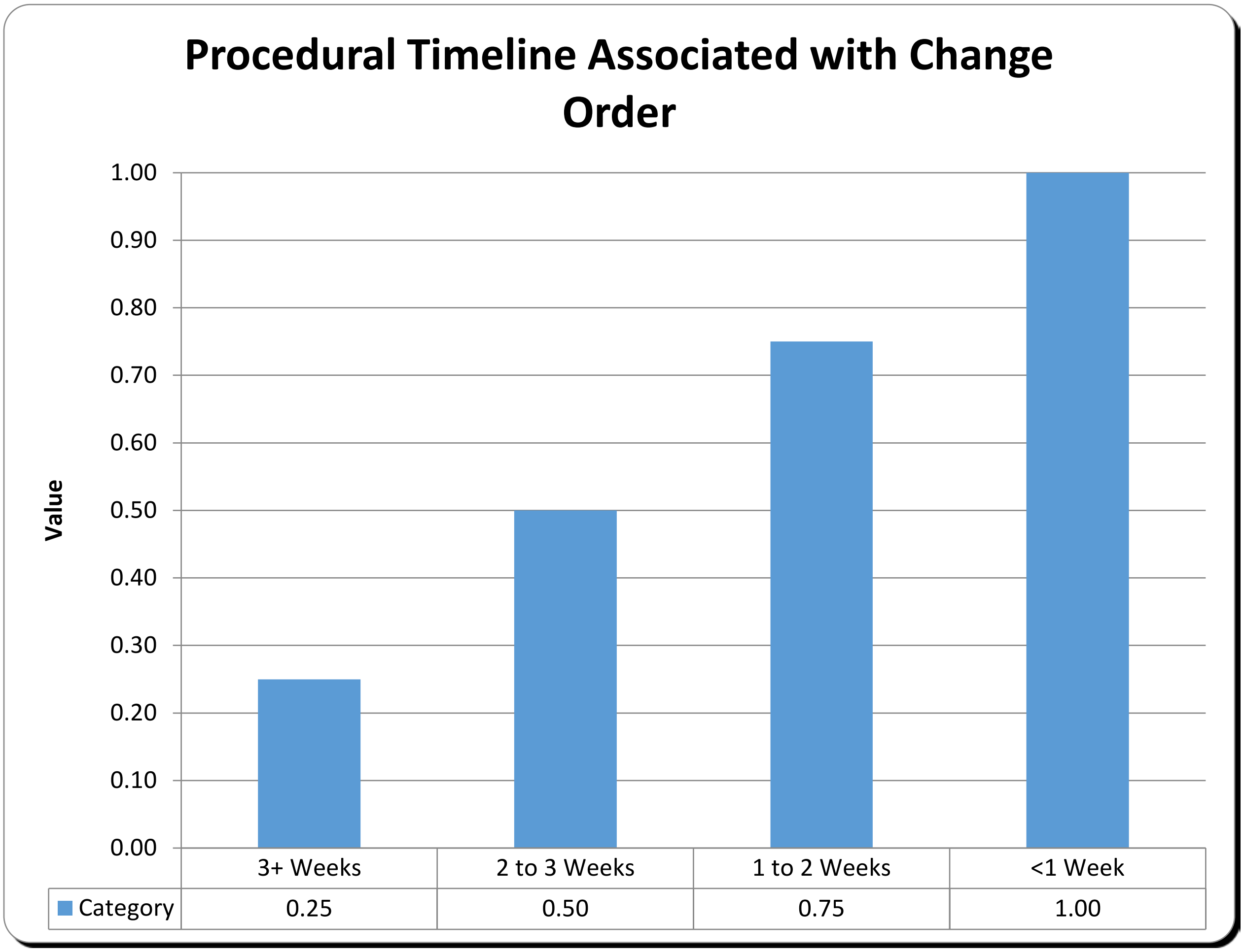

Figure 31. Change Order Timeline SDVF

The procedural timeline associated with processing a change order is a proxy measure for the flexibility value. An alternative with an established and expedient change order process will score high on the SDVF scale. An advertised change order process of less than a week would receive a maximum score of 1 for the measure. An advertised change order process of more than three weeks would receive the lowest score of .25.

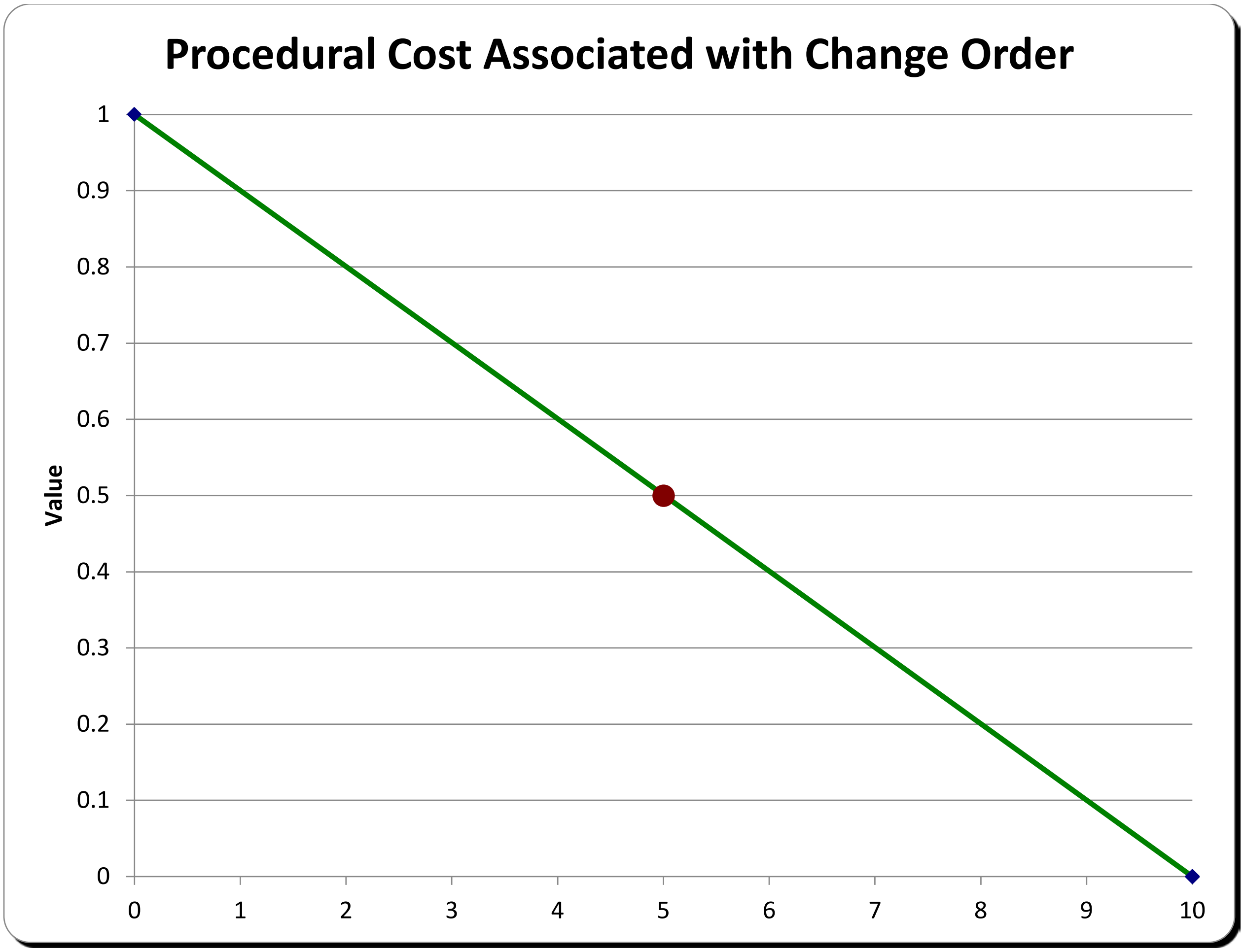

Figure 32. Change Order Cost SDVF

The procedural cost associated with processing a change order is a proxy measure for the flexibility value. An alternative with that charges a minimal fee for processing a change order or the fee is included in the services provided will score high on the SDVF scale. An advertised change order fee of zero would receive a maximum score of 1 for the measure. An advertised change order fee that is the highest amongst alternatives would receive a score of zero.

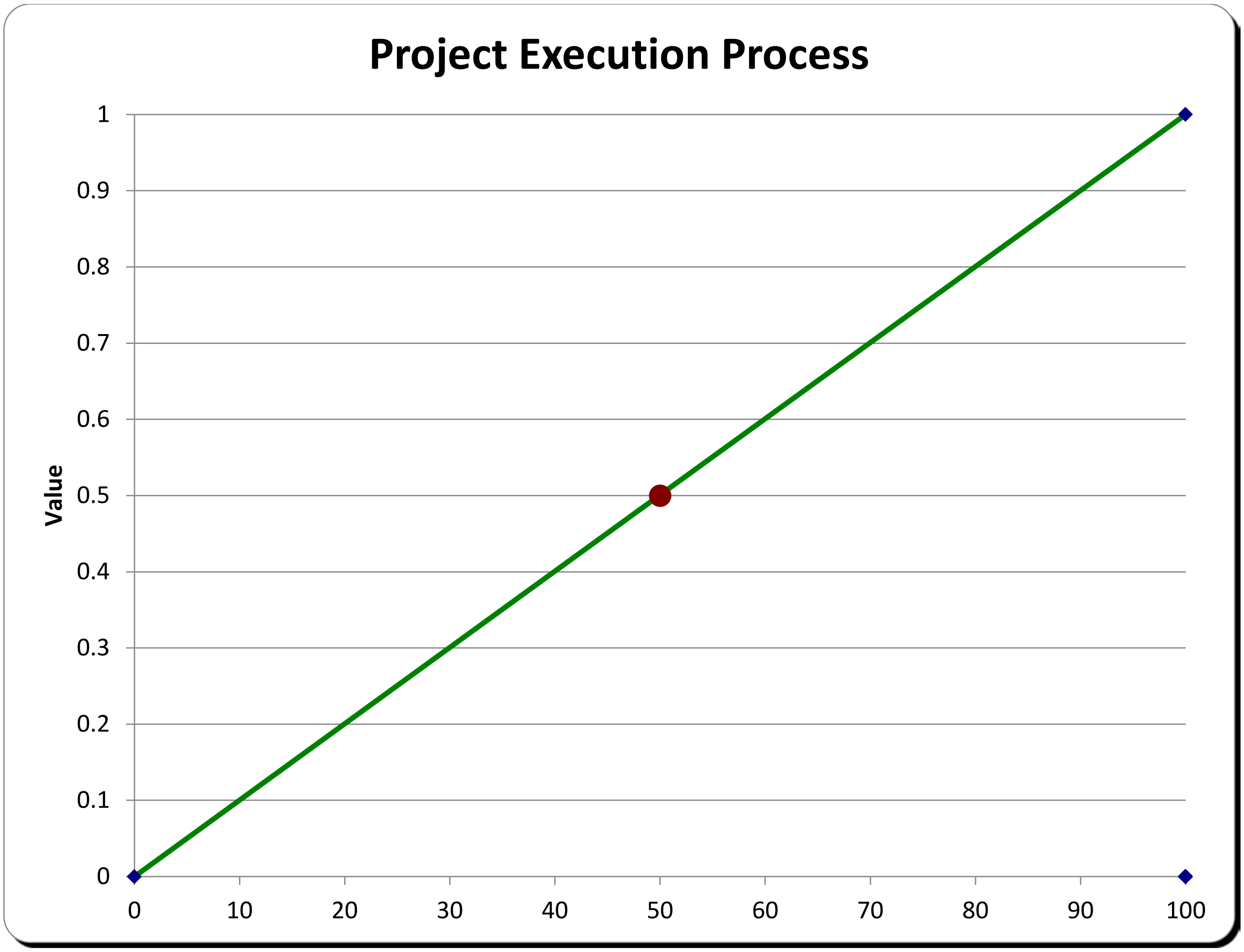

Figure 33. Defined Project Execution Process SDVF

The defined project execution process is a constructed measure for the quality value. The quality refers to the ease of working with the construction and contracting agency as well as the quality of the facility. This attainment is measured by the advertised quality and assurance processes associated with the alternative. An ill-defined or minimal Q&A process would receive a lower bound value of 0 while a robust Q&A program would receive an upper bound value of 1.

Appendix C: Alternative Data Input

Alternative Name	Additional Prograr	Additional Proced	Advertised Proced	Procedural Timeline	Procedural Cost A	Level of Involveme	Percieved Impact t	Level of Transpare	Organizational Re	Additional AFSAC I	Frequency of Ager	Experience with Similar Projects	Site-Survey Available	Two-Phase Bid Process Available	Number of Contractors Allowed to Bid	Project Close-Out Process
U.S. Army Corps of Engineers & Bid-Build Full Competition	0.065	120+ Days	2 to 3 Years	1 to 2 Weeks	0	40	35	Meets All Requirer	8	2	Weekly	>20	Yes	No	7	100
U.S. Army Corps of Engineers & Design-Bid-Build Full Competition	0.164	120+ Days	3+ Years	1 to 2 Weeks	0	60	35	Meets All Requirer	8	2	Weekly	>20	Yes	No	10	100
U.S. Army Corps of Engineers & Bid-Build Limited Invite for Bid	0.065	30 to 60 Days	1 to 2 Years	1 to 2 Weeks	0	30	35	Meets All Requirer	8	2	Weekly	>20	No	Yes	3	100
U.S. Army Corps of Engineers & Design-Bid-Build Limited Invite for Bid	0.164	30 to 60 Days	2 to 3 Years	1 to 2 Weeks	0	50	35	Meets All Requirer	8	2	Weekly	>20	Yes	Yes	5	100
Naval Facilities Engineering Command & Bid-Build Full Competition	0.062	120+ Days	2 to 3 Years	1 to 2 Weeks	0	40	50	Meets All Requirer	6	4	Weekly	>20	Yes	No	7	100
Naval Facilities Engineering Command & Bid-Build Limited Invite for Bid	0.062	30 to 60 Days	1 to 2 Years	1 to 2 Weeks	0	60	50	Meets All Requirer	6	4	Weekly	>20	No	Yes	3	100
Naval Facilities Engineering Command & Design-Bid-Build Full Competition	0.097	120+ Days	3+ Years	1 to 2 Weeks	0	30	50	Meets All Requirer	6	4	Weekly	>20	Yes	No	7	100
Naval Facilities Engineering Command & Design-Bid-Build Limited Invite for Bid	0.097	30 to 60 Days	2 to 3 Years	1 to 2 Weeks	0	50	50	Meets All Requirer	6	4	Weekly	>20	Yes	Yes	10	100
Air Force Installation Contracting Agency & Bid-Build Full Competition	0.065	120+ Days	2 to 3 Years	<1 Week	0	50	50	Meets All Requirer	2	8	Weekly	10 to 20	Yes	No	7	80
Air Force Installation Contracting Agency & Bid-Build Limited Invite for Bid	0.065	30 to 60 Days	1 to 2 Years	<1 Week	0	30	50	Meets All Requirer	2	8	Weekly	10 to 20	No	Yes	3	80
Air Force Installation Contracting Agency & Design-Bid-Build Full Competition	0.065	120+ Days	3+ Years	<1 Week	0	60	50	Meets All Requirer	2	8	Weekly	10 to 20	Yes	No	7	80
Air Force Installation Contracting Agency & Design-Bid-Build Limited Invite for Bid	0.065	30 to 60 Days	1 to 2 Years	<1 Week	0	40	50	Meets All Requirer	2	8	Weekly	10 to 20	Yes	Yes	10	80
Other U.S. Governmental Agency & Bid-Build Full Competition	0.1	120+ Days	2 to 3 Years	1 to 2 Weeks	5	40	50	Meets Some Requ	0	10	Monthly	<10	Yes	No	7	50
Other U.S. Governmental Agency & Bid-Build Limited Invite for Bid	0.1	30 to 60 Days	1 to 2 Years	1 to 2 Weeks	5	30	50	Meets Some Requ	0	10	Monthly	<10	No	Yes	3	50
Other U.S. Governmental Agency & Design-Bid-Build Limited Invite for Bid	0.14	120+ Days	1 to 2 Years	1 to 2 Weeks	5	50	50	Meets Some Requ	0	10	Monthly	<10	Yes	Yes	5	50
Other U.S. Governmental Agency & Design Bid-Build Full Competition	0.14	120+ Days	3+ Years	1 to 2 Weeks	5	60	50	Meets Some Requ	0	10	Monthly	<10	Yes	No	10	50
Direct Commercial Sale	0.15	<30 Days	1 to 2 Years	2 to 3 Weeks	7	100	75	Does Not Meet Re	0	10	Quarterly	None	Yes	No	5	25

Appendix D. Alternative SDVF Scoring

Alternative Name	Additional Programmatic Fee	Additional Procedural Timeline Prior to Project Execution	Advertised Procedural Timeline During Project Execution	Procedural Timeline Associated with Change Order	Procedural Cost Associated with Change Order	Level of Involvement	Percieved Impact to US-Purchasing Nation Relationship	Level of Transparency	Organizational Resources Provided	Additional AFSAC Resources Required	Frequency of Agency/AFSAC Interaction	Experience with Similar Projects	Site-Survey Available	Two-Phase Bid Process Available	Number of Contractors Allowed to Bid	Project Close-Out Process
U.S. Army Corps of Engineers & Bid-Build Full Competition	0.67	0.20	0.40	0.75	1.00	0.40	0.34	1.00	0.80	0.80	0.67	1.00	1.00	0.00	0.70	1.00
U.S. Army Corps of Engineers & Design-Bid-Build Full Competition	0.18	0.20	0.20	0.75	1.00	0.60	0.34	1.00	0.80	0.80	0.67	1.00	1.00	0.00	1.00	1.00
U.S. Army Corps of Engineers & Bid-Build Limited Invite for Bid	0.67	0.80	0.60	0.75	1.00	0.30	0.34	1.00	0.80	0.80	0.67	1.00	0.00	1.00	0.30	1.00
U.S. Army Corps of Engineers & Design-Bid-Build Limited Invite for Bid	0.18	0.80	0.40	0.75	1.00	0.50	0.34	1.00	0.80	0.80	0.67	1.00	1.00	1.00	0.50	1.00
Naval Facilities Engineering Command & Bid-Build Full Competition	0.69	0.20	0.40	0.75	1.00	0.40	0.49	1.00	0.60	0.60	0.67	1.00	1.00	0.00	0.70	1.00
Naval Facilities Engineering Command & Bid-Build Limited Invite for Bid	0.69	0.80	0.60	0.75	1.00	0.60	0.49	1.00	0.60	0.60	0.67	1.00	0.00	1.00	0.30	1.00
Naval Facilities Engineering Command & Design-Bid-Build Full Competition	0.51	0.20	0.20	0.75	1.00	0.30	0.49	1.00	0.60	0.60	0.67	1.00	1.00	0.00	0.70	1.00
Naval Facilities Engineering Command & Design-Bid-Build Limited Invite for Bid	0.51	0.80	0.40	0.75	1.00	0.50	0.49	1.00	0.60	0.60	0.67	1.00	1.00	1.00	1.00	1.00
Air Force Installation Contracting Agency & Bid-Build Full Competition	0.67	0.20	0.40	1.00	1.00	0.50	0.49	1.00	0.20	0.20	0.67	0.75	1.00	0.00	0.70	0.80
Air Force Installation Contracting Agency & Bid-Build Limited Invite for Bid	0.67	0.80	0.60	1.00	1.00	0.30	0.49	1.00	0.20	0.20	0.67	0.75	0.00	1.00	0.30	0.80
Air Force Installation Contracting Agency & Design-Bid-Build Full Competition	0.67	0.20	0.20	1.00	1.00	0.60	0.49	1.00	0.20	0.20	0.67	0.75	1.00	0.00	0.70	0.80
Air Force Installation Contracting Agency & Design-Bid-Build Limited Invite for Bid	0.67	0.80	0.60	1.00	1.00	0.40	0.49	1.00	0.20	0.20	0.67	0.75	1.00	1.00	1.00	0.80
Other U.S. Governmental Agency & Bid-Build Full Competition	0.50	0.20	0.40	0.75	0.50	0.40	0.49	0.67	0.00	0.00	0.33	0.50	1.00	0.00	0.70	0.50
Other U.S. Governmental Agency & Bid-Build Limited Invite for Bid	0.50	0.80	0.60	0.75	0.50	0.30	0.49	0.67	0.00	0.00	0.33	0.50	0.00	1.00	0.30	0.50
Other U.S. Governmental Agency & Design-Bid-Build Limited Invite for Bid	0.30	0.20	0.60	0.75	0.50	0.50	0.49	0.67	0.00	0.00	0.33	0.50	1.00	1.00	0.50	0.50
Other U.S. Governmental Agency & Design Bid-Build Full Competition	0.30	0.20	0.20	0.75	0.50	0.60	0.49	0.67	0.00	0.00	0.33	0.50	1.00	0.00	1.00	0.50
Direct Commercial Sale	0.25	1.00	0.60	0.50	0.30	1.00	0.74	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.50	0.25

References

Anderson, S., & Oyetunji, A. (2004). Selection Procedure for Project Delivery and Contract Strategy. https://doi.org/10.1061/40671(2003)83

Ashley, D. B., Uehara, K., & Robinson, B. E. (1983). Critical Decision Making During Construction. *Journal of Construction Engineering and Management*. https://doi.org/10.1061/(ASCE)0733-9364(1983)109:2(146)

Auletta, L. (2011). Federal Acquisition Regulation; Submission for OMB Review; Payment by Electronic Fund Transfer. *Federal Register*.

Braziel, C. (2014). Public Opinion and Security Cooperation in the Middle East and Central Asia. *The Defense Institute of Security Assistance Management Journal of International Security Cooperation Management*, (December).

Braziel, C. (Defense I. of S. A. M. (2012). Relationship Building Considerations for Security Cooperation Officers in the Middle East. *The Defense Institute of Security Assistance Management Journal of International Security Cooperation Management*, *151*(1), 199–204. https://doi.org/10.1145/3132847.3132886

Chua, D. K. H., Kog, Y. C., & Loh, P. K. I. (1999). Critical Success Factors for Different Project Objectives. *Journal of Construction Engineering and Management1*, *125*(3), 142–150. https://doi.org/10.1061/(ASCE)0733-9364(1999)125:3(142)

Defense Security Cooperation Agency. (2012). Security Assistance Management Manual. Arlington, VA: Department of Defense. Retrieved from https://www.samm.dsca.mil

Defense, U. S. D. of. National Defense Strategy (2018). Retrieved from https://www.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf

Flug, M., Seitz, H. L. H., & Scott, J. F. (2000). Multicriteria Decision Analysis Applied to Glen Canyon Dam. *Journal of Water Resources Planning and Management*. https://doi.org/10.1061/(ASCE)0733-9496(2000)126:5(270)

Kalish, B. (Naval P. G. S., & Tarescavage, M. (Naval P. G. S. (2015). *Comparison Between Navy and Army Implementation of SIOH and Recommendations for Navy Implementation*. Naval Post Graduate School.

Keeney, R. L. (1992). *Value-focused thinking: A Path to Creative Decisionmaking*. *Journal of Multi-Criteria Decision Analysis*. https://doi.org/HD30.23.K354

Keeney, R. L. (2008). Applying Value-Focused Thinking. *Military Operations Research*. https://doi.org/10.5711/morj.13.2.7

Keeney, R. L. (2012). Value-focused brainstorming. *Decision Analysis*. https://doi.org/10.1287/deca.1120.0251

Kirkwood, C. W. (1998). Strategic Decision Making Multiobjective Decision Analysis with Spreadsheets. *Journal of the Operational Research Society*. https://doi.org/10.1038/sj.jors.2600003

Kog, Y. C., & Loh, P. K. (2012). Critical Success Factors for Different Components of Construction Projects. *Journal of Construction Engineering and Management*. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000464

Loh, P. K. I., Chua, D. K. H., Kog, Y. C., & Henningsen, M. (2000). Decision Support for Contract Strategy. *Construction Congress*, *IV*(1), 503–513. Retrieved from https://ascelibrary.org/doi/abs/10.1061/40475%28278%2955

Melito, T. (2017). DOD Needs to Improve Its Use of Performance Information to Manage the Progr...: Discovery Service for Air Force Institute of Technology. *GAO Reports*, *pi*(41), 45. Retrieved from http://eds.b.ebscohost.com.afit.idm.oclc.org/eds/detail/detail?vid=3&sid=0dfee647-72a3-4caa-8822-a351364cb24f%40pdc-v-sessmgr05&bdata=JnNpdGU9ZWRzLWxpdmU%3D#AN=124782113&db=bth

Parnell, G. S., Bresnick, T. A., Tani, S. N., & Johnson, E. R. (2013). *Handbook of Decision Analysis*. *Handbook of Decision Analysis*. https://doi.org/10.1002/9781118515853

Parnell, G. S., Conley, H. W., Jackson, J. A., Lehmkuhl, L. J., & Andrew, J. M. (1998). Foundations 2025: A Value Model for Evaluating Future Air and Space Forces.

Management Science. https://doi.org/10.1287/mnsc.44.10.1336

Rennack, D. E. (2011). Foreign assistance act of 1961: Authorizations and corresponding appropriations. In *U.S. Foreign Aid and Assistance*.

Teeney, A. (2010). United States Government Benefits as a Result of foreign Military Sales Programs. *DISAM Journal of International Security Assistance Management*. https://doi.org/Article

Trump, D. (2017). National Security Strategy. United States White House Press Office.

USG. (2018). DSCA MISSION STATEMENT. Retrieved from http://www.dsca.mil/about-us/mission-vison-values

Ware, M. J. L. (2009). Foreign Military Sales Construction in Iraq By. *The Defense Institute of Security Assistance Management Journal*, (November), 154–158.

REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 0704-0188*

1. REPORT DATE *(DD-MM-YYYY)*
03/21/2019

2. REPORT TYPE
Master's Thesis

3. DATES COVERED *(From - To)*
Aug 2017 - Mar 2019

4. TITLE AND SUBTITLE
Selecting a Construction Contract Acquisition Strategy to Support Foreign Military Sales Facility Construction

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Shuler, Robert H., Maj, USAF

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Air Force Institute of Technology
Graduate School of Engineering and Management (AFIT/EN)
2950 Hobson Way
Wright-Patterson AFB OH 45433-7765

8. PERFORMING ORGANIZATION REPORT NUMBER
AFIT-ENV-MS-19-M-196

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Air Force Security Assistance and Cooperation Directorate
Dr. Carlos Braziel, International Construction Branch
5215 Thurlow Street, Area A, Bldg 70
Wright-Patterson AFB, OH 45433

10. SPONSOR/MONITOR'S ACRONYM(S)
AFSAC

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
DISTRIBUTION STATEMENT A.
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
A decision analysis model using Value-Focused Thinking (VFT) was created through this research to assist AFSAC in selecting a construction delivery strategy for major construction efforts within FMS cases. The construction delivery strategy for this model is defined by two primary elements: 1) the contracting project delivery method and 2) the construction and contracting agent. The model accounted for the competing objectives from the multiple stakeholders to include cost, schedule, quality, and intergovernmental relationship. AFSAC can utilize the resulting VFT model on future construction projects to make a defensible recommendation regarding the construction contract acquisition strategy.

15. SUBJECT TERMS
Decision Analysis, International Construction, Foreign Military Sales, Value-Focused Thinking

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Alfred E. Thal Jr., PhD, ENV
					19b. TELEPHONE NUMBER *(Include area code)*
U	U	U	UU	94	(937) 255-3636 x7401