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USING VALUE-FOCUSED THINKING AS AN ALTERNATIVE MEANS OF OPPORTUNITY ASSESSMENT FOR STRATEGIC SOURCING APPLICATIONS

Andrew R. Myers, Capt

AFIT-ENV-13-M-18

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

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THESIS

Presented to the Faculty

Department of Systems and Engineering Management

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In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Engineering Management

Andrew R. Myers, B.S.M.E.

Captain, USAF

March 2013

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Abstract

In recent years, the Federal Government has attempted to utilize strategic sourcing to reduce acquisition and operating expenses. Currently accepted best practices for implementing strategic sourcing of services and commodities developed in the private sector fail to account for the diverse and unique set of strategic objectives present in public sector acquisitions. Value Focused Thinking (VFT) was used to develop a hierarchy of values and objectives to assist the Air Force Civil Engineer Commodity Council (CECC) in assessing opportunities for the strategic sourcing program. This hierarchy represents the full range of program objectives, and was used to develop a value function useful for systematically evaluating service and commodity requirements for strategic sourcing potential. In addition, a comparative study was conducted between the results obtained with the new VFT model and the results of the existing opportunity assessment process.

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To Air Force Civil Engineers Past, Present, and Future

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I would like to acknowledge several individuals who were instrumental in making this research possible. First of all, Todd Grimes for being my point of contact for all areas of this research project, from problem identification to data collection; Larry Garlit for his assistance coordinating information from the Air Force Civil Engineer Center; The team of engineers from the 771st Enterprise Sourcing Squadron, particularly Christina Campbell, for assisting with data collection; Finally, the team of subject matter experts from the Air Force Civil Engineer Center for their willingness to submit to all my interviews. Thanks for all your help!

Andrew R. Myers

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Table of Contents

www.manaraa.com

Page

المنارة للاستشارات
www.manaraa.com

List of Figures

المنارة للاستشارات

www.manaraa.com

Page

www.manaraa.com

List of Tables

Page

www.manaraa.com

USING VALUE-FOCUSED THINKING AS AN ALTERNATIVE MEANS OF OPPORTUNITY ASSESSMENT FOR STRATEGIC SOURCING APPLICATIONS

I. Introduction

As the Department of Defense (DOD) seeks to streamline acquisition process in an effort to decrease overall expenses, strategic sourcing programs have been established to develop enterprise solutions that will better leverage the buying power of the government in order to achieve lower costs. In the Air Force, obstacles to conducting a thorough assessment of all possible enterprise contract opportunities have prevented such an analysis from occurring. This research project seeks to overcome these obstacles through the development of an accurate and usable means of assessing strategic sourcing opportunities in order to further advance cost reduction goals in the DoD.

Background

At the present moment, the nation is in the midst of a fiscal crisis. The Federal government's expenses over the past decade have far exceeded revenues due to a variety of factors. Among these are rising costs of entitlement programs, a decade of armed conflict, and government actions to soften the blow of a global recession. Regardless of the external factors that have contributed to the recent explosion of national debt, the fact remains that the current fiscal course of the United States is unsustainable. According to the Congressional Budget Office, if current policies are allowed to proceed unchanged, the national debt will balloon to over ninety percent of the nation's Gross Domestic Product in the coming decade, and will expand to two hundred percent in the year 2037

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(Congressional Budget Office, 2012). This crisis has elicited reactions from leaders both within and outside of the federal government, but perhaps no governmental organization has made as much of an effort to prepare for the pending changes in public policy as the DoD. In fact, the chairman of the Joint Chiefs of Staff recently deemed the national debt the number one threat to the national security of the United States (Armed Forces Press Service, 2011).

In 2005, the Office of Management and Budget released a memorandum requiring all federal agencies to take steps to implement a strategic sourcing program with the overall goal of reducing the cost of government operations. This memo defined strategic sourcing as "the collaborative and structured process of critically analyzing an organization's spending and using this information to make business decisions about acquiring commodities and services more effectively and efficiently" (OMB, 2005). Since 2005, strategic sourcing efforts have grown consistently within the DoD, with each service establishing programs to search for acquisition efficiencies using this process.

Within the Air Force Civil Engineer (CE) community, strategic sourcing was identified as a key component of CE Transformation efforts announced in 2008 (Eulberg, 2005). The first enterprise-wide strategic sourcing contract to supply Light Emitting Diode (LED) airfield lighting on all Air Force Installations was announced in 2011. Additional strategically sourced contracts are in development for elevator maintenance, flooring maintenance, and protective coatings requirements (Burt, 2011).

Currently, strategic sourcing efforts in the Air Force are being executed by the Enterprise Sourcing Group (ESG). Organizationally, the ESG is divided into multiple cross-functional teams that manage strategic sourcing efforts for each of the eight

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commodity groupings. The eight commodity groupings are Information Technology, Medical Service, Furnishings, Force Protection, Office Supplies, Knowledge-Based Services, and Civil Engineering. This research will focus primarily on the Civil Engineering Commodity Council (CECC).

The CECC consists of a diverse group of members from the ESG, the Air Force Civil Engineer Center (AFCEC), and the Air Staff. Because the CECC is not staffed to provide a strategic sourcing solution for each of the thousands of commodities and services procured by the CE community, a process known as an opportunity assessment has been developed to prioritize opportunities for which strategic sourcing solutions will be implemented. In order to conduct this assessment, the CECC has been relying on broadly accepted method of analyzing expenditures to determine the best opportunities for strategic sourcing. This method, known as a spend analysis, was developed to divide procurement items into broad categories that determined the optimal strategy for a strategic sourcing solution.

Due to the fact that the spend analysis method was developed for use in the private sector, it focuses almost exclusively on expenditure data without regard to additional organizational objectives. While this may work well for private organizations, public sector organizations, particularly the DoD, have a diverse set of organizational values that oftentimes run counter to simply spending the least amount possible. For example, the stated objectives of the CECC listed in the organization's charter document are as follows (Civil Engineering Commodity Council, 2010):

- Create enterprise-wide supplies and services sourcing strategies

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- Create and maintain strategic supplier relationships
- Drive commonality and standardization of requirements
- Minimize supply chain cost through integration/collaboration
- Reduce procurement processing times
- Minimize duplication of effort
- Lower total cost of ownership
- Leverage forecasting data through collaboration

While minimizing costs is clearly an important part of the CECC's mission, other objectives, such as standardization of requirements, are also important aspects of the organizational objectives. Because of this fact, a new method of opportunity assessment that is capable of addressing the full range of organizational objectives is needed.

Problem Statement

Current opportunity assessment tools based on private-sector strategic sourcing efforts focus on developing strategies for implementing strategic sourcing solutions. While these models have proven to be effective when used in private industry, they fail to provide a framework for evaluating the potential for strategic sourcing opportunities to achieve the full range of organizational objectives present in a public sector organization. A new method of opportunity assessment is needed that can evaluate opportunities based on the broad range of objectives of a public sector strategic sourcing program.

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Research Questions

Given the importance of the strategic sourcing efforts in the CECC to save the maximum amount of money across the Air Force in the shortest time-frame, this research is primarily focused on developing a method of prioritization for existing service and commodity contract areas that accounts for potential savings, costs, and efficiencies of strategic sourcing efforts in the CECC according to the objectives of Air Force leadership. The intent of this research project is to produce a model that is immediately usable by the CECC to assess opportunities for strategic sourcing efforts given available data and resources. In order to accomplish this goal, the following investigative questions will be examined:

- What are the objectives that Air Force leadership believes strategic sourcing should accomplish?
- What are the relative priorities of those objectives?
- What variables predict potential efficiencies in a service or commodity contract areas?
- Can the variables mentioned above be accurately measured with existing data sets and current data collection efforts?
- What is the model that accurately balances all objectives according to leadership priorities that predicts progress toward strategic sourcing goals?

Methodology

This research project uses Value Focused Thinking (VFT) as the decision analysis methodology for creating an opportunity assessment decision model for the CECC. This model consists of a hierarchy of the full spectrum of values important to the CECC and relevant to the opportunity assessment problem as well as a mathematical function that converts an alternative's relevant data into units of value used to compare alternatives.

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Once the VFT-based model is developed, a pilot study will be conducted using the model to analyze a small group of strategic sourcing opportunities. The results of the analysis will be compared with results of the existing opportunity assessment process in use by the CECC in order to determine the impact of the additional values on the results of the opportunity assessment process. Where possible, data used in the CECC's current analysis of opportunities will be used to evaluate the same alternatives using the new model. Data requirements driven by the addition of new values to the opportunity assessment process will be generated using a series of interviews with subject matter experts of the services or commodities being evaluated.

Overview

This document is arranged in five separate chapters. The following chapter contains a review of pertinent literature that relates to the subject of strategic sourcing. Chapter III contains a detailed discussion on the methodologies used in the generation of results of this research project. Chapter IV provides a detailed description of the results of the research effort and an analysis of the impact and significance of the results. Finally, Chapter V provides a summary and a list of conclusions of the project.

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II. Literature Review

The purpose of this chapter is to provide an overview of existing research relevant to this project. This chapter begins with a summary of the background of the strategic sourcing concept, explores efforts within the Department of Defense (DoD) to implement strategic sourcing, explains current policies and procedures within the Air Force strategic sourcing organizations, and concludes with a background of the multiple criteria decision analysis tool known as VFT.

Strategic Sourcing

Over the past 35 years, studies of effective business procurement strategies and best practices have developed the currently understood concept of strategic sourcing. Because the concept developed from observation of practical results, strategic sourcing is less a concrete set of methods for achieving supply excellence and more a collection of related ideas that are accepted as important in formulating an effective, competitive supply strategy. The following paragraphs provide a brief summary of pertinent research that has identified trends and concepts that have formed the core of what has come to be known as strategic sourcing.

The idea of taking a more strategic approach to purchasing and procurement in business developed as an area of research interest in the early 1980s. Adamson (1980) summarized the emerging concepts of integrating corporate strategy into supply and purchasing plans. He also addressed several basic conceptual questions identifying both the need for long-range corporate planning and several methodologies for accomplishing

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it. He proposed several methods, including linear programming and dynamic programming for closely linking corporate objectives to decisions made in the planning process (Adamson, 1980).

Kraljic (1983) created several practical models for clarifying the strategic environment in which purchasing decisions were being made. Based on the concept of assessing and managing risk among various suppliers in an increasingly global marketplace, Kraljic's purchasing model, shown below in Figure 1, notionally divides supplies into four categories based upon both the importance of the asset to corporate objectives and the complexity of the market in which the product is available (Kraljic, 1983).

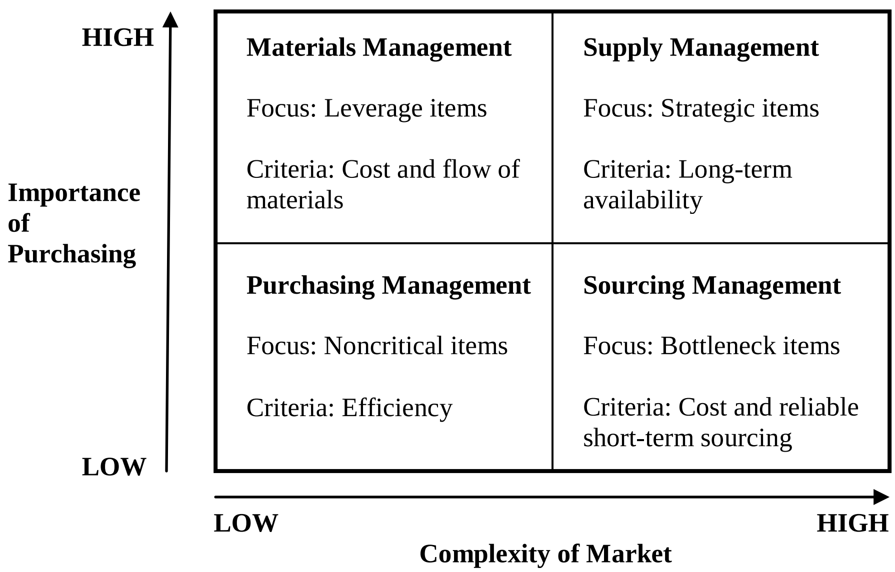

Figure 1. Kraljic's Purchasing Model (1983)

Each of the four groups has a distinct focus as well as different criteria by which to evaluate opportunities found in each category. This method provides a systematic,

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comprehensive analysis of all procurement items, and helps the user develop sourcing strategies tailored to the needs and environment of each individual requirement. For example, items with high importance but little market complexity lend themselves to a purchasing strategy that seeks to leverage the purchasing power of the organization to achieve lower costs (Kraljic, 1983). This strategy in particular will be discussed later in this chapter.

As globalization increased competition in the marketplace in the late 1980s, Speckman (1988) highlighted the emerging trend in industry for the integration of companies with their suppliers. He proposed a method of evaluating and selecting potential suppliers for strategic, integrated relationships based on the experience and capability of the supplier as well as the volume and importance of the commodity being purchased (Speckman, 1988). This concept has formed one of the central ideas of strategic sourcing, extending the idea of integrating long-term corporate planning into the supply strategy to develop buyer-supplier relationships.

Currently, the concept of strategic sourcing has become an accepted best practice in the discipline of supply chain management, and variations of its concepts can be found within the pages of virtually all texts on purchasing and supply chain management. While it has grown to be synonymous with making good procurement decisions, there are several concepts that are central to the idea. Johnson, Leenders, and Flynn (2006) define strategic sourcing as focusing "on long-term supplier relation and commodity plans with the objectives of identifying opportunities in areas such as cost reduction, new technology advancements, and supply market trends". This definition highlights several of the central ideas of strategic sourcing: that it involves deliberate well-thought out

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planning, that it involves developing inter-connected relationships between buyer and supplier, and that it can be used to further organizational objectives.

While the literature relevant to strategic sourcing clearly defines what it is and explains strategies for strategically sourcing the goods and services an organization procures, very little is written regarding decision models related to strategic sourcing. Talluri and Narasimhan (2004) presented a decision model related to the selection of an organization's suppliers using Data Envelopment Analysis (DEA). Other published methodologies, like Kraljic's method described previously, focus on finding the best solution for a strategic sourcing opportunity, not on identifying what the best opportunities are. While no reason for this is stated in the literature, it is reasonable to conclude that researchers generally assume that an organization will be making a strategic sourcing decision on every service and commodity purchased enterprise-wide. Because no methodology has been developed to address the unique opportunity assessment problem in the DoD, organizations have been left with developing their own methods for opportunity assessment.

Strategic Sourcing in the Department of Defense

While the concept of strategic sourcing has been widely used in the private sector, little effort was made to implement any of the best practices in the government until the early 2000s. In 2002, the Government Accountability Office (GAO) released a report highlighting the potential for savings in government acquisition programs based on case studies of six companies that had implemented strategic sourcing programs. The GAO (2002) found that implementing strategic procurement practices resulted in lower cost,

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higher quality products. The report cited four common components that contributed to success in each of the six organizations: an organizational commitment to a strategic approach; improved knowledge of spending patterns; a sufficient supporting structure, processes, and roles; and a leadership focus including communication of metrics to subordinates (GAO, 2002).

In response to this study and the 2002 Defense Authorization Act, the DoD began a pilot program aimed at implementing a comprehensive spend analysis of enterprise-wide expenditures on service acquisitions. According to a follow-up study by the GAO (2003), while the program did attempt to implement a one-time spend analysis of some service contract areas, it failed to provide a repeatable and comprehensive examination of enterprise-wide service contract spending. DoD cited several reasons for this problem, including decentralized procurement practices and the multitude of disparate financial programs that are used to track expenditures in various DoD organizations (GAO, 2003).

The Office of Management and Budget subsequently released a memorandum requiring all federal agencies to take steps to implement a strategic sourcing program with the overall goal of reducing the cost of government operations (OMB, 2005). This memo defined strategic sourcing as "the collaborative and structured process of critically analyzing an organization's spending and using this information to make business decisions about acquiring commodities and services more effectively and efficiently" (OMB, 2005). In response, strategic sourcing efforts have grown consistently within the DoD, with each service establishing programs to search for acquisition efficiencies using this process.

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Air Force Strategic Sourcing

Prior to the release of the OMB directive for all federal departments to utilize strategic sourcing, the Air Force began its strategic sourcing program with the formulation of the Information Technology Commodity Council in 2003. This organization was successful in demonstrating the capability of strategic sourcing to improve efficiencies with the acquisition of commodities (IT Commodity Council, 2013). In 2009, the Air Force launched an expansion of the Commodity Council concept with the establishment of the Enterprise Sourcing Group at Wright Patterson Air Force Base, Ohio. This new organization was established in 2010 and was charged with the formulation and oversight of the all Air Force commodity councils, including civil engineering, force protection, furnishings, information technology, knowledge-based services, medical, and office supplies (Enterprise Sourcing Group, 2013).

The Civil Engineer Commodity Council (CECC) serves as the primary hub of strategic sourcing actions for the Civil Engineering (CE) community. Unique in organizational structure, the CECC is charged with managing strategic sourcing solutions for the CE community while not actually being inside the CE chain of command. The CECC primarily interfaces with the Air Force Civil Engineer Center (AFCEC) to obtain feedback and information in order to meet the evolving needs of Air Force CE (Civil Engineering Commodity Council, 2013).

The CECC's strategic sourcing process is graphically detailed in Figure 2.

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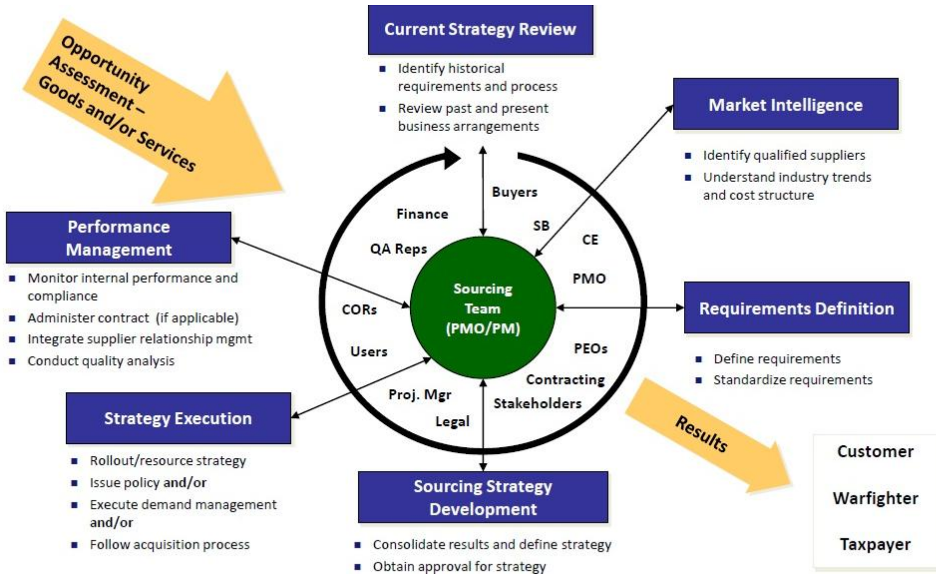

Figure 2. The Air Force Strategic Sourcing Process Model (ESG, 2011)

As Figure 2 shows, the strategic sourcing process begins with an opportunity assessment, where potential areas of commodity or service contracts are evaluated for the potential to reap savings for the Air Force. Potential contract areas are then undergo a review process that includes an evaluation of existing contract processes, an evaluation of the commercial market for the commodity or service, and a definition of the user's requirements for the product or service. This information is then used to generate a sourcing strategy that will result in the optimal contract solution for the user on an enterprise-wide level. Once this sourcing strategy is approved, the ESG competes, awards, and monitors the contract throughout its lifecycle.

Currently, the opportunity assessment phase of the strategic sourcing process is being executed via a spend analysis similar to Kraljic's method. Historical spend data are captured primarily from two databases, the Contracting Business Intelligence System (CBIS) and the Commander's Resource Integration System (CRIS) and then analyzed to

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identify the commodities and services where the most money is being spent. These high spend areas are then more closely examined for potential opportunities for efficiencies. This method has resulted in one successful strategic sourcing contract, Light Emitting Diode (LED) taxiway lighting, being executed by the Enterprise Sourcing Group since 2010.

Value Focused Thinking

Value-Focused Thinking (VFT) is a Multiple Criteria Decision Analysis (MCDA) method developed by Keeney (1992) that is based on broad organizational values or objectives. The VFT process requires the decision-maker to first identify his or her values that are relevant to the decision that needs to be made. This contrasts from traditional alternative-focused decision analysis methods in that it focuses on developing alternatives and evaluation criteria after the organizational goals and objectives have been identified. Alternative-focused decision methods suffer from being focused on merely finding ways to differentiate each alternative, rather than evaluating alternatives based on the strategic objectives of the decision-maker. This reactionary method also stovepipes decision makers into only considering alternatives presented at the outset of the problem-solving process (Keeney, 1992). Alternatively, VFT seeks to fully understand the underlying objectives behind the decision, leading the decision-maker down a path of greater understanding that results in the potential for alternatives to be developed based in the insight gained during the value identification process.

In addition to increased understanding of the values important to the decision-maker, the VFT method results in decision models that are flexible to changes in

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alternatives and/or criteria without the need to completely revise the model. This is particularly useful for an application such as strategic sourcing opportunity assessments, where there are a multitude of ever-changing alternatives. Other MCDA methods, namely Saaty's Analytical Hierarchy Process, require decision models to be completely re-generated if any change is made to the alternatives or criteria to be evaluated (Saaty, 1980). The insight gained during the VFT process and the flexibility of the resulting decision model makes VFT ideally suited for use in conducting an opportunity assessment for public sector organizations. The following paragraphs will detail the eight specific steps of the VFT decision making process as set forth by Kirkwood (1997) and shown graphically in Figure 3.

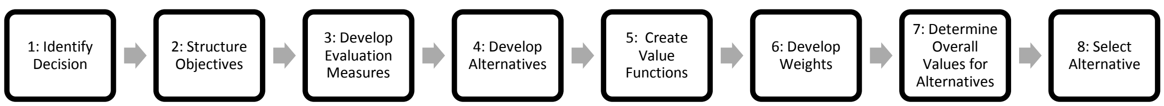

Figure 3. Kirkwood's eight-step VFT process (1997)

Step 1: Identify Decision

The first step in the VFT process is to identify the decision that needs to be made. While this step may seem obvious, failure to fully understand the context and intent of the decision to be made will result in a model that does not necessarily fit the actual decision space.

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Step 2: Structure Objectives

As the VFT name implies, clearly identifying the values or objectives that are applicable to the decision is essential to the decision making process. One method of accomplishing this is by creating a value hierarchy. A value hierarchy is a graphical depiction of the full range of objectives relevant to the decision in question. The hierarchy is arranged with a primary, or fundamental, objective at the top, with subsequent tiers of subordinate objectives listed below (Keeney, 1992). Figure 4 provides a notional diagram of a typical hierarchy structure.

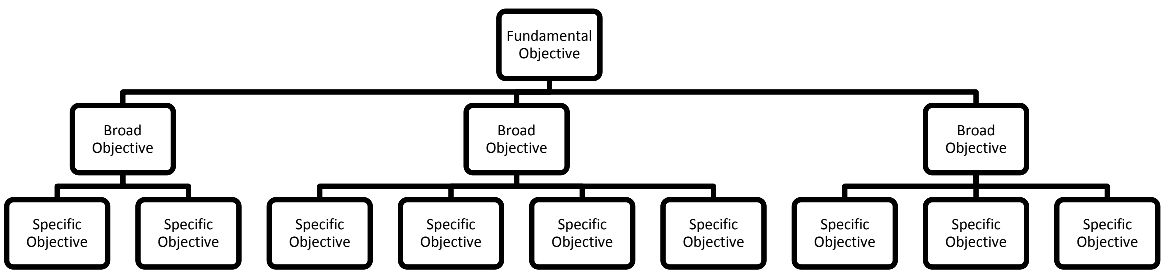

Figure 4. Notional Diagram of a Value Hierarchy

Kirkwood (1997) identifies five desirable properties of a value hierarchy. First, it should be complete. This means it should cover the full range of values relevant to the decision. In other words, no part of the fundamental objective is being ignored and it can be fully evaluated based on the subordinate tier objectives present in the hierarchy structure. The second desirable property is nonredundancy. Specific sub-objectives should not be found within multiple tiers as this will lead to double-counting of the

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objective when it is evaluated. The third desirable property is independence. This means each objective must be able to be evaluated in a manner that is comparable to the other objectives. While it is possible for objectives to require that dissimilar metrics be compared (e.g., money vs. intangible tradeoffs such as environmental quality), a means must be available to convert the metrics into a common system of measure. This is accomplished in VFT models through the use of Single Dimensional Value Functions (SDVFs). The fourth value hierarchy quality that is needed is operability. Operability means simply that the objective is clearly and explicitly defined and able to be understood within the decision context. Finally, small size is the fifth desirable property. Hierarchies should be as small as possible to meet the other four desirable qualities and reduce the burden of data gathering and calculations on the part of the decision maker (Kirkwood, 1997).

Step 3: Develop Evaluation Measures

Once the values have been identified, a means must be developed to measure the relative merits of each alternative. These measures are the bridge that connects the desired objectives with the data available to the decision maker. There are three primary types of evaluation measures: natural, proxy, and constructed measures. Natural evaluation measures lend themselves to direct, quantitative measurement. As the name implies, natural objectives are intuitive and require that the objective both be quantitatively measurable and that measurement is possible for the decision maker. Natural evaluation measures are the preferred method of evaluating alternatives as they provide the most objective measurement to the process. Less desirable than natural

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attributes, constructed attributes are used when no quantifiable measurement is possible related to a specific objective. Typically, these are accomplished by formulating a scale that an expert uses to assign a "score" directly evaluating an alternative based on its potential to further the objective in question. Finally, the proxy attribute is the least desirable method of evaluating alternatives. The proxy evaluation measure is for objectives that do not lend themselves to direct measurement by either a natural or constructed measure, but for which there is data available that indirectly measures the alternative's contribution toward the objective in question (Keeney, 1992).

Step 4: Develop Alternatives

Alternative creation is a step in the decision analysis process that is unique to VFT. In accomplishing the previous three process steps, the decision maker gains a significant amount of insight into the objectives and motivations that frame the decision context. Using this insight, a decision maker is well-prepared to evaluate the known alternatives and generate new hybrid alternatives that seems to best fit the objectives that were identified (Keeney, 1992).

Step 5: Create Value Functions

Single Dimensional Value Functions (SDVF) are mathematical representations of the relationship between an alternative's data point for a given evaluation measure and its associated score that indicates a positive impact on the fundamental objective. Each evaluation measure must have this relationship clearly established to create the overall value function that will identify the preferred alternative. This is accomplished by

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converting data for all evaluation measures into units of value via a SDVF. SDVFs can be linear, curvilinear, or discrete, but must either increase or decrease in value monotonically. That is, the slope must always be positive or negative over the entire range of possible values. SDVFs provide the value hierarchy with the independence necessary to allow for comparison of dissimilar objectives. (Kirkwood, 1997). Graphical examples of different types of SDVFs are provided in Figure 5.

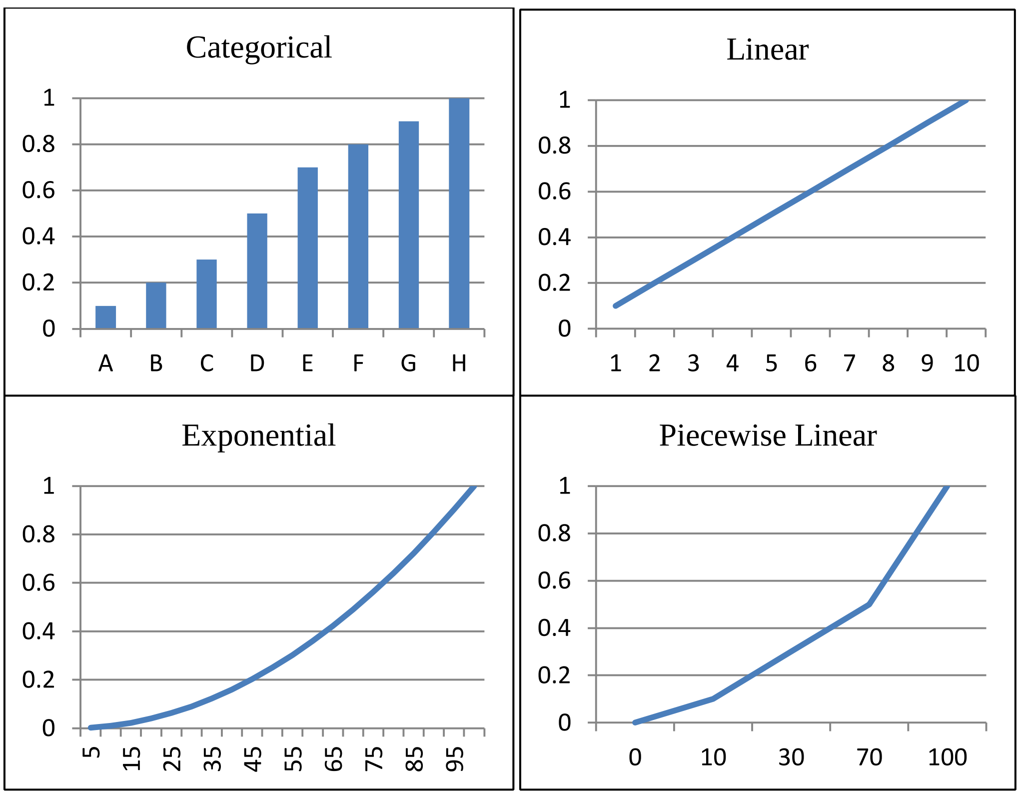

Figure 5. Single Dimensional Value Function Examples

Step 6: Develop Weights

The next component of the value function is the weight factor that is assigned to each evaluation measure. Weighting factors are used to model the relative importance of

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each evaluation measure as it relates to the fundamental objective. There are two primary methods for determining evaluation measure weights, the direct method and the swing method. Direct weighting is accomplished by having the decision maker directly assign relative importance to each of the objectives in the objective hierarchy by each branch with a tier. Typically, this is accomplished with a top-down approach, where weights are first assigned to the top tiers of the hierarchy, and then weights are developed for the subordinate set of objectives as a group. This process leads to the development of local and global weights for each objective. Local weights refer to the weight assigned under the parent objective, whereas the global weight factors in the weighting of the parent tiers into the overall weight of the sub-objective (Shoviak, 2001).

Weights are assigned as percentages, where a value of 1 refers to the entirety of available weight. One method of conceptualizing this weighting system, called the "100 coin method," is for decision makers to assume they have 100 coins to distribute among the objectives that represent units of weighting. Once all 100 coins have been distributed among the objectives, percentage weights have been determined. For example, if fifty coins were given to a particular objective, it would receive a weight of 0.5, and would correspond to the concept that that particular objective is worth half of the entire weight in the hierarchy (Jurk, 2002).

Swing weighting is the weighting method proposed by Keeney, and refers to weights being determined by evaluating the effects of weights assigned and evaluating those effects in an iterative process. Typically, this is accomplished via a pair-wise comparison between two objectives at a time. The decision maker develops a micro-version of the value equation using only the two objectives that are being considered in

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this particular comparison. Assigning notional scores and seeing the outcome of the equation gives the decision maker a less subjective picture of the actual relative importance of objective, particularly when the objectives are quantified in a dissimilar manner (Keeney, 1992).

Step 7: Determine Overall Values for Alternatives

Once SDVFs, objective weights, and data have been gathered, the value function can be created according to Equation 2.1 (Kirkwood, 1997):

$$v(x) = \sum_{i=1}^{n} w_i v_i(x_i) \qquad (2.1)$$

Where v represents the total value score for the alternative, w_i represents the weight factor for the ith objective, v_i represents the SDVF for the ith objective, and x_i represents the data input for the ith objective. This function generates an overall value score for each alternative that can be used for comparison.

Step 8: Select Alternatives

Once each of the alternatives has received an aggregate value score, a basis for comparison exists that can be used to select the most attractive alternative. While this is a straightforward process, simple steps can be taken to double check the model itself. Chambal recommends conducting a sensitivity analysis on the higher tiers of the value hierarchy in order to explore how varying the weights affects the decisions recommended by the value function. This is accomplished by altering the global weight of a single objective, while maintaining proportional weights across the remaining objectives. This

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analysis is useful in identifying alternatives could potentially look more attractive given a small adjustment in the weight factors (Chambal, Weir, Yucel, & Gutman, 2011).

Chapter Summary

While strategic sourcing has yielded significant results in both the public and private sector, DOD has struggled with implementing a thorough, enterprise-wide spend analysis on its expenditures. This is due largely to decentralized management practices that have made gathering the data necessary to accomplish the analysis extremely difficult. As a result, a thorough and comprehensive method of accomplishing an opportunity assessment in the CECC has not been developed. This has left the CECC with little insight into which of the multitude of contract areas in which to begin investigating a strategically sourced solution. VFT can be used to develop a decision support tool that can be used to effectively conduct a systematic, comprehensive, and objective opportunity assessment of all possible contract areas. The next chapter will provide a detailed explanation of the specific methodology applied in this research project.

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III. Methodology

The purpose of this chapter is to explain in detail the methodology used in this research effort. Specifically, it provides details of the application of Value Focused Thinking (VFT) to the opportunity assessment Multiple Criteria Decision Analysis (MCDA) problem faced in the Civil Engineer Commodity Council (CECC). This section begins with an overview of the model development process, and then explains in detail the specifics of the eight step process used in this research project, including the data gathering process. The decision model developed during this research project is described in this chapter, as explaining the results of certain process steps is necessary to adequately explain the methods used in subsequent steps. The model will be fully presented again in Chapter IV with the remainder of the results.

The VFT Process

VFT differs from other MCDA methods in that it evaluates alternatives based upon the values of the decision-maker, and not merely based on characteristics that differentiate known alternatives. Because of this, the VFT process requires an additional set of analyses in order to define the values of the decision-maker. This is of particular importance in the Civil Engineering Commodity Council (CECC) opportunity assessment decision context due to the wide range of strategic objectives important to Air Force Civil Engineering (CE) acquisitions that the current opportunity assessment methods fail to address.

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To accurately capture and understand the strategic objectives relevant to this decision-making process, Kirkwood's eight-step VFT model (1997) was used as the overarching methodology in this research project. Figure 6 below provides an overview of the eight-step VFT process along with a diagram of the process inputs used. This diagram depicts the sequence of the VFT methodology as well as broad categories of inputs to various steps of the decision making process. A combination of expert opinion, published official documents, and quantitative data was used throughout the model building process to assign value to alternatives based on objectives. The following sections of this chapter explain in detail the process steps executed during this research project.

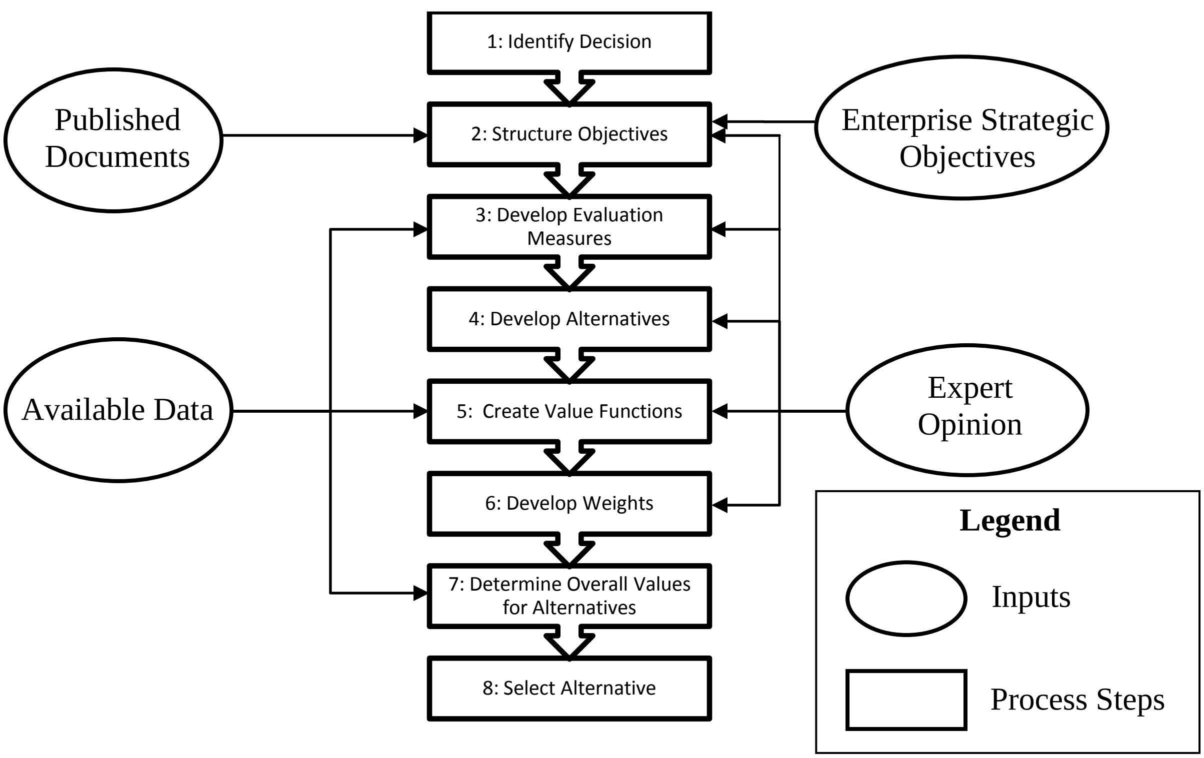

Figure 6. VFT Process Diagram with Inputs

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Step 1. Problem Identification

The opinion that the right strategic sourcing opportunities were not being evaluated was initially identified during informal conversations with engineers at Air Force Materiel Command (AFMC). Further discussions with engineers at the Major Command and Field Operating Agency level mirrored the comments made at AFMC. Based on these discussions, a meeting was held with members of the Enterprise Sourcing Group (ESG), the organization responsible for the planning and execution of the Air Force's strategic sourcing program. During this meeting, ESG staff indicated that a problem existed regarding the opportunity assessment phase of the strategic sourcing process. While a process for conducting opportunity assessments had been in use for two years, it failed to accurately capture the full range of objectives important to the Air Force CE functional community. As a result, the ESG had been struggling to deliver strategic sourcing contracts and were having difficulty identifying new opportunities for evaluation.

Based on this information, this research project was implemented to create an alternative means of opportunity assessment that would accurately capture the full range of objectives relevant to the CECC and the Air Force CE community. Upon review of literature relevant to the problem, VFT emerged as the methodology best suited to providing a solution to the CECC's opportunity assessment problem. Once the problem and associated methodology were identified, the next step was to define what exactly the objectives of the CE strategic sourcing program were.

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Step 2. Structure Objectives

The first step of understanding the context in which the opportunity assessment decision problem occurs is to identify the strategic objectives of the strategic sourcing program. While most VFT applications require "deep and serious thought" (Keeney, 1992), many of the objectives of the CECC were stated in the organization's charter document. Eight objectives were developed jointly by the CE and Contracting functional leadership to provide a broad vision of what the CECC was meant to accomplish. The eight objectives contained in the charter are as follows (Civil Engineering Commodity Council, 2010):

1. Create enterprise-wide supplies and services sourcing strategies
2. Create and maintain strategic supplier relationships
3. Drive commonality and standardization of requirements
4. Minimize supply chain cost through integration/collaboration
5. Reduce procurement processing times
6. Minimize duplication of effort
7. Lower total cost of ownership
8. Leverage forecasting data through collaboration

The first objective, to create enterprise-wide sourcing strategies, applies broadly to the overall mission of the CECC, but does not have any direct, measurable bearing on the opportunity assessment phase. Three other objectives, numbers 2, 5, and 8, apply to the contracting process that occurs after the opportunity assessment has been conducted. The

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remaining four objectives provide the basis for the desirable elements of a strategic sourcing contract.

Each of these objectives fall under the overall objective of strategic sourcing, which is “to make business decisions about acquiring commodities and services more effectively and efficiently” (OMB, 2005). Several of these objectives can be further divided into sub-objectives in order to accurately capture the various dimensions of meaning inherent in the language. This relationship is shown in Figure 7 as an objective hierarchy. This hierarchy displays the association between all objectives, stated and implicit, in the CECC charter document.

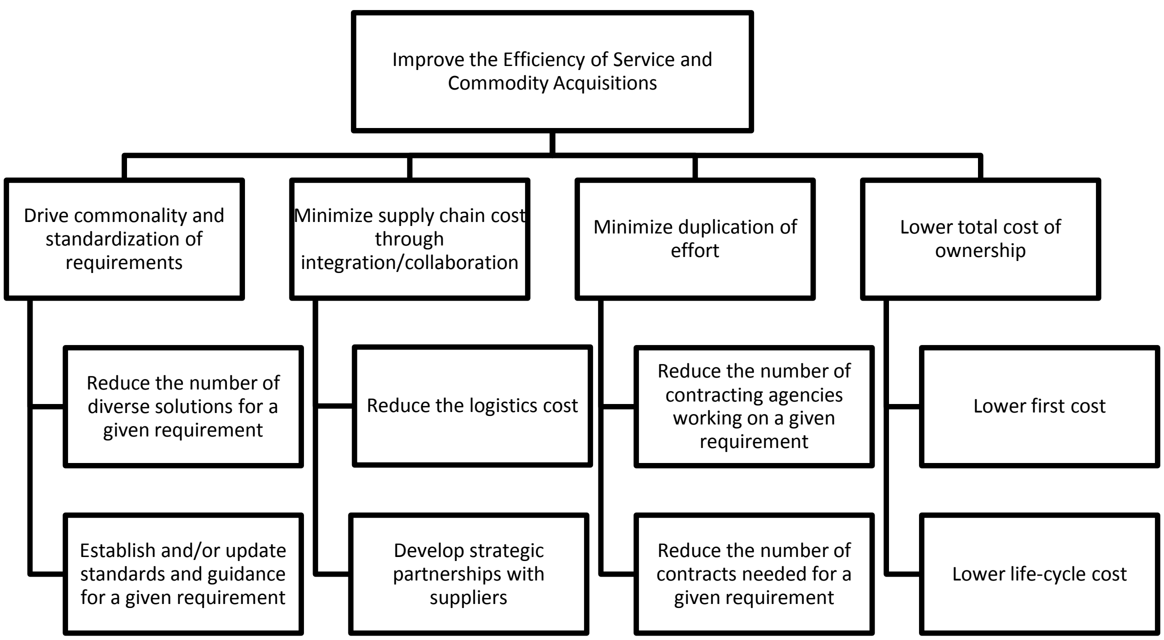

Figure 7. Objective Hierarchy of CECC Charter Strategic Objectives

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As shown in Figure 7, the objectives stated in the CECC charter can be clarified to apply more directly to the opportunity assessment process itself. Based on the CECC charter document, the following list of opportunity assessment objectives was developed:

1. Reduce the number of diverse solutions for a given requirement
2. Establish and/or update standards and guidance for a given requirement
3. Reduce the logistics cost on contracts
4. Develop strategic partnerships with suppliers
5. Reduce the number of contracting agencies working on a given requirement
6. Reduce the number of contracts needed for a given requirement
7. Lower first costs of commodities and services
8. Lower lifecycle costs of commodities and services

In addition to the objective hierarchy distilled from the CECC charter document, a series of informal interviews with panels of subject matter experts was used to develop the objective hierarchy for this decision problem. This was primarily done for two reasons: the charter document was published prior to the formation of the current process and the ESG personnel had been operating since the organization was formed without knowledge of these objectives. By combining the approved, official CECC charter documents with the current working knowledge of the subject matter experts, a more accurate model of the true strategic objectives of the strategic sourcing program was developed that meets Parnell's (1998) gold standard as defined in Chapter II.

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Subject matter experts were consulted from both the ESG and the Air Force Civil Engineer Center (AFCEC), with data being collected in two phases. First, the ESG engineers developed a draft hierarchy independent of input from published official documents and the subject matter experts from AFCEC. This was accomplished through a brainstorming process whereby potential objectives were written onto note cards. As objectives were suggested, the cards were taped to the wall of the conference room and arranged according to similar categories. As the hierarchy evolved, three broad categories of objectives emerged: rate-related objective (cost and quality), process efficiency-related objectives, and demand management objectives. These categories also aligned with the current terminology in use by the senior-level decision-makers at the ESG, and were therefore adopted as the tier 1 objectives with the same terminology to facilitate ease of understanding with stakeholders and decision-makers. Through this process, the overall objective "Support the CE Mission by improving the efficiency of CE acquisitions" was formulated. After this first iteration of objective hierarchy building was completed, the draft hierarchy was sent to subject matter experts at AFCEC for review and comment. The draft hierarchy is provided in Appendix A.

Upon receipt of the revisions and comments from AFCEC subject matter experts, the draft hierarchy was again presented to the ESG panel of experts along with the objectives obtained from review of the CECC charter document presented in Figure 7. Using this information, the panel created a revised objective hierarchy that was submitted back to AFCEC for approval and was validated by CECC leadership. The resulting objective hierarchy is displayed in Figure 8, and definitions of each objective are provided in Table 1 and Table 2.

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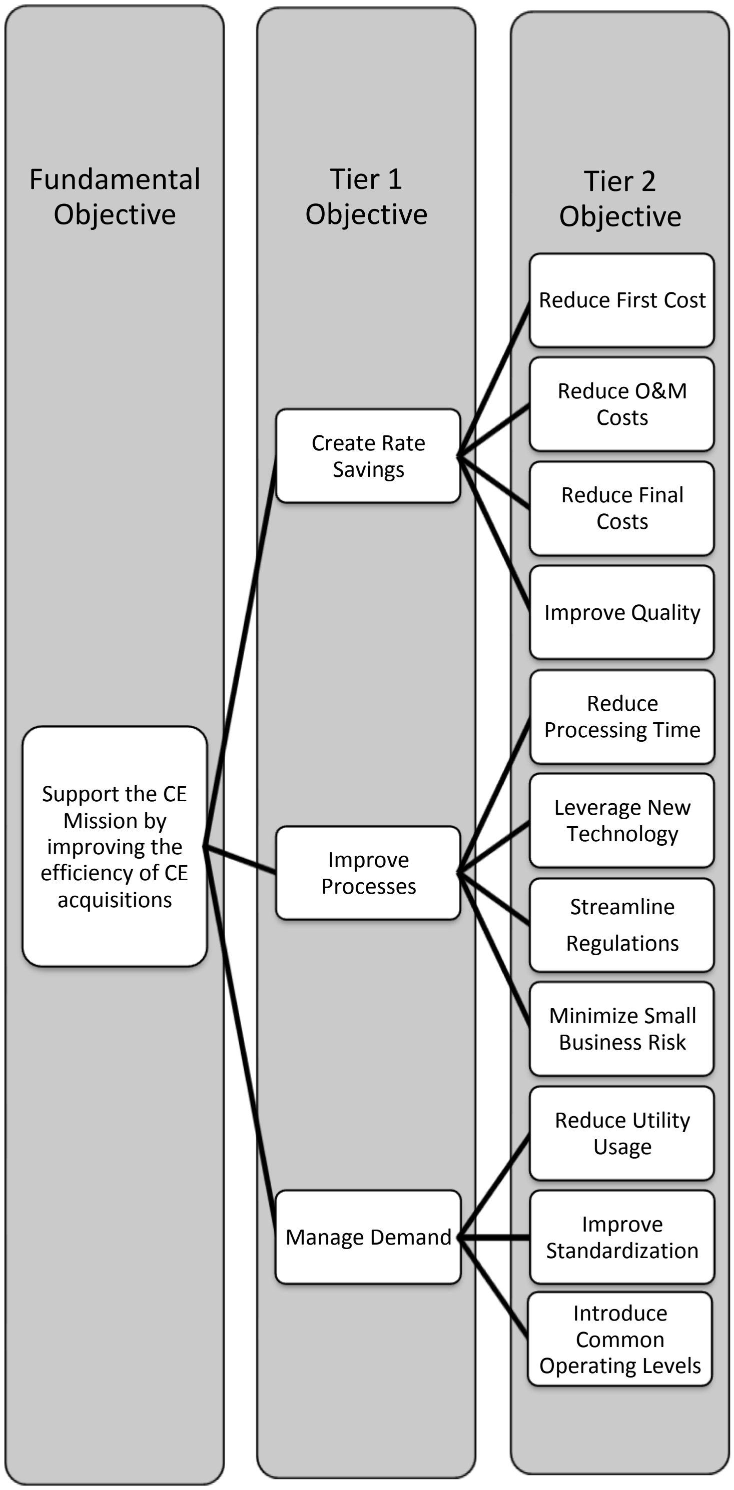

Figure 8. CECC Opportunity Assessment Objective Hierarchy

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Table 1. Tier 1 Objectives and Definitions

Objective Name	Definition
Create Rate Savings	This category contains objectives that are associated with managing the cost of the service or commodity that is being considered for strategic sourcing.
Improve Processes	Improve processes refers to objectives that promote efficiencies in services and commodities by reducing the risk and resource demands associated with the acquisitions process.
Manage Demand	This category refers to realizing efficiencies related to increasing or decreasing demand for commodities, services, or resources.

Table 2. Tier 2 Objectives and Definitions

Objective Name	Definition
Reduce first costs	Strategic sourcing solutions should reduce the initial expenses related to the acquisition of services and commodities
Reduce O&M costs	Strategic sourcing solutions should reduce the Operations and Maintenance (O&M) burden in both manpower and resource requirements for services and commodities
Reduce final costs	Strategic sourcing solutions should reduce the final cost component of services and commodities acquired. This includes, but it not limited to, disposal, demolition, environmental remediation, and other removal costs associated with the commodity or service
Improve quality	Strategic sourcing solutions should improve the quality of commodities and services acquired
Reduce processing time	Strategic sourcing solutions should seek to reduce the burden of the acquisition system by both reducing the number of contracts, and the resource requirements associated with them
Leverage new technology	Strategic sourcing solutions should seek to leverage new technology, where appropriate and feasible, across the Air Force that can improve the efficiency of services and commodities
Streamline regulations	Strategic sourcing efforts should reduce the overall burden of outdated and conflicting guidance and regulations to the acquisitions system
Minimize small business risk	Strategic sourcing contracts should support the federal government's philosophy of encouraging free and open competition between vendors, and should strive to support government small business participation goals
Reduce utility usage	Strategic sourcing efforts should seek to reduce the utility demand associated with the services and commodities that are evaluated
Improve standardization	Strategic sourcing should exploit the potential for efficiencies by increasing demand through standardizing solutions to common requirements where feasible
Introduce COLs	Strategic sourcing efforts should manage demand for services through the creation and implementation of Common Output Levels (COLs) that standardize requirements for common services across the enterprise

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Step 3: Develop Evaluation Measures

Once the objective hierarchy had been established, evaluation measures were developed for each tier-two objective to quantify the units of value for each alternative in furthering the objectives of the CECC. Two requirements were established by the expert panel at the ESG: the measures must use existing data sources and the data gathering process must be simple enough to be consistently repeatable by the CECC. Furthermore, the evaluation measures were developed according to the desirability criteria explained in Chapter II.

Natural criteria, or criteria for which there is a direct, quantitative measurement, is the most desirable. Constructed criteria, which indirectly evaluates the degree to which an alternative contributes to the associated objective based on qualitative data obtained from a subject matter expert, is second in the hierarchy of desirable evaluation criteria. Proxy criteria, the least desirable, uses available quantitative data that indirectly measures the alternative's contribution toward the objective in question when a direct means of measurement is not possible (Keeney, 1992).

Using this guidance, the ESG panel of subject matter experts developed the evaluation criteria shown in Table 3. A brief description of each evaluation measure is listed with its associated objective name along with the name of the measure type. Detailed descriptions of the data used to score alternatives according to these criteria are listed in the section for process step 7.

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Table 3. Model Evaluation Measures

	Objective	Measure	Type
1	Reduce first costs	Average total spent per FY on the service or commodity	Natural
2	Reduce O&M costs	Average total spent per FY on O&M for the commodity	Natural
3	Reduce final costs	SME evaluation of the range of potential final cost savings	Constructed
4	Improve quality	SME evaluation of current quality issues in the commodity or service area	Constructed
5	Reduce processing time	Average number of contracts executed per FY	Proxy
6	Leverage new technology	SME evaluation of available new technology	Constructed
7	Streamline regulations	SME evaluation of currency and consolidation potential of existing regulations, standards, and guidance pertaining to the commodity or service area	Constructed
8	Minimize small business risk	Percentage of total contracts per FY awarded to small businesses	Proxy
9	Reduce utility usage	SME evaluation of percentage of possible utility reductions	Constructed
10	Improve standardization	SME evaluation of the number of current distinct solutions for the requirement	Constructed
11	Introduce COLs	SME evaluation of percentage of demand reduced by the implementation of applicable COLs	Constructed

Based on the input of the ESG panel of experts, natural evaluation measures were only possible for objectives 1 and 2 since actual cost data is available for all services and commodities purchased by the CE community. Objective 5, reduce processing time, was assigned a proxy evaluation measure since it is not feasible to measure the total time personnel across the entire Air Force spend working on contracts related to a specific opportunity. Instead, the total number of contracts executed per FY can serve as a proxy measure, as the total time spent across the Air Force is closely related to the number of

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contracts in development. Similarly, objective 8, minimize small business risk, does not have a direct, objective means of measurement. A proxy evaluation measure was assigned that uses the total percentage of contracts that are awarded to small businesses. This measure can approximate the level of adverse impact on small business objectives possible by pursuing a strategic sourcing solution. The rest of the objectives were assigned constructed evaluation measures that focus on the professional opinions of the opportunity's Subject Matter Expert (SME) at AFCEC. These measures utilize an interview process with the SME asking specifically defined questions developed to make the evaluation as objective as possible. The questionnaire used during the interview process for each of the SME interviews is included in Appendix B.

Step 4: Develop Alternatives

Alternatives were developed by first examining existing documents pertaining to the establishment of the CECC. During the initial phases of planning for the CECC's first contract targets, a Commodity Management Plan (CMP) was developed to both provide internal direction to CECC personnel as well as to forecast potential efficiencies for budgeting purposes. During this process, the CECC developed a prioritized list of strategic sourcing opportunities according to the original spend analysis method discussed in Chapter II. The prioritized opportunities listed in the CMP were therefore selected as alternatives to facilitate comparison of the original opportunity assessment model with the model developed during this research project. Table 4 lists the prioritized strategic sourcing opportunities identified in the CECC CMP.

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Table 4. CMP-prioritized Strategic Sourcing Opportunities (Civil Engineering Commodity Council, 2011)

Opportunity Name	**Priority**
Taxiway Lighting	1
Heating Ventilation and Air Conditioning (HVAC) Systems, Chillers and Boilers	2
Fire Protection and Suppression	3
Rubber Removal and Airfield Restriping	4
Services (including Elevator Maintenance, Hood/Duct Cleaning, and Dorm Appliance Leasing/Maintenance	5
Energy Monitoring and Control Systems	6
Automatic Gates and Doors	7
Paint and Protective Coatings	8
Flooring	9
Roofing	10
Generators	11
Paved Surface Striping, Painting, and Marking	12

Since the CMP was approved in 2011, the ESG had conducted research on several of the listed items that indicated they were not opportune candidates for strategic sourcing. Based on this research and the experience of the ESG engineers, the list of CMP commodities and services to be evaluated was reduced to six. In addition, the service contract category originally listed as fifth on the CMP priority list was limited to elevator maintenance only. This provided a sufficient number of alternatives to compare with the CMP priority model while limiting the data gathering burden to a manageable level.

The ESG engineers also recommended adding three alternatives they were aware of that were not evaluated and prioritized in the CMP for comparison purposes. Fire Personal Protective Equipment (PPE), HVAC retrocommissioning, and water leak detection were already being evaluated in an opportunity assessment process. The

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priorities of these three alternatives in the new opportunity assessment model were compared with the priorities of the services and commodities already identified in the CMP in order to provide insight into their relative merit in advancing the goals of the strategic sourcing program.

Finally, during the subject matter expert interview process described in step seven, experts were asked to identify additional alternatives for consideration. Although this research project did not include the evaluation of these alternatives, they are provided for future evaluation in Chapter IV. Table 5 lists the outcome of the CMP review and the recommendations made by the ESG staff. These nine alternatives underwent evaluation according to the model developed in this research project. Detailed descriptions of each alternative are provided in Chapter IV.

Table 5. List of Identified Alternatives

Opportunity Name	**Source**
Elevator Maintenance	Commodity Management Plan
Fire Personal Protective Equipment	ESG Recommendation
HVAC Retrocommissioning	ESG Recommendation
HVAC Systems, Chillers and Boilers	Commodity Management Plan
Roofing	Commodity Management Plan
Rubber Removal and Airfield Restriping	Commodity Management Plan
Generators	Commodity Management Plan
Taxiway Lighting	Commodity Management Plan
Water Leak Detection	ESG Recommendation

Step 5: Create Value Functions

The correlation between an alternative's raw data point for each evaluation measure and its associated value score is made by a Single Dimensional Value Function (SDVF). SDVFs can be either linear, curvilinear, or discrete, but must either increase or

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decrease in value monotonically. That is, the slope must always be positive or negative over the entire range of possible values. In general, indirect evaluation measures result in discrete SDVFs, while direct evaluation measures use linear SDVFs.

The first step to developing the SDVFs was to define the ranges of data associated with each individual evaluation measure. This necessitated that the SDVF development process occurred after the data had been gathered for the alternatives selected in the previous step. While the collected data is detailed in Chapter IV, Table 6 below displays the data ranges for the evaluated alternatives. It is also important to note that if new alternatives are evaluated with this opportunity assessment model, the data must be checked to ensure it falls within the upper and lower bounds shown in the table. If not, it will be necessary to alter the SDVFs to account for the new range.

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Table 6. Data Ranges for Evaluation Measures

	Objective	Measure	Lower Bound	Upper Bound
1	Reduce first costs	Average total spent per FY on the service or commodity	$0	$92.3M
2	Reduce O&M costs	Average total spent per FY on O&M for the commodity	$0	$52.37M
3	Reduce final costs	SME evaluation of the range of potential final cost savings	0-2%	>25%
4	Improve quality	SME evaluation of current quality issues in the commodity or service area	Never	Constant
5	Reduce processing time	Average number of contracts executed per FY	0	307
6	Leverage new technology	SME evaluation of available new technology	No	Yes
7	Streamline regulations	SME evaluation of currency and consolidation potential of existing regulations, standards, and guidance pertaining to the commodity or service area	No	Yes
8	Minimize small business risk	Percentage of total contracts per FY awarded to small businesses	0	100
9	Reduce utility usage	SME evaluation of percentage of possible utility reductions	0-2%	>25%
10	Improve standardization	SME evaluation of the number of current distinct solutions for the requirement	1	>11
11	Introduce COLs	SME evaluation of percentage of demand reduced by the implementation of applicable COLs	0-2%	>25%

The next step in developing SDVFs is to determine the relationship between the possible data scores within the ranges that were identified and the desired value score. Since value scores for each evaluation measure can range from 0 to 1, the decision-maker must decide whether the minimum data value will achieve a zero value score or vice-versa. This will determine whether or not the SDVF will be increasing or decreasing. Finally, the decision-maker must determine the relationship between the data and the

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value score within the range of possible data values. For linear SDVFs, this is achieved by use of a mathematical relationship between the data point and the value score. For discrete SDVFs, each category must be individually assigned a corresponding value score. The following sections explain in detail the development process for each of the eleven SDVFs developed for this opportunity assessment model.

The SDVF for reduce first cost shown graphically in Figure 9 is a linear, monotonically increasing function ranging between \$0 and \$92.3 Million. Cost data for alternatives that contained multiple fiscal years was averaged across the years collected. The upper bound was determined based on the maximum calculated average annual first cost value for the alternatives considered. This function yields a value of 1 for the upper bound of \$92.3 Million, and decreases linearly to zero as the annual first cost approaches zero. The first cost data was obtained for each alternative by the ESG from the Commander's Resource Information System (CRIS). The SDVF is defined by equation 3.1, where v is the objective value score, x is the alternative's average annual first cost, and x_{max} is the maximum average annual first cost value for all the alternatives considered.

$$v(x) = \frac{x}{x_{max}} \tag{3.1}$$

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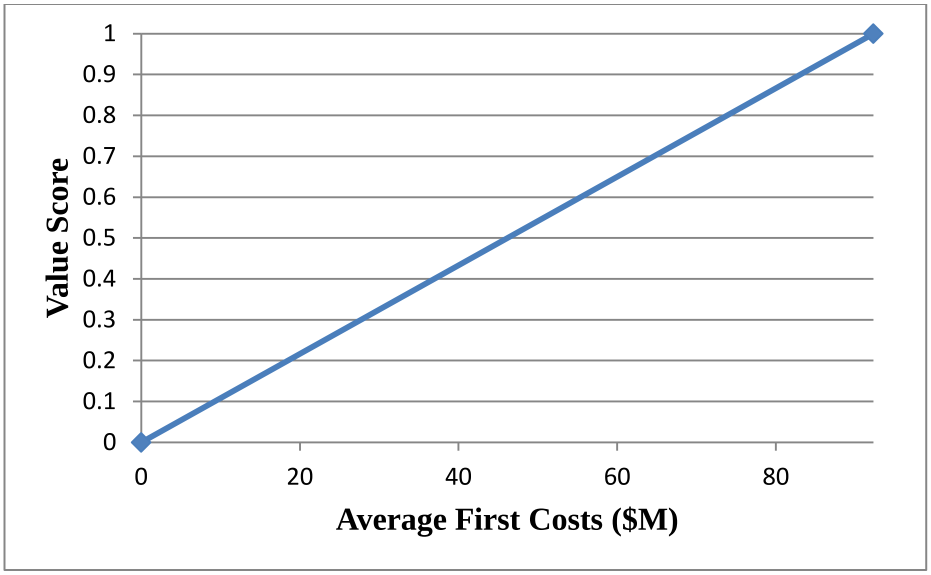

Figure 9. SDVF for Reduce First Costs

The SDVF for reduce O&M costs shown graphically in Figure 10 is a linear, monotonically increasing function ranging between $0 and $52.37 Million. Cost data for alternatives that contained multiple fiscal years was averaged across the years collected. The upper bound was determined based on the maximum calculated average annual O&M spend for the alternatives considered. This function yields a value of 1 for the maximum average annual O&M cost, and decreases linearly to zero as average first cost approaches zero. The O&M cost data was obtained for each alternative by the ESG from CRIS. The SDVF is defined by Equation 3.2, where *v* is the objective value score, *x* is the alternative's average annual O&M cost, and x_{max} is the maximum average annual O&M cost for all the alternatives considered.

$$v(x) = \frac{x}{x_{max}} \tag{3.2}$$

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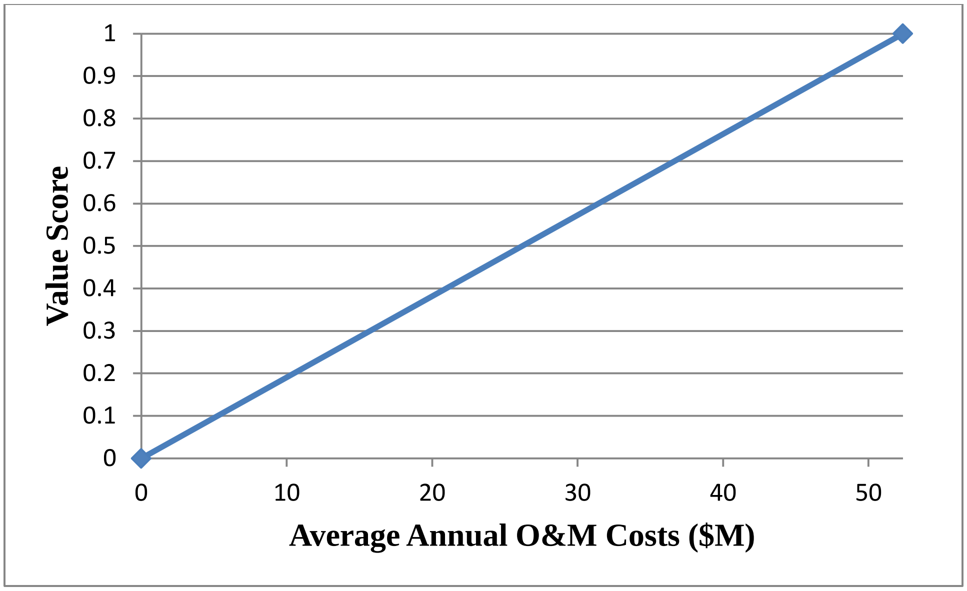

Figure 10. SDVF for Reduce O&M Costs

The SDVF for reduce final costs is a categorical, monotonically increasing function based on the evaluation of potential for a final cost reduction by the subject matter expert at AFCEC. The categories were separated into five percent ranges, with a value of 0.25 being assigned to each subsequent category. Figure 11 displays the percentage range for each category and its corresponding value score.

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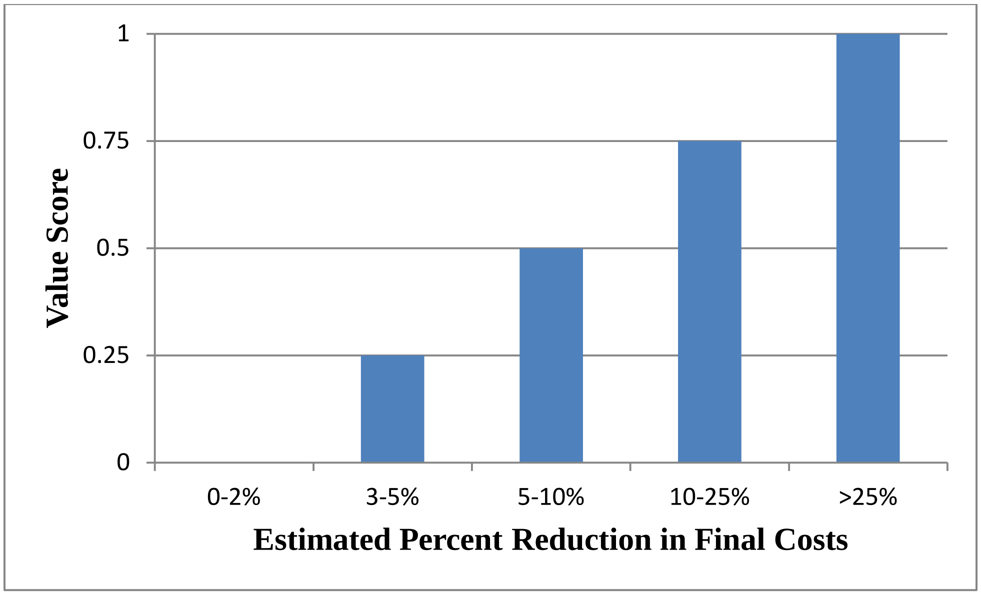

Figure 11. SDVF for Reduce Final Costs

The SDVF for improve quality is a categorical, monotonically increasing function based on the evaluation of the relative quantity of quality issues that currently arise with non-strategically sourced contracts by the subject matter expert at AFCEC. There are five categories, with a value of 0.25 being assigned to each subsequent category. Figure 12 displays the response for each category and its corresponding value score.

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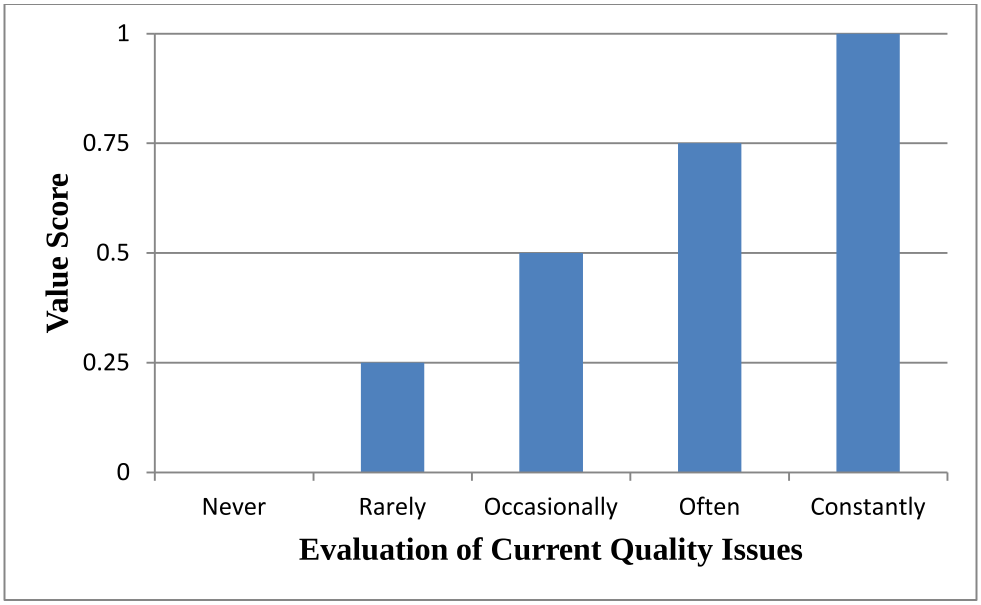

Figure 12. SDVF for Improve Quality

The SDVF for reduce processing time shown in Figure 13 is a linear, monotonically increasing function ranging between 0 and 307. The maximum was determined based on the average number of contracts executed per Fiscal Year (FY) for the alternatives considered. This function yields a value of 1 for the maximum number of contracts executed, and decreases linearly to zero as the number of contracts executed approaches zero. Average number of contracts executed per FY was calculated for each alternative by averaging the total number of contracts collected by the ESG from the CRIS over the number of fiscal years collected. Equation 3.3 defines the SDVF where *v* is the objective value score, *x* is the alternative's average number of executed contracts per FY, and x_{max} is the maximum number of executed contracts per FY for all the alternatives considered.

$$v(x) = \frac{x}{x_{max}} \quad (3.3)$$

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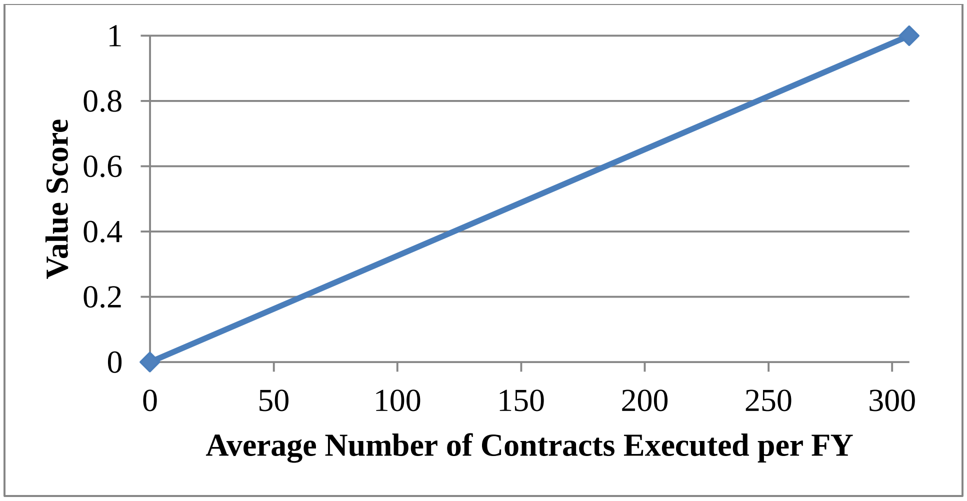

Figure 13. SDVF for Reduce Processing Time

The SDVF for leverage new technology is a categorical, binary function with possible values of "yes" and "no". This assessment is based on the evaluation of the availability of a new technology pertinent to a strategic sourcing opportunity by the subject matter expert at AFCEC.

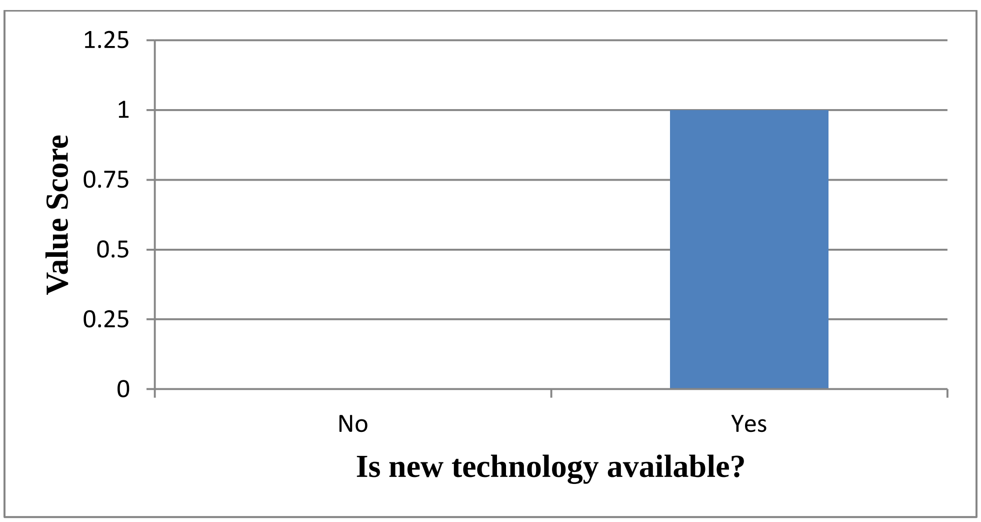

Figure 14. SDVF for Leverage New Technology

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The SDVF for streamline regulations is a categorical, binary function with possible values of "yes" and "no". This assessment is based on the evaluation of the need for updating or consolidating guidance, standards, or regulations pertaining to a strategic sourcing opportunity by the subject matter expert at AFCEC.

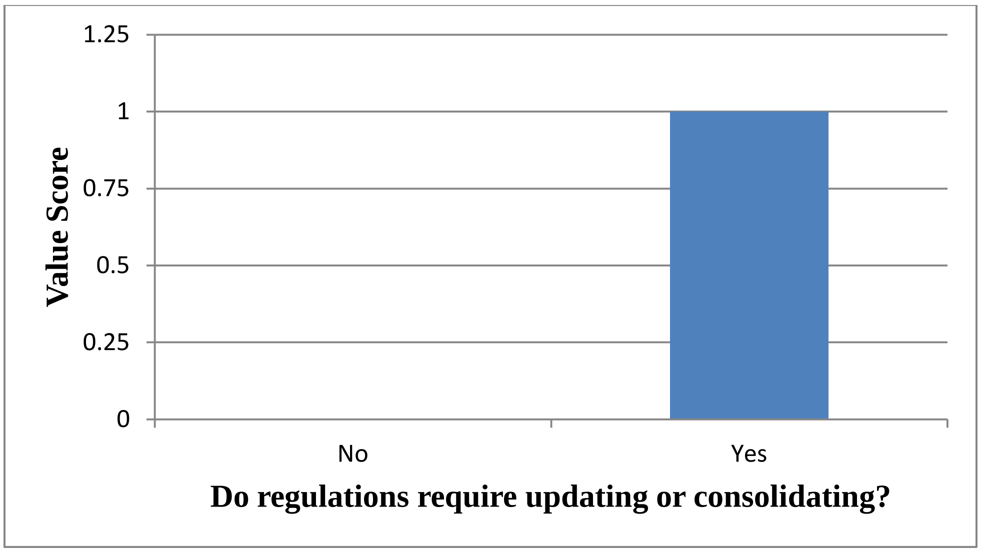

Figure 15. SDVF for Streamline Regulations

The SDVF for minimize small business risk is a monotonically decreasing function that assigns a value score to alternatives based on the percentage of total contracts that are awarded to small business. This relationship was determined to assign a higher value score for opportunities that have a higher percentage of small business involvement. A non-linear function was used to emphasize the negative desirability for opportunities that were heavily or exclusively awarded to small businesses. The percentage was calculated by dividing the total number of contracts awarded to small businesses by the total number of contracts awarded from contract data gathered from

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CBIS. The relationship is defined by Equation 3.1 and displayed graphically in Figure 16. In the equation, *v* represents the value score for this objective and *x* represents the percentage of contracts awarded to small businesses.

$$v(x) = 1 - \left(\frac{x}{100}\right) \quad (3.1)$$

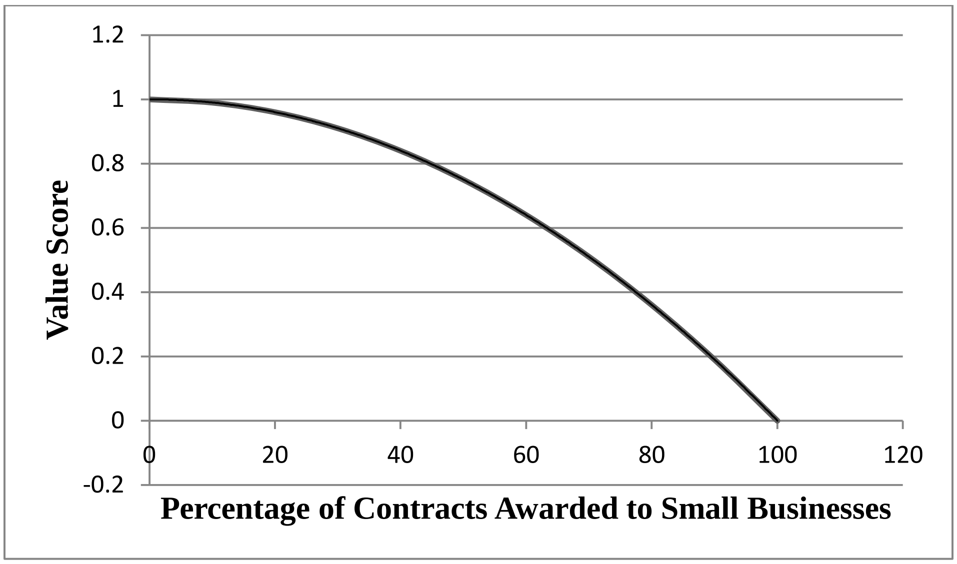

Figure 16. SDVF for Minimize Small Business Risk

The SDVF for reduce utility usage is a categorical, monotonically increasing function based on the evaluation of the potential percent reduction in utility usage by the subject matter expert at AFCEC. There are five categories, with a value of 0.25 being assigned to each subsequent category. Figure 17 displays the percentage breakdown for each category and its corresponding value score.

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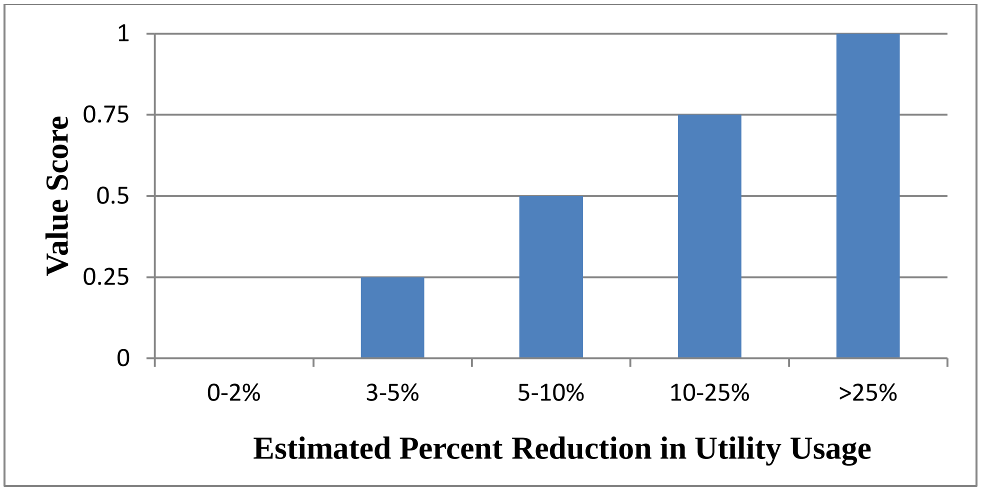

Figure 17. SDVF for Reduce Utility Usage

The SDVF for improve standardization is a categorical, monotonically increasing function based on the evaluation of the total number of distinct solutions currently in use for the opportunity being assessed by the subject matter expert at AFCEC. There are four categories, with a value of 0.333 being assigned to each subsequent category. Figure 18 displays the range of solution types for each category and its corresponding value score.

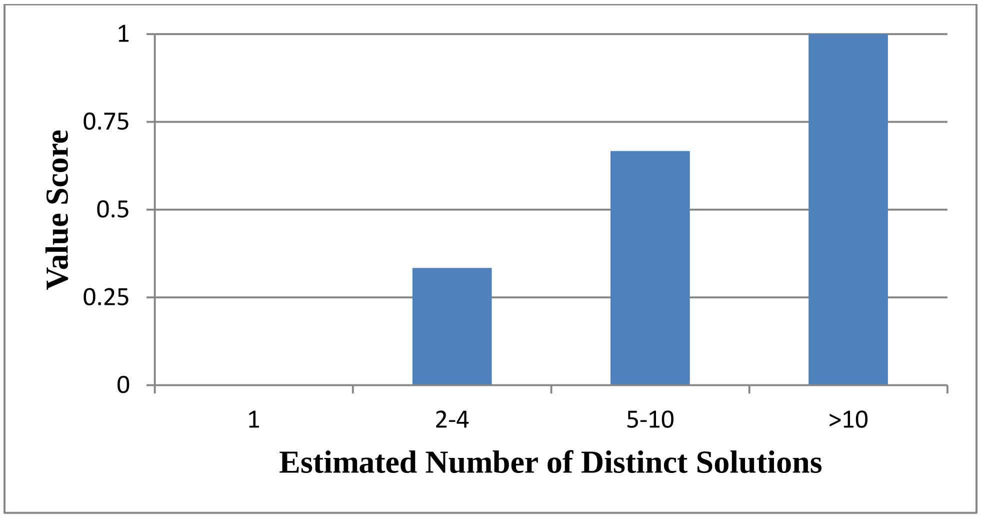

Figure 18. SDVF for Improve Standardization

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The SDVF for introduce COLs is a categorical, monotonically increasing function based on the evaluation of the potential percent reduction in service demand due to the proposed COL by the subject matter expert at AFCEC. There are five categories, with a value of 0.25 being assigned to each subsequent category. Figure 17 displays the percentage breakdown for each category and its corresponding value score.

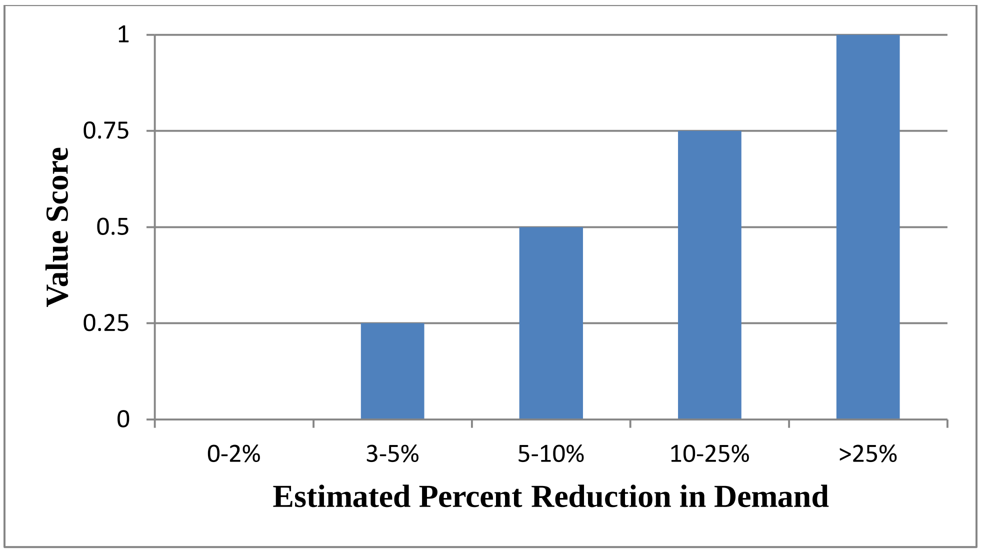

Figure 19. SDVF for Introduce COLs

Step 6: Develop Weights

To assign a relative level of importance to each objective, weight factors were developed for each of the objectives contained in the objective hierarchy. Weights were assigned in tier groups, with tier one objectives being weighted first, followed by each sub-objective family group in tier two. The weight of the parent objective is then applied to each of its sub-objectives, giving rise to the concept of global and local weights. Local weights are the factors directly assigned to each sub-objective in the preliminary

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weighting process, and global weights are the overall weight factor assigned to an objective. Global weights are simply the product of the multiplication of the local weight by the parent objective's weight. The following paragraphs detail the specific methodology used in this research project to assign weight factors to each objective in the objective hierarchy.

Similar to the objective hierarchy creation process, two groups of experts were used to assign weight factors. Engineers from the ESG were first asked to assign weights to the objective hierarchy in a top-down manner. That is, the first tier objectives were weighted first, followed by each set of sub-objectives on the second tier subordinate to a first tier objective. The "100 coin" method explained in Chapter II was used, where panel members were asked to conceptually divide a group of 100 coins among the objective according to the relative importance of each. Individual opinions were identified to the group, and the group converged on a solution. Each score from 0 to 100 corresponded to the percent weight assigned to the objective, ranging from 0 to 1. Once the ESG panel completed their weight factors, the list of weights was submitted to the panel of experts at AFCEC for review. The AFCEC revisions were submitted again to the ESG panel, who adjusted their weighting responses and produced the final list of weights.

Once the entire hierarchy was weighted, the weight system was validated by ESG leadership by examining the weight factors from the bottom up. That is, ESG leadership looked at the outcome of the global weight factors of each sub-objective relative to each other to determine whether the system was consistent with the priorities of the senior CECC decision-makers. Figure 20 and Figure 21 graphically display the relative global

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weights of each of the objectives contained within the objective hierarchy. Table 7 contains the specific numerical weights assigned to each objective based on the method explained above.

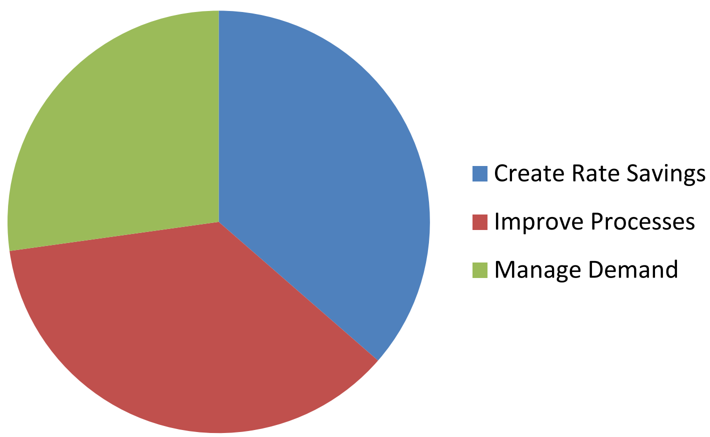

Figure 20. Tier 1 Objective Weights

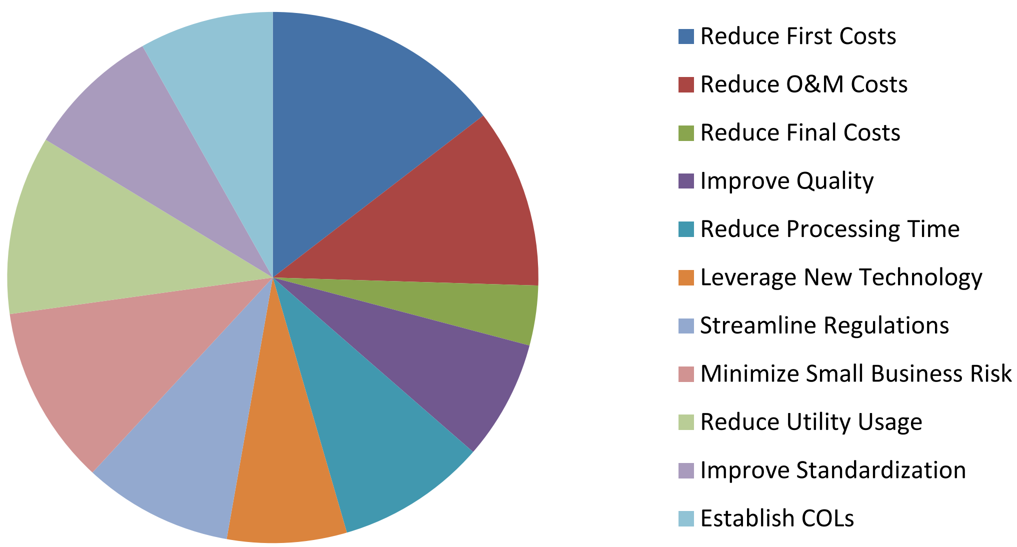

Figure 21. Tier 2 Objective Weights

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Table 7. Local and Global Weight Factors for Model Objectives

Objective Name	Local weight	Global Weight
Create Rate Savings		**0.3640**
Reduce first costs	0.40	0.1456
Reduce O&M costs	0.30	0.1092
Reduce final costs	0.10	0.0364
Improve quality	0.20	0.0728
Improve processes		**0.3640**
Reduce touch time	0.25	0.0910
Leverage new technology	0.20	0.0728
Streamline regulations	0.25	0.0910
Minimize small business risk	0.30	0.1092
Manage Demand		**0.2720**
Reduce utility expenses	0.40	0.1088
Establish standard solutions	0.30	0.0816
Establish COLs	0.30	0.0816

Step 7: Determine Overall Values for Alternatives

Steps 1-3 and 5 of the VFT process provide the various components that comprise the overall decision model for the problem. These components can be combined into a single mathematical equation known as the value equation. The value equation determines overall value scores for each alternative. This score can be used to compare the relative alignment of each alternative with the objectives of the decision maker. The value equation for each objective, shown below in equation 3.2, consists of two main parts: the objective weight and the SDVF for the alternative that is being evaluated. Each of the *n* objectives has its own weight factor, SDVF, and data input. The sum of the value scores for each of the objectives is the overall value score for the alternative. In the equation, $v(x)$ represents the value score, w_i represents the global weight factor, and $v_i(x)$

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represents the SDVF for the i^{th} objective. Table 8 provides a list of values for the variables and the SDVF definitions.

$$v(x) = \sum_{i=1}^{n} w_i v_i(x_i) \tag{3.2}$$

Table 8. Value Equation

i	**Objective Name**	**Weight Factor (w_i)**	**SDVF ($v_i(x_i)$)**
1	Reduce first costs	0.1456	$v_1(x_1) = \frac{x_1}{x_{1\,max}}$
2	Reduce O&M costs	0.1092	$v_2(x_2) = \frac{x_2}{x_{2\,max}}$
3	Reduce final costs	0.0364	Categorical (0, 0.25, 0.5, 0.75, 1)
4	Improve quality	0.0728	Categorical (0, 0.25, 0.5, 0.75, 1)
5	Reduce touch time	0.0910	$v_5(x_5) = \frac{x_5}{x_{5\,max}}$
6	Leverage new technology	0.0728	Categorical (0, 1)
7	Streamline regulations	0.0910	Categorical (0, 1)
8	Minimize small business risk	0.1092	$v_8(x_8) = 1 - \left(\frac{x_8}{100}\right)^2$
9	Reduce utility expenses	0.1088	Categorical (0, 0.25, 0.5, 0.75, 1)
10	Establish standard solutions	0.0816	Categorical (0, 0.333, 0.666, 1)
11	Establish COLs	0.0816	Categorical (0, 0.25, 0.5, 0.75, 1)

Once the value function was created, data for each of the alternatives was needed in order to calculate the associated value scores. As explained previously, several of the objectives were able to be measured directly with natural or proxy evaluation measures, while others were measured indirectly with constructed evaluation measures. In general, all natural and proxy evaluation measures used data collected from CRIS by ESG engineers, while all constructed attributes used data obtained through interviews with subject matter experts from AFCEC.

Objectives 1, 2, 5, and 8 were measured using data obtained from CRIS. These reports were generated by ESG personnel during their opportunity assessment phase

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evaluations of various alternatives under the current opportunity assessment system. Using this existing data allowed for a closer comparison between the two opportunity assessment models, and greatly decreased the workload on the ESG engineers related to this research effort. Because the data sets were created for independent projects, there is some variation in the time ranges and the specific data fields included in each database. The data was typically contained within a Microsoft Excel spreadsheet, although some spreadsheets had been imported into Microsoft Access database files to enable a higher degree of interaction. Most databases contained data for fiscal years 2010-2012. The data used is available from the author upon request.

The remaining objectives were measured using data obtained from interviews with the subject matter experts at AFCEC for each of the services or commodities that were evaluated. Interviews were primarily conducted over the phone; however, several of them were completed via a written questionnaire sent and received through e-mail. A list of questions and definitions of response categories is included in Chapter IV. The full questionnaire is included in Appendix A.

Once the data were collected for each alternative, it was recorded on a Microsoft Excel spreadsheet. A value score for each evaluation measure was then calculated. The spreadsheet was used to sum the objective value scores to find the overall value score for each alternative. Results of the value scores for each alternative along with the prioritized list of opportunities are provided in Chapter IV.

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Step 8: Select Alternative

The result of the alternative evaluation was a value score for each of the alternatives considered. Value scores can range from 0 to 1, with 1 being the most desirable. These value scores provide an objective basis for the comparison of the alternatives considered. The complete list of value scores for the alternatives is included in Chapter IV. In addition to simply producing the raw value scores for the alternatives selected, a sensitivity analysis was conducted in order to evaluate how variations in weight factors influence the outcome of the model.

The sensitivity analysis was conducted on all the evaluated alternatives as well as two dummy alternatives that were assigned randomly-generated data. These dummy alternatives serve to allow for insight into how other previously unconsidered alternatives would respond to changes in the weighting factors. The sensitivity analysis consisted of varying the weight of each factor, and observing the effect on the resulting value scores for each alternative. Results from this process, including figures and tables, are included in Chapter Four

Chapter Summary

This chapter described the methods used in this research project to develop the decision support model, select alternatives, gather the necessary data, and evaluate the final outcome of the decision analysis process. All eight of the VFT process steps were described in detail. The next chapter provides a comprehensive review and analysis of the results of the research project and an analysis of the data and the implementation of the decision model.

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IV. Results and Analysis

The purpose of this chapter is to provide a detailed summary of the results of this research. The objective of the research was to develop a decision support model to assist the Civil Engineer Commodity Council (CECC) with opportunity assessments. The decision model takes the form of a value equation, with an associated value hierarchy tying the model to the strategic objectives of the CECC. In addition to the creation of the decision model, the results of the Commodity Management Plan (CMP) opportunity assessment were compared with results from the newly developed model to demonstrate the model characteristics. The results of the comparison study are presented along with a sensitivity analysis of the weighting factors assigned to each of the evaluation criteria used in the model.

The Opportunity Assessment Decision Model

To understand the value equation developed in this research, the value hierarchy explained in Chapter III is re-presented in its entirety in Figure 22 along with the value weights and associated evaluation factors. Both the local and global weights are provided for each objective. The value hierarchy consists of a fundamental objective with two tiers of subordinate objectives. Each tier-two objective was assigned an evaluation measure to determine an alternative's potential to further the accomplishment of the objective. Each evaluation measure corresponds to an i_{th} variable set in the value equation described in Chapter III and used to determine the overall score for each of the alternatives that was evaluated.

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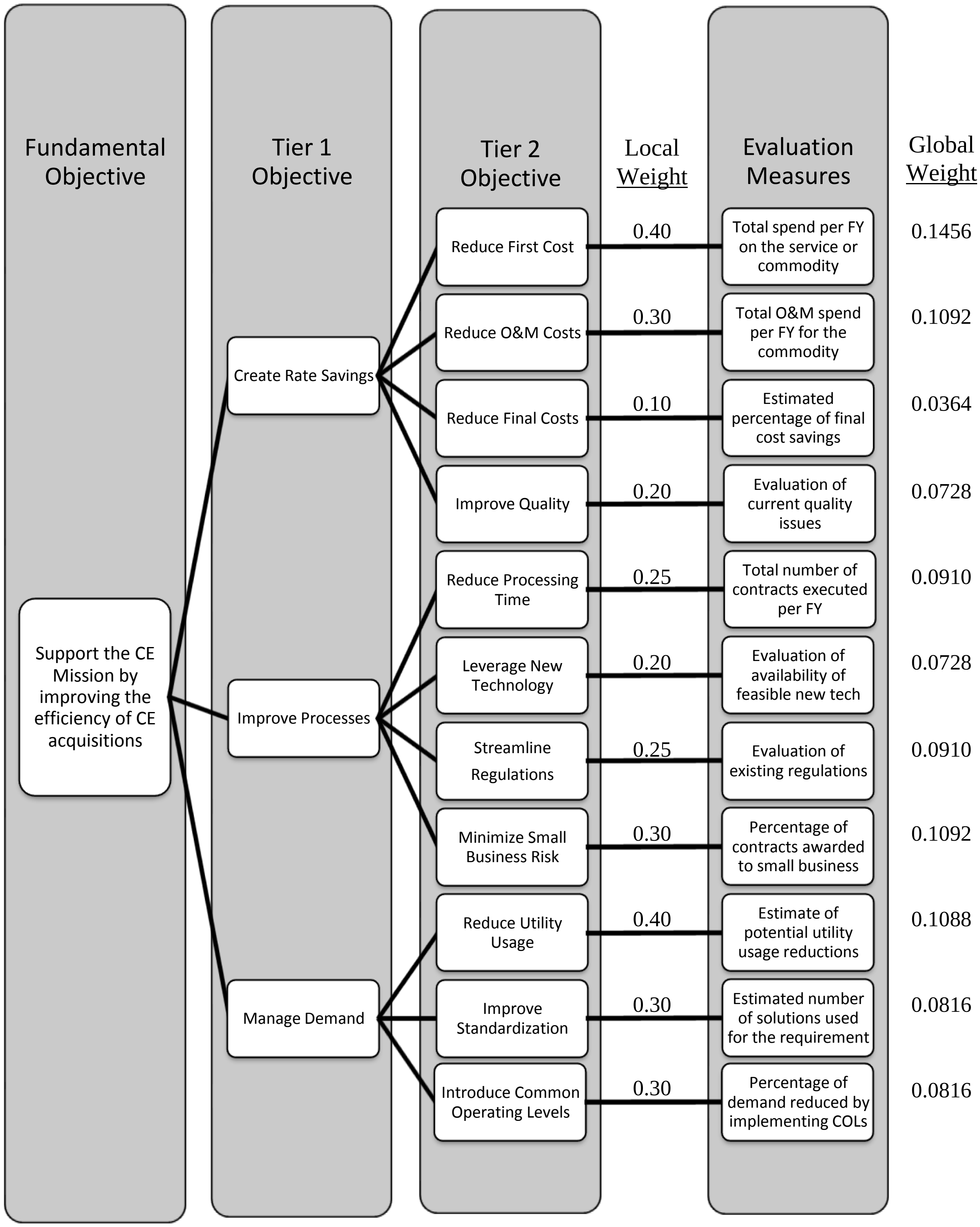

Figure 22. The CECC Opportunity Assessment Decision Model

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Analysis of Alternatives

Alternatives were evaluated using the value equation described in Chapter III. Data entered into the model for each alternative were collected from either spend and contract data collected from the ESG or from interviews conducted with subject matter experts from AFCEC as described in Chapter III. Data was recorded using a Microsoft Excel spreadsheet programmed to calculate the value scores for each alternative according to the value equation. The final prioritized list of the nine evaluated alternatives is presented in Table 9.

Table 9. Results of the Alternative Assessment

Rank	Alternative	Value Score
1	HVAC Equipment	0.5830
2	Roofing	0.4853
3	Fire Protection PPE	0.3361
4	Generators	0.2874
5	Water Leak Detection	0.2731
6	Grounds Maintenance	0.2751
7	Elevator Maintenance	0.2866
8	Taxiway Lighting	0.2480
9	Runway Rubber Removal and Restriping	0.1594

Figure 23 provides a visual representation of the individual objective scores associated with each alternative. This graph can be used to see the relative impact of each objective on the overall score for the alternatives. General trends can also be observed regarding the relative effect each objective had on the outcome of the alternative analysis. For example, the single largest contributor to the value scores of the

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alternatives was the streamline regulations objective, even though it had the fifth highest weighting factor. This can be attributed to the fact that the objective used a binary categorical Single Dimensional Value Function (SDVF) for which most of the alternatives achieved a maximum score.

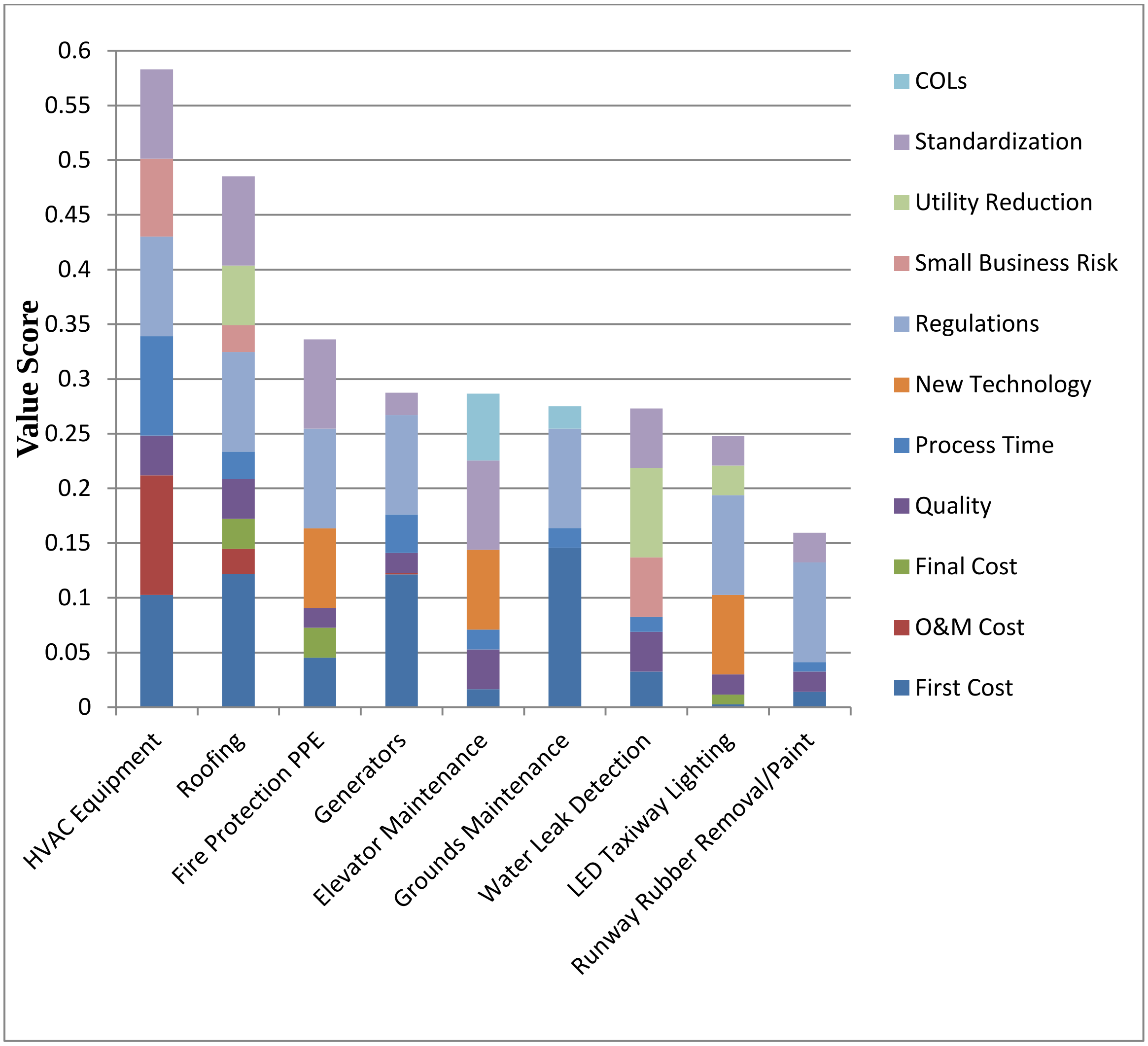

Figure 23. Value Score Breakdown for All Alternatives

As the data in Figure 23 indicates, a high score from any individual objective did not necessarily guarantee a high ranking for the alternative. On the contrary, no individual objective had an overpowering influence on the overall priority rankings of the

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alternatives. This fact indicates that the model was well balanced between all of the objectives, and did not rely too heavily on any particular objective.

Another important consideration of the analysis of this research is the comparison between the results of the model used in this research with the results obtained using the existing opportunity assessment method captured in the CECC CMP. As stated in Chapter III, to make a valid comparison between the models, the same data was used to evaluate the alternatives in both methods to the maximum extent allowable by the model. However, since the new model developed in this research effort evaluated a wider range of alternative factors based on the developed objective hierarchy, most of the data used in the new model was not considered during the CMP analysis process. The objectives that utilized the same or similar data were reduce first cost, reduce O&M cost, reduce processing time, and reduce small business risk objectives. The remaining objectives included in the new model used objectives outside of the scope of the original model. Figure 24 displays a comparison of the alternative rankings between the VFT model and the CMP opportunity assessment analysis. Arrows indicate positional changes in the rankings between the two methods. In general, the VFT model produced drastically different results due to the inclusion of the additional objectives for consideration.

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CMP Rankings	
Rank	**Alternative**
1	Taxiway Lighting
2	HVAC Equipment
3	Runway Rubber Removal and Restriping
4	Elevator Maintenance
5	Roofing
6	Generators

VFT Model Rankings	
Rank	**Alternative**
1	HVAC Equipment
2	Roofing
3	* Fire Protection PPE
4	Generators
5	* Water Leak Detection
6	* Grounds Maintenance
7	Elevator Maintenance
8	Taxiway Lighting
9	Runway Rubber Removal and Restriping

* Alternative not included in CMP

Figure 24. Comparison of Model Alternative Rankings

The difference in the alternative rankings indicates that the new criteria included in the VFT alternative evaluation process add information to the model that is independent of and fundamentally different from the information included in the CMP model. Because inclusion of this additional information is justified by the objectives of the strategic sourcing program specified in the objective hierarchy, the new model's results are influenced by a more complete picture of each alternative's true value to the strategic sourcing program. This indicates the new model is successful in introducing new criteria in the evaluation process, thereby strengthening the validity of the model.

Identification of New Alternatives

In addition to the alternatives presented in the CECC Commodity Management Plan (CMP) and detailed in Chapter III, new alternatives were developed for evaluation based on input from subject matter experts at the Enterprise Sourcing Group (ESG) and the Air Force Civil Engineer Center (AFCEC). Due to the fact that the data required to

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complete an assessment of these alternatives had not already been collected by the ESG, evaluation of these alternatives was beyond the scope of this research effort. The list of newly identified alternatives and their source is provided in Table 10. The list includes nine new alternatives in a variety of different functional areas.

Table 10. New Alternatives Identified

Alternative	**Source**
Base Recycling Services	AFCEC
Airfield Pavement Repair	AFCEC
Wastewater Treatment Privatization	AFCEC
Bridge and Dam Inspections	AFCEC/ESG
Hazardous Material Response Equipment	AFCEC
Fire Response Equipment (non-PPE)	AFCEC
Fan Coil Units	AFCEC
Water Source Heat Pumps	AFCEC
Automatic Transfer Switches	AFCEC

Sensitivity Analysis

As part of the research, a sensitivity analysis was conducted on the results of the alternative evaluation. Weight factors were varied for each objective from 0 to 0.2, and the resulting value scores for each alternative were tabulated using Microsoft Excel. 0.2 was chosen as the maximum weight used in the analysis because no significant changes in the results occurred when weight factors were increased to greater than 0.2. In addition, a simulated service contract alternative and a simulated commodity alternative were created using data generated by the Excel random number generation tool. The data was created by causing the random number generation tool to generate an integer between the minimum and maximum values of the data found in the alternatives that were analyzed. This random number was then used to calculate an overall value score for

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the alternative using the value equation. The results from the sensitivity analysis are presented in Figures 24-34 as spider diagrams.

Each spider diagram displays the value scores of each alternative as the weight of a specific objective is varied from 0 to 0.2 as a line. Because value scores are always positive, the lines will always have a positive slope. Horizontal lines indicate that the alternative received a zero value score for the objective being analyzed in the graph. The vertical line in each figure represents the original weight factor assigned in the model. The priority ranking of the alternatives can be determined at any weight by observing the relative value score for each alternative at the weight factor being considered. Alternatives at the top will rank higher than those below it. As a result, when lines cross, a change in the priority ranking occurs at the weight where the intersection is located.

The first objective, reduce first cost, had a global weight of 0.1456. The sensitivity analysis indicates that five alternatives were sensitive to changes in the objective weight: generators, elevator maintenance, grounds maintenance, taxiway lighting and water leak detection. While the top four and bottom two alternatives do not vary significantly over the range of the analysis, the ranking of the other five alternatives do vary significantly. The sensitivity analysis results are presented in the spider diagram shown in Figure 25.

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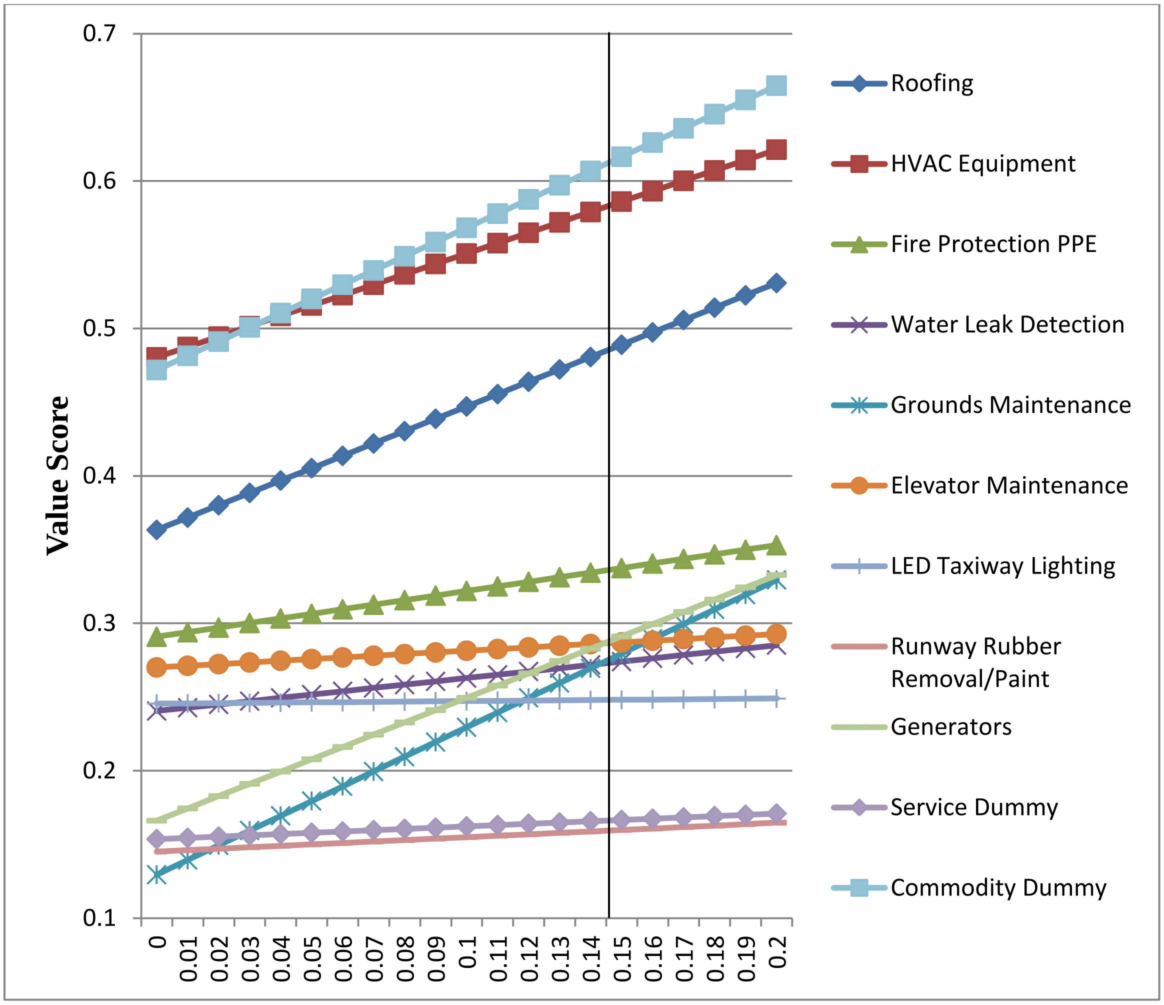

Figure 25. Sensitivity Analysis for Reduce First Cost

The second objective, reduce O&M costs, had an initial weight factor of 0.1092. Figure 26 displays a spider diagram of the sensitivity analysis for the alternatives considered and the additional simulated alternatives. The analysis indicates that this is a relatively stable objective less sensitive to changes in the weighting factor for the alternatives considered. The only difference in the outcome occurs if the objective is assigned a weight factor over 0.17. This is due mainly to the fact that the O&M cost data

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for the alternative was not available for inclusion in the analysis, or that O&M costs are not applicable to the alternative, as is the case with service contracts.

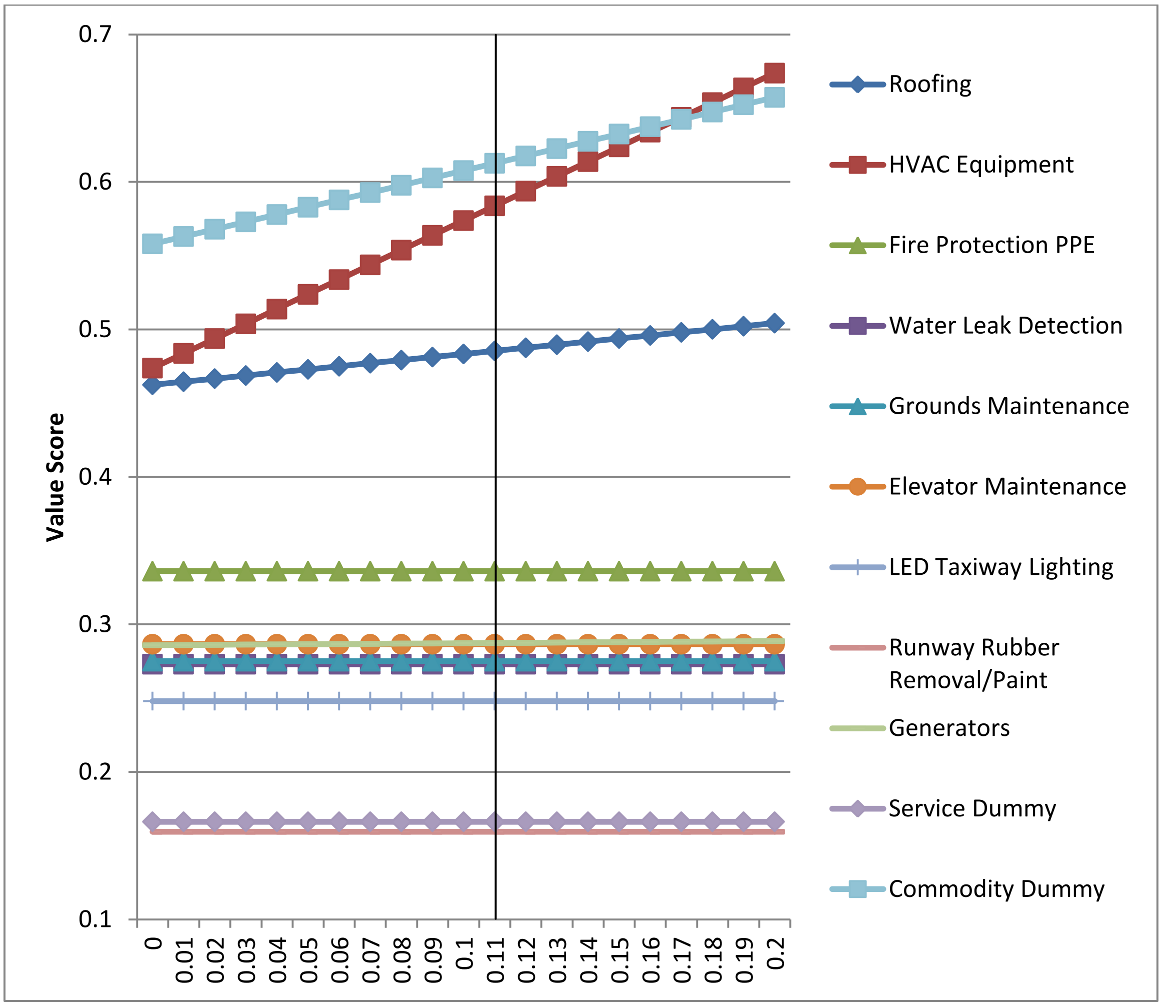

Figure 26. Sensitivity Analysis for Reduce O&M Cost

The third objective, reduce final costs had an initial weight factor of 0.0364. The sensitivity analysis indicated no significant changes in results for weight factors below 0.12. Above 0.12, roofing and LED taxiway lighting scores increase enough to alter the

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rankings. Horizontal lines indicate the alternative received a score of 0 for this objective by the SME

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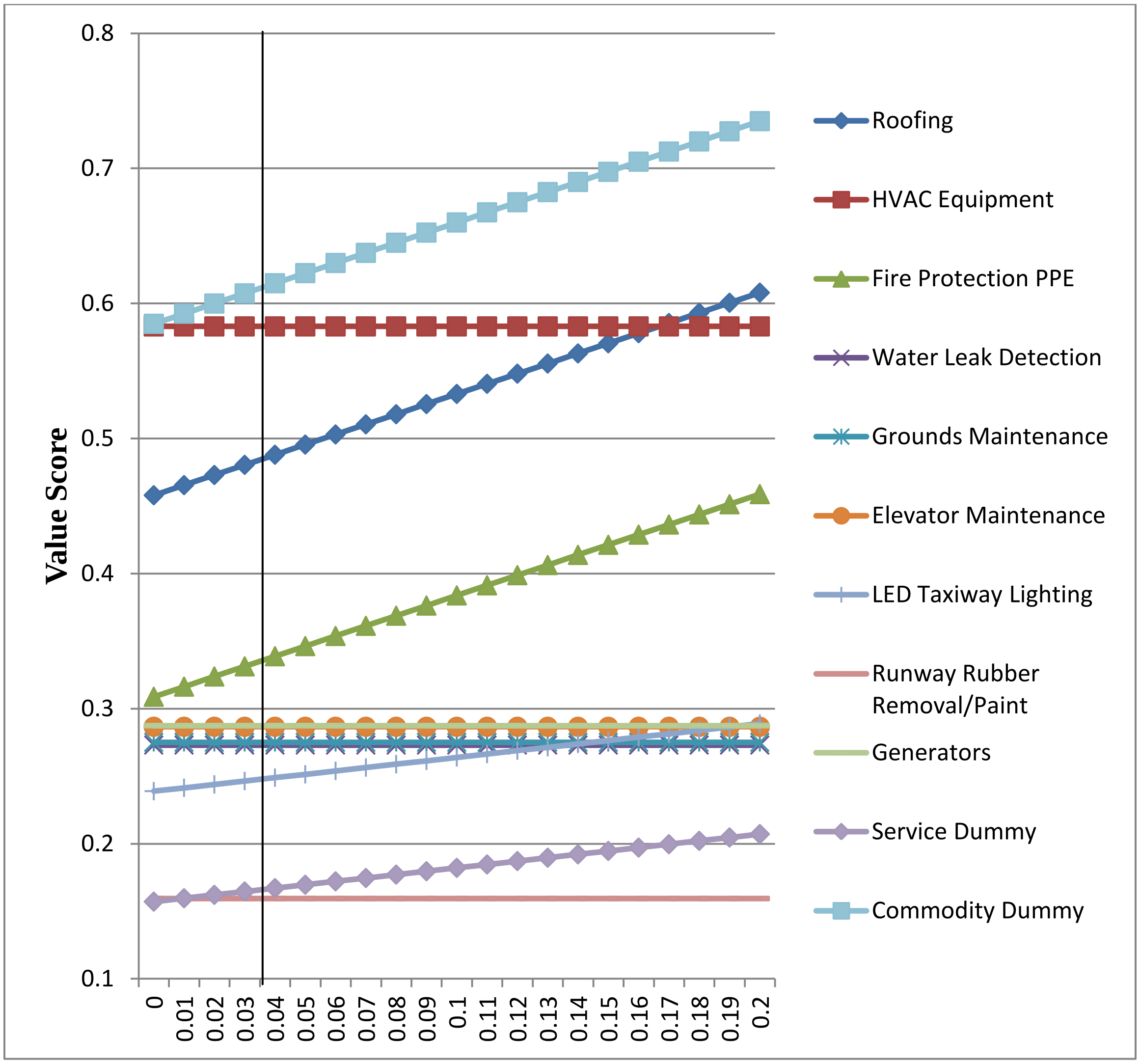

Figure 27. Sensitivity Analysis for Reduce Final Costs

The sensitivity analysis for the fourth objective, improve quality, indicated that slight changes to the weight factors will affect the model results. The original weight

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factor assigned was 0.0728. Five changes in the rank order of the alternatives occur between weight factors of 0.02 and 0.13 as indicated in Figure 28.

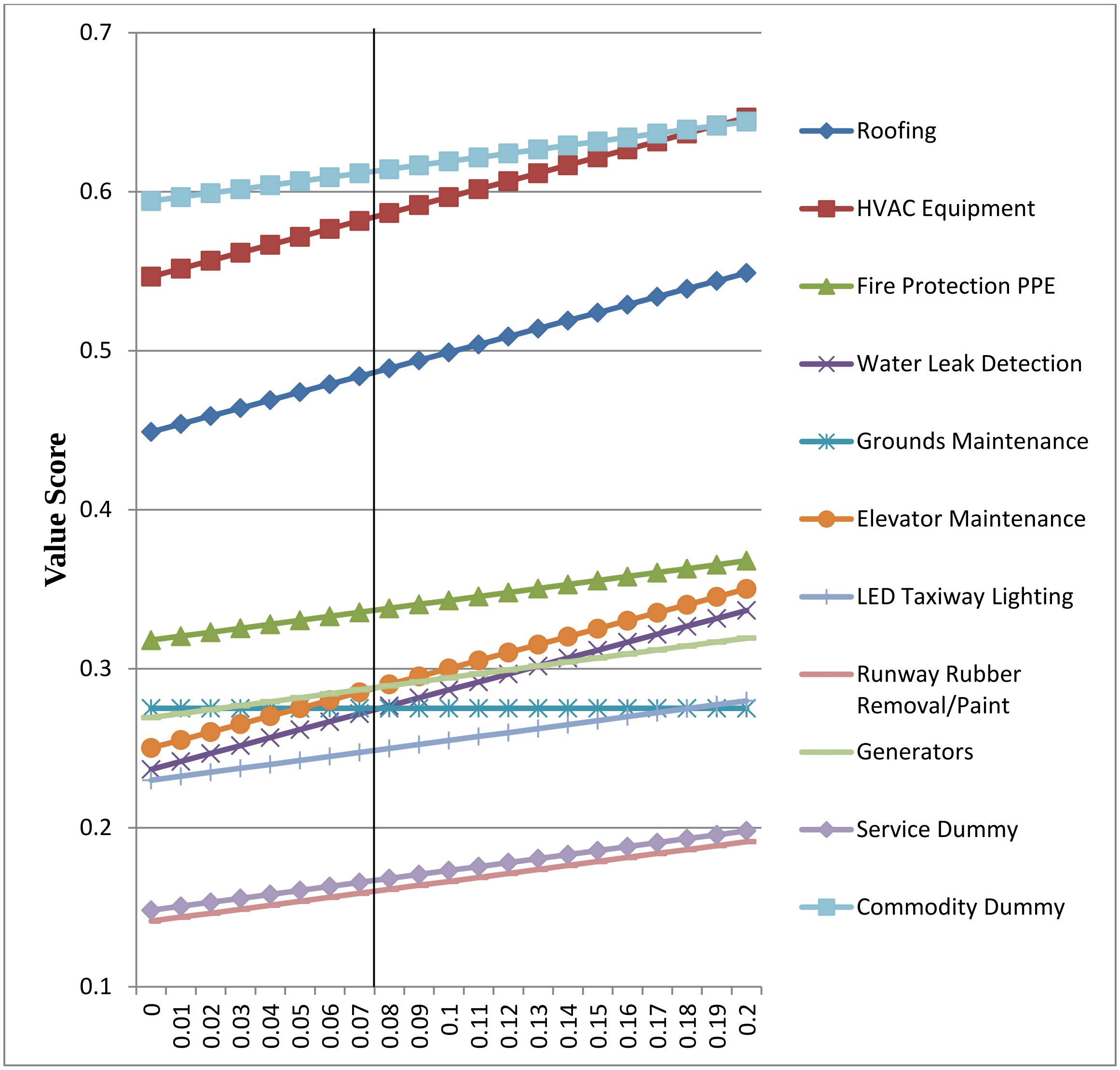

Figure 28. Sensitivity Analysis for Improve Quality

Figure 29 displays the sensitivity analysis for the objective to reduce processing time. The weight factor for this objective in the decision model is 0.091. A slight decrease in the objective weight will cause elevator maintenance to overtake generators

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on the alternative rankings. Other less significant changes occur as indicated on the spider diagram.

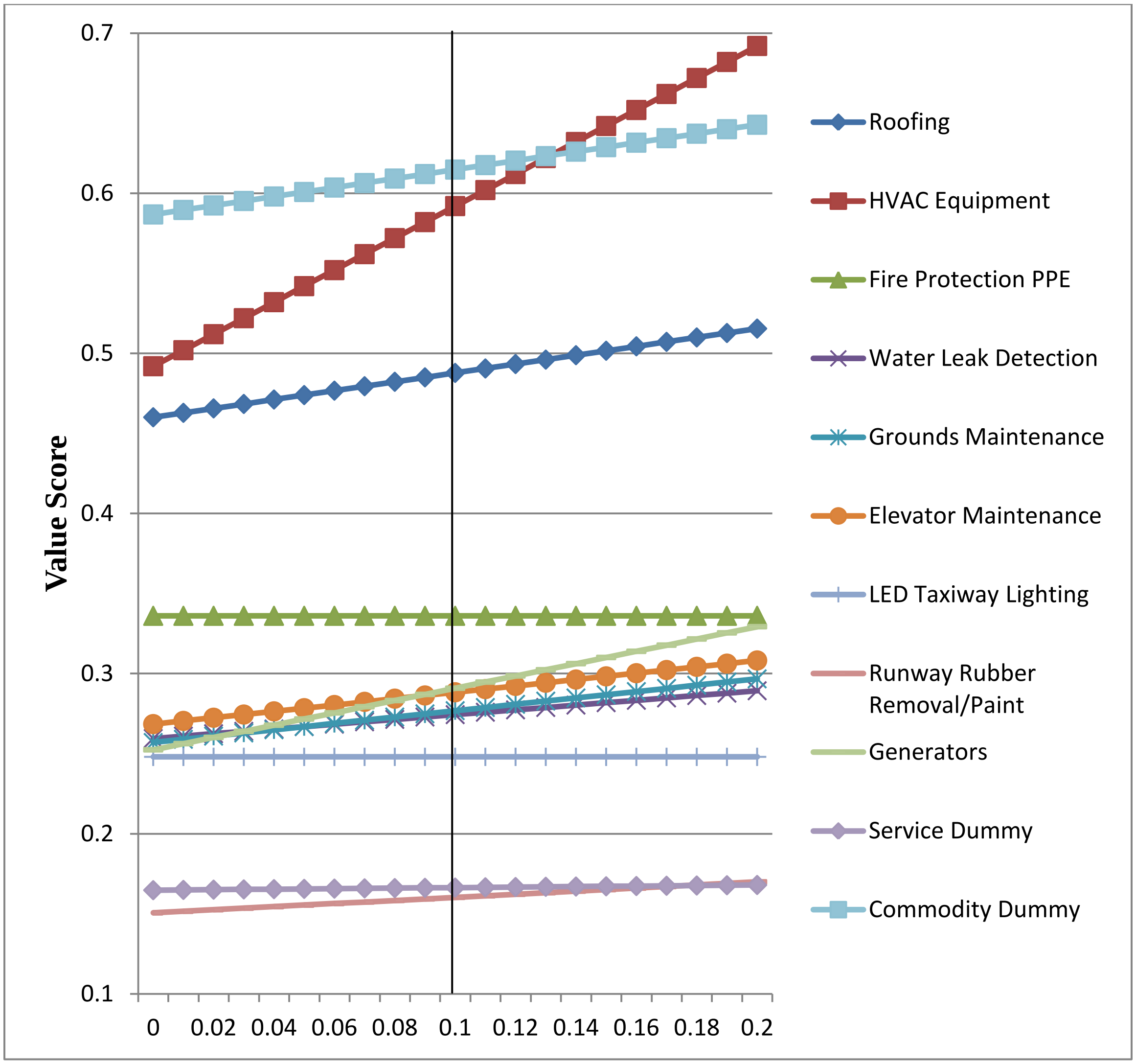

Figure 29. Sensitivity Analysis for Reduce Processing Time

The sixth objective, leverage new technology, has a model objective weight of 0.0728. Because of the binary nature of this objective's SDVF, alternatives with a positive value score in this objective will have dramatically changing scores as the objective weight is manipulated as indicated in Figure 30. The elevator maintenance

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alternative is indicative of this as either a slight decrease or a slight increase in the objective weight will affect the alternative rankings.

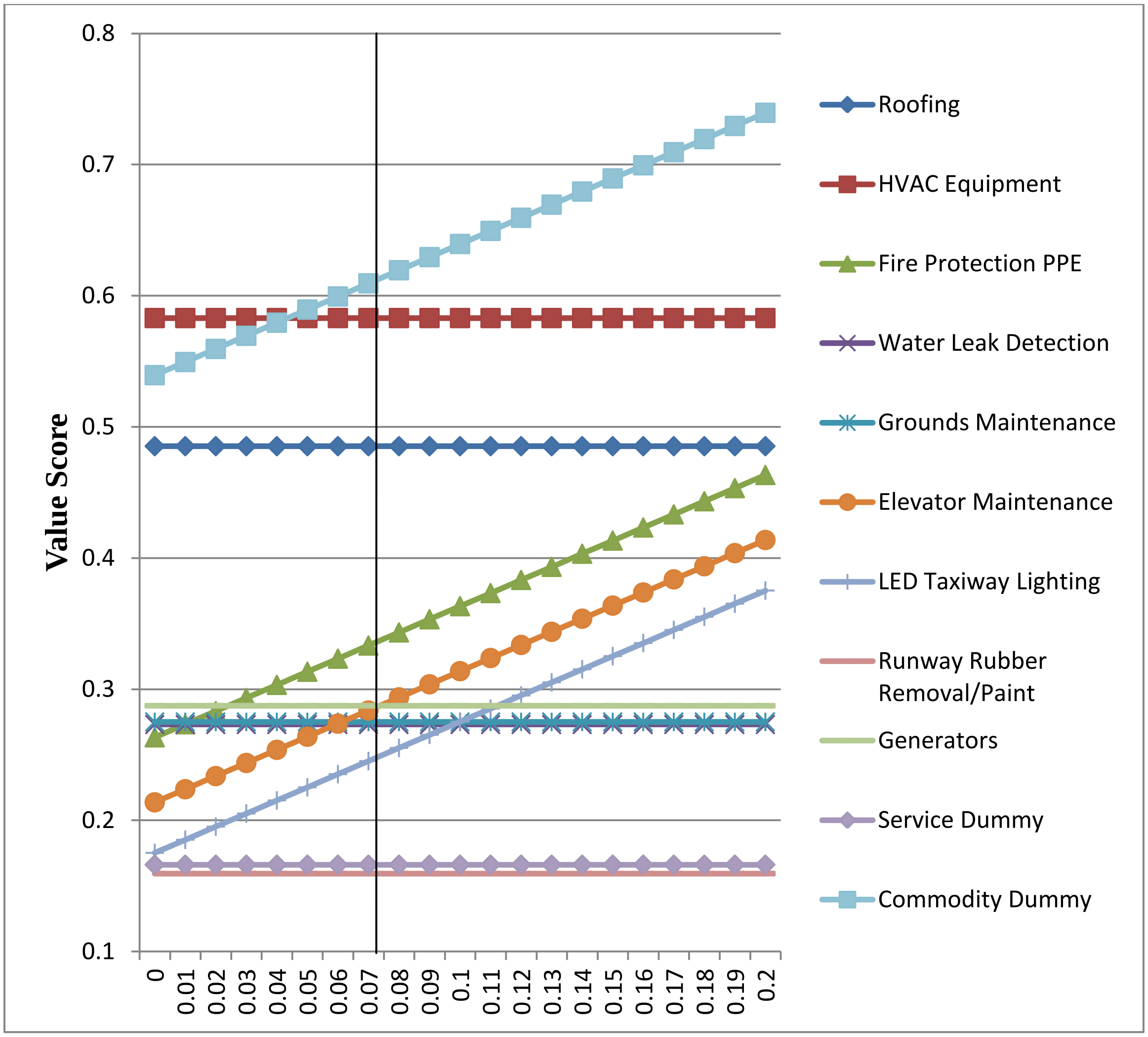

Figure 30. Sensitivity Analysis for Leverage New Technology

Similar to the previous objective, the model results for streamline regulations is greatly affected by the assigned weight factor as it also has a binary SDVF. The model weight factor for this objective is 0.091. The priority rankings of elevator maintenance, generators, water leak detection, grounds maintenance, and taxiway lighting change six

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times as the weight is varied between 0.07 and 0.13. Figure 31 displays additional changes in the alternative rankings as the weight factor is varied.

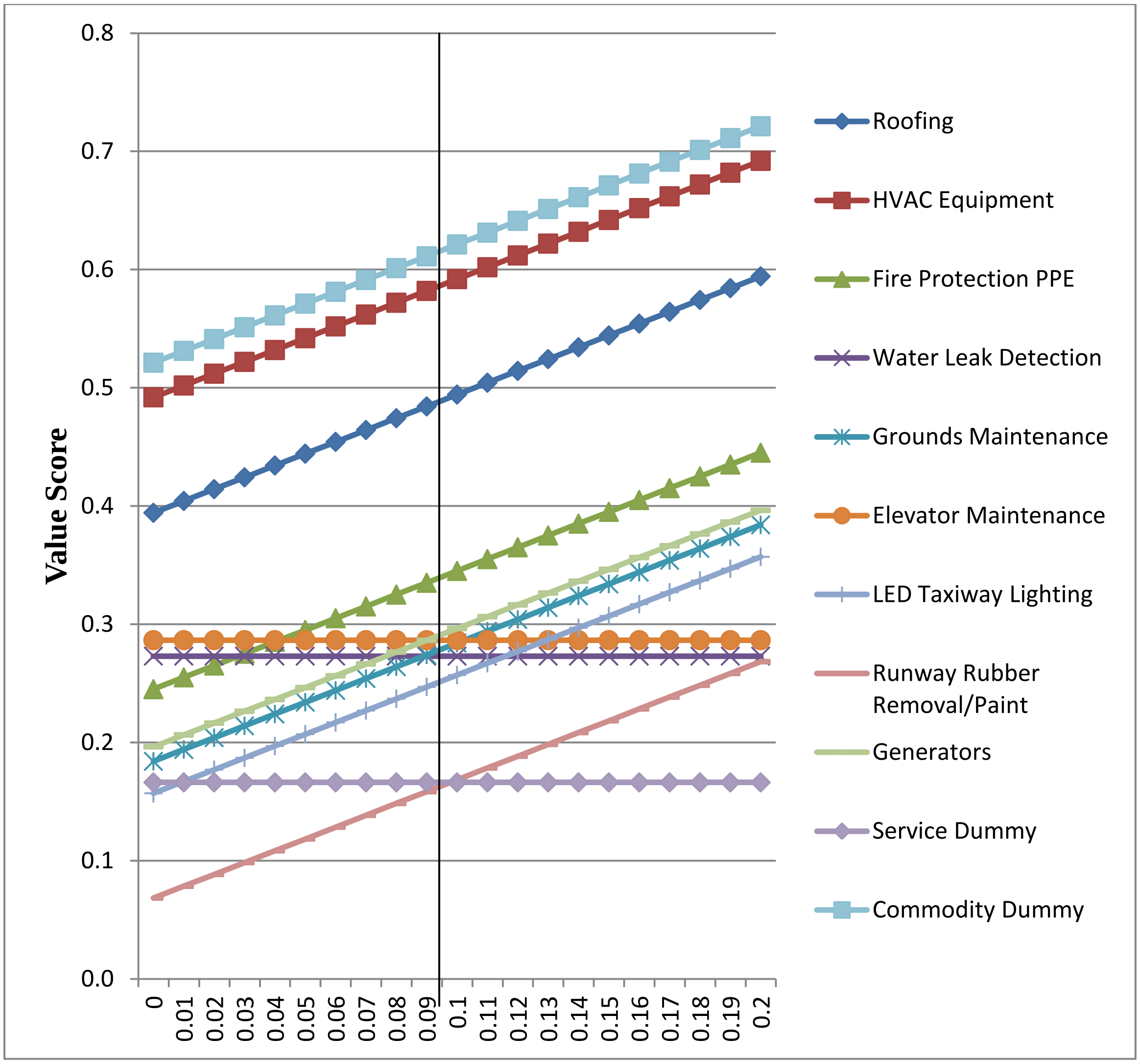

Figure 31. Sensitivity Analysis for Streamline Regulations

The eighth objective, minimize small business risk, was the most stable of the objectives to variations in objective weight. While this objective has a high weight factor of 0.1092 in the model, the exponentially decreasing SDVF resulted in a low magnitude

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for all the alternatives evaluated. Figure 32 displays the full result of the sensitivity analysis. This is partially due to lack of contract data for many of the alternatives.

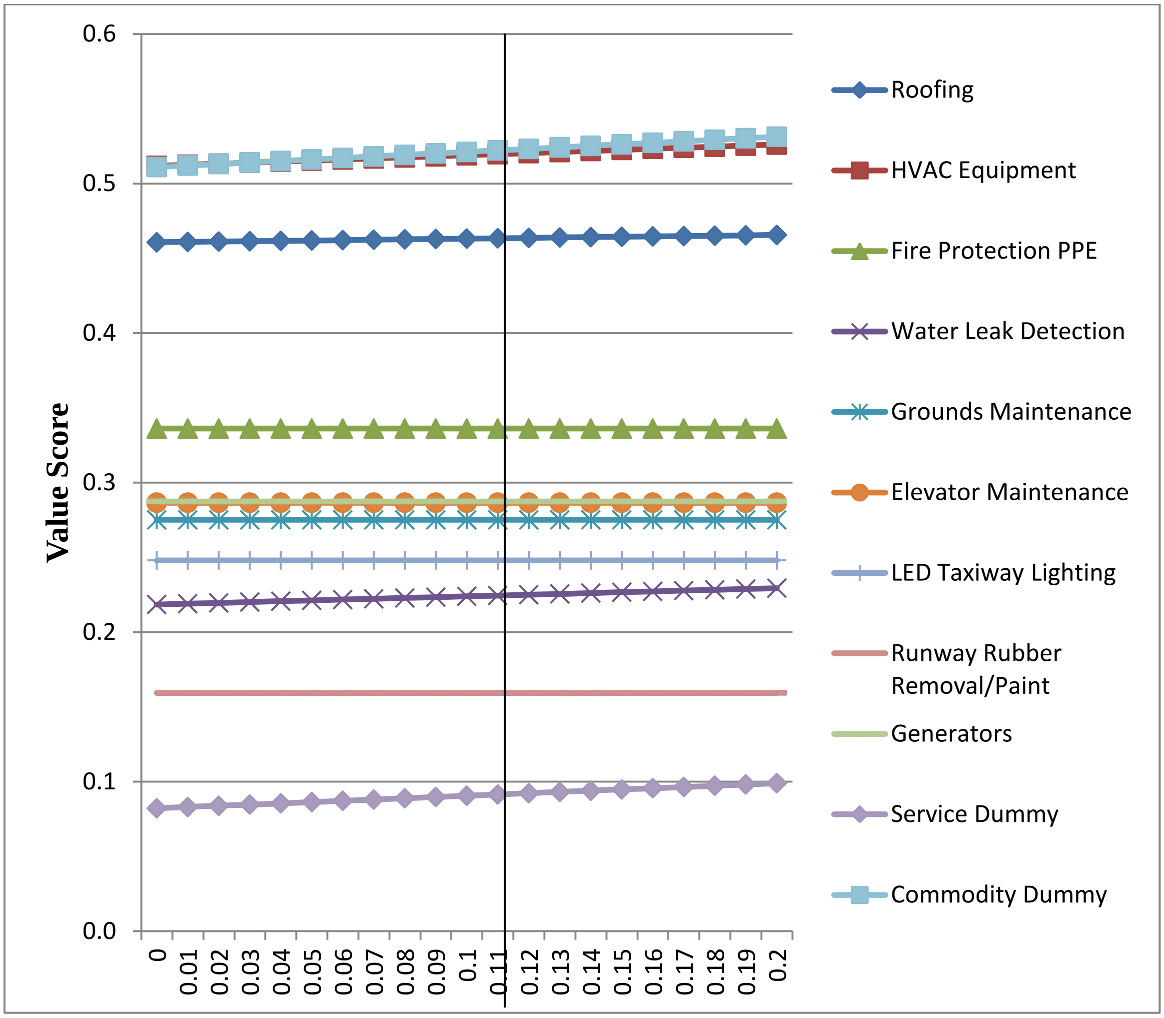

Figure 32. Sensitivity Analysis for Minimize Small Business Risk

The objective to reduce utility expenses has a high model weight factor of 0.1088. As shown in Figure 33, variations in the weight factor significantly affected the value scores for those alternatives that exhibited utility reduction potential. The alternative

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most sensitive to changes in the objective weight was water leak detection. As the objective weight is varied between 0.05 and 0.13, four changes in the alternative priority ranking occur.

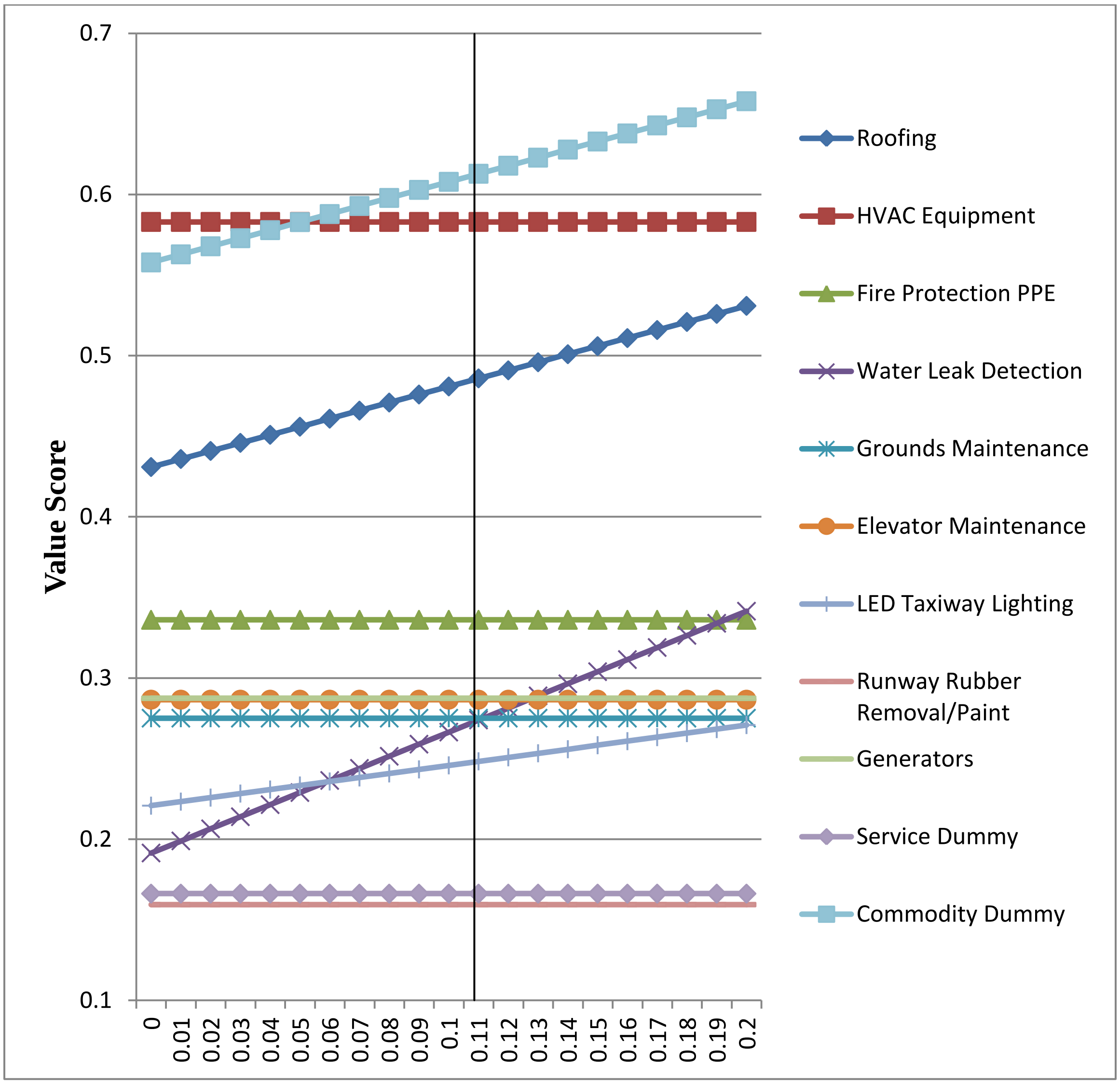

Figure 33. Sensitivity Analysis for Reduce Utility Expenses

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The tenth objective, establish standard solutions is the most sensitive of the objectives to changes in the objective weight. This is due to the widely varying scores assigned to each of the alternatives. Thirteen rank changes are identified within the range of weights used in this sensitivity analysis. The model weight for this objective is 0.0816. Results of the analysis are displayed in Figure 34.

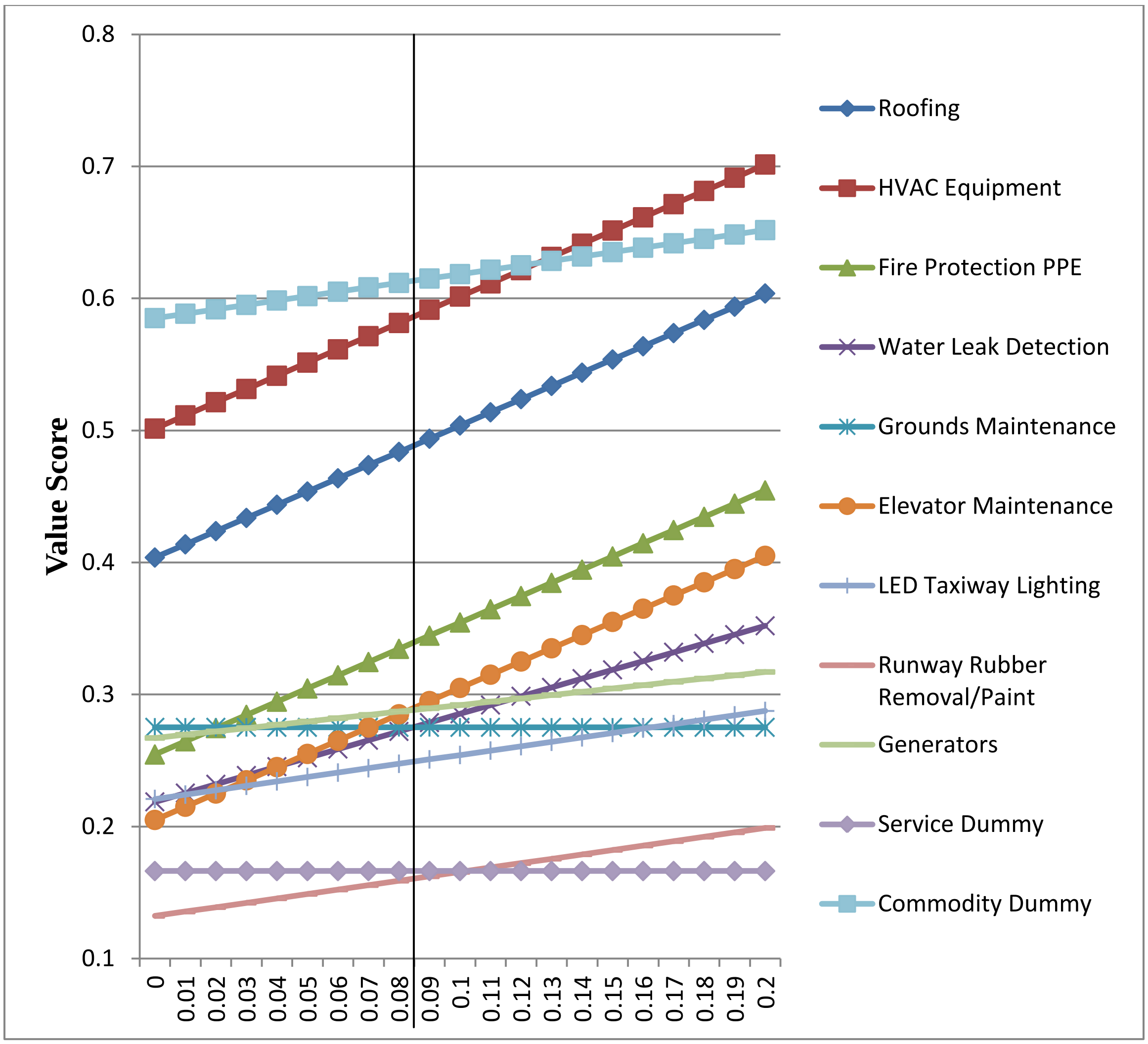

Figure 34. Sensitivity Analysis for Establish Standard Solutions

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The final objective, establish COLs, has a model weight of 0.0816. Because this objective is only applicable to service contracts, the scores of most alternatives did not vary over the range of the analysis. Elevator maintenance, grounds maintenance, and the simulated service contract alternative were greatly affected by the weight changes, with seven changes occurring in the alternative rankings as the objective weight was varied.

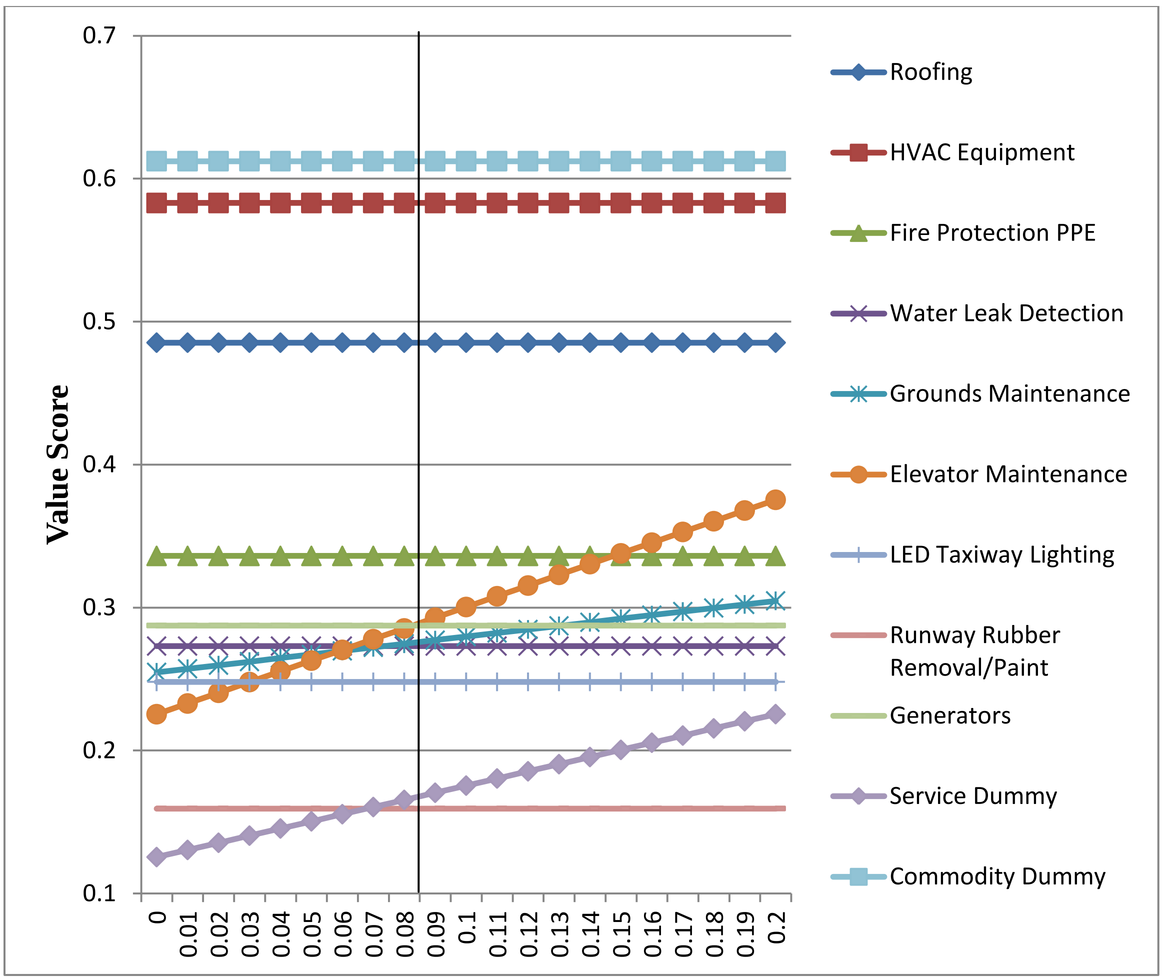

Figure 35. Sensitivity Analysis for Establish COLs

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Overall, the sensitivity analysis indicates that the results of the analysis are highly sensitive to changes to the weight factors assigned to each objective. This fact underscores the need for the decision-maker to fully understand the effect of each weight factor on the overall outcome of the model, and to ensure that an appropriate amount of care is taken when objective weight factors are assigned.

Conclusion

This chapter presented the results of the research, including both the VFT-based decision model for the CECC opportunity assessment, and the analysis of selected alternatives. In addition, the results of the alternative analysis were compared with the analysis results of the decision model currently in use by the CECC, demonstrating the significance of the new information included in the analysis based on the full range of strategic sourcing objectives found in the objective hierarchy. A sensitivity analysis was presented detailing the difference in results of the model as the weighting factors for each objective were varied within a specified range, and highlighted the importance of accurate weight factors to accurate model outcomes. Chapter V will present the conclusions of the research, as well as present opportunities for future research related to this effort.

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V. Conclusions

The purpose of this chapter is to summarize the results and impact of this research, including both the Value Focused Thinking-based opportunity assessment model that was developed and the comparative analysis conducted using the model to evaluate a select group of alternatives. The initial research questions and objectives are reviewed, and the results are compared to those objectives. A discussion of both the significance and limitations of the research is provided, as well as a list of future opportunities for research.

Review of Results

As presented in Chapter I, the objective of this research project was to develop a decision support model for the Civil Engineer Commodity Council (CECC) to assist with opportunity assessments of strategic sourcing alternatives. As part of this effort, the following five research questions were developed:

1. What are the objectives that Air Force leadership believes strategic sourcing should accomplish?
2. What are the relative priorities of those objectives?
3. What variables predict potential efficiencies in a service or commodity contract areas?
4. Can the variables mentioned above be accurately measured with existing data sets and current data collection efforts?
5. What is the model that accurately balances all objectives according to leadership priorities that predicts progress toward strategic sourcing goals?

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The Value Focused Thinking (VFT) process selected as the methodology for this research addressed each of these questions through the application of the eight-step decision-making process. Question one was addressed through the creation of the value hierarchy created in step two of the VFT process. Priorities for each of the objectives were developed in step six with the assigning of weight factors for each of the priorities. The variables mentioned in question three took the form of evaluation measures that were used to determine the suitability of each opportunity for furthering the objectives of the strategic sourcing program. While question four was not explicitly linked to a specific step of the VFT process, the data sources explained in Chapter III were identified to evaluate alternatives based on the objectives established in the value hierarchy. Finally, the value equation developed using the VFT process satisfied the need for a new decision model that considered the full range of objectives of the strategic sourcing program.

In addition to the fact that all the research questions were addressed, the overall goal of developing a decision model for the CECC to assist with opportunity assessments was achieved. Instead of using an alternative-focused system of opportunity assessment like the one currently in use by the CECC, an objective hierarchy was developed to determine the broad range of values and objectives important to the Air Force and the civil engineer community. By opening the aperture of how opportunities are examined for strategic sourcing potential to encompass all aspects of the program important to senior leadership, it is possible to make better, more informed decisions about the most attractive opportunities to invest the time and resources pursuing for strategic sourcing.

The value function developed in the research serves as a systematic means of objectively analyzing alternatives for the CECC opportunity assessment process. The

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Single Dimensional Value Functions (SDVF) for each of the objectives effectively converts the raw data collected on each alternative into units of value according to the unique relationship between the data and the desirability of the alternative. Using this method serves to limit subjectivity in the decision-making process by applying a consistent means of ascribing value to each alternative based on quantitative or qualitative data collected in a consistent, objective manner.

In an effort to validate the model developed in the research, nine alternatives were evaluated. The alternatives consisted of a mixture of alternatives previously evaluated in the CECC Commodity Management Plan (CMP), alternatives currently under review that were not included in the CMP, and one alternative not actively under consideration by the CECC. Data were collected for each of the alternatives, and value scores were assigned according to the value equation developed in the research. The resulting value scores provided a much different result compared to the original CMP rankings. The addition of the new evaluation criteria provided fundamentally different information from that of the model used to evaluate the alternatives in the CMP. This indicates that many factors not considered in the original CMP decision model have a significant impact on the resulting priorities assigned to the alternatives.

Due to the fact that the additional information that was collected was directly related to objectives of the strategic sourcing program and not considered in the original CMP analysis, and that the consideration of this information resulted in fundamentally different results, it is clear that further analysis of strategic sourcing alternatives must take into account the full range of strategic sourcing objectives to make decisions

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consistent with the goals of the program. Incorporation of these additional objectives into the decision method used by the CECC is the main recommendation of this research.

In addition to incorporating the full range of program objectives into the decision-making process, it is recommended that the CECC should adopt a more systematic and objective approach to opportunity assessments. The imminent nature of the current budget issues facing the federal government have greatly increased the pressure for the Enterprise Sourcing Group (ESG) to focus narrowly on predicting reductions in direct expenses in an effort to drive budget cuts for various items across the Future Years Defense Program. This pressure has resulted in an overemphasis on first costs as a discriminator in strategic sourcing decisions to the exclusion of additional efficiency factors. In addition to this, the pressure to produce results in the form of accurate future savings projections drives the CECC and the ESG to spend an inordinate amount of time and energy analyzing the few alternatives they have been able to consider to date. This process greatly delays the execution of strategic sourcing contracts to the point of negatively impacting the Civil Engineer community's perception of the effectiveness of the strategic sourcing process.

Creating and implementing a defensible methodology for opportunity assessments based on scientific methods like VFT can help alleviate this issue by institutionalizing the full range of strategic sourcing objectives into an approved, standardized process. This process can then be executed without an overemphasis on first costs as the "low hanging fruit" of the strategic sourcing process. Educating and achieving the approval of the model by senior leadership is critical to this concept.

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Limitations

While the decision model developed in the research is useful for evaluating strategic sourcing alternatives, there are limitations to its effectiveness. The quality of the data used to evaluate the alternatives is of utmost importance to the quality of the results produced by the model. Threats to the validity of the data used for analysis exist for both the qualitative and quantitative data analyzed by the model. In particular, the quantitative data used from the Commander's Resource Information System (CRIS) to calculate first costs and operations and maintenance costs seemed to be plagued with errors. While the monetary amounts listed for each item in the database were very accurate, the supporting data fields that characterized the nature of the expenses were not. It seemed that the consistency and accuracy of the data describing the type of expenses varied as much as the users who generated the data. This inevitably has caused the cost data used in the model to be inaccurate. Utilizing the same data for alternatives that were used in the CMP analysis was an attempt to mitigate the effect of this bias on the comparison of the model results. The fact that the original CMP decision model relied much more completely on this inaccurate data than the model developed in this research adds more credence to the need to implement additional factors for consideration into the decision model.

In addition to limitations due to the quantitative data used in the decision model, because the qualitative data used in the model relied on personal opinions of a few subject matter experts, the personal biases of the experts consulted impact the results of the model. The most prominent instance of bias encountered during this research was a hostility bias against the strategic sourcing concept itself. Due to the experts' personal

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experiences with the strategic sourcing program over the past several years, opinions to the effectiveness of both the strategic sourcing concept and its implantation methods in the Air Force have developed. For some of the experts, these opinions may have influenced the answers to questions posed during the interview process to limit any perceived credit ascribed to strategic sourcing. To limit the effect of this bias, the interview questions were designed to compel the experts to quantify their opinions in an objective manner. Questions were standardized between the different interviews, and answers were limited to specific quantifiable factors where possible. While this served to mitigate the effect of bias on the part of the experts consulted, some level of bias is inevitable whenever personal opinions are used for data.

Future Research Opportunities

Through the process of conducting this research, various opportunities for future research related to the VFT opportunity assessment model and strategic sourcing in general were identified. One major complication with completing an accurate analysis of services and commodities in use in federal government acquisitions is the poor quality of spend data available. Exploring new ways to capture opportunity data related to cost that are independent of the Commander's Resource Information System would result in a more accurate and consistent opportunity assessment model.

While this research conducted an analysis of several alternatives in the Civil Engineer community, conducting a systematic analysis of all commodity and service contract areas would identify new opportunities for strategic sourcing that have not yet been considered. In addition, the methodology used in this research can be used to

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develop similar models for each of the other Commodity Councils. Finally, further research in improving the VFT opportunity assessment model developed in this research can be further refined to more effectively evaluate strategic sourcing alternatives for the CECC.

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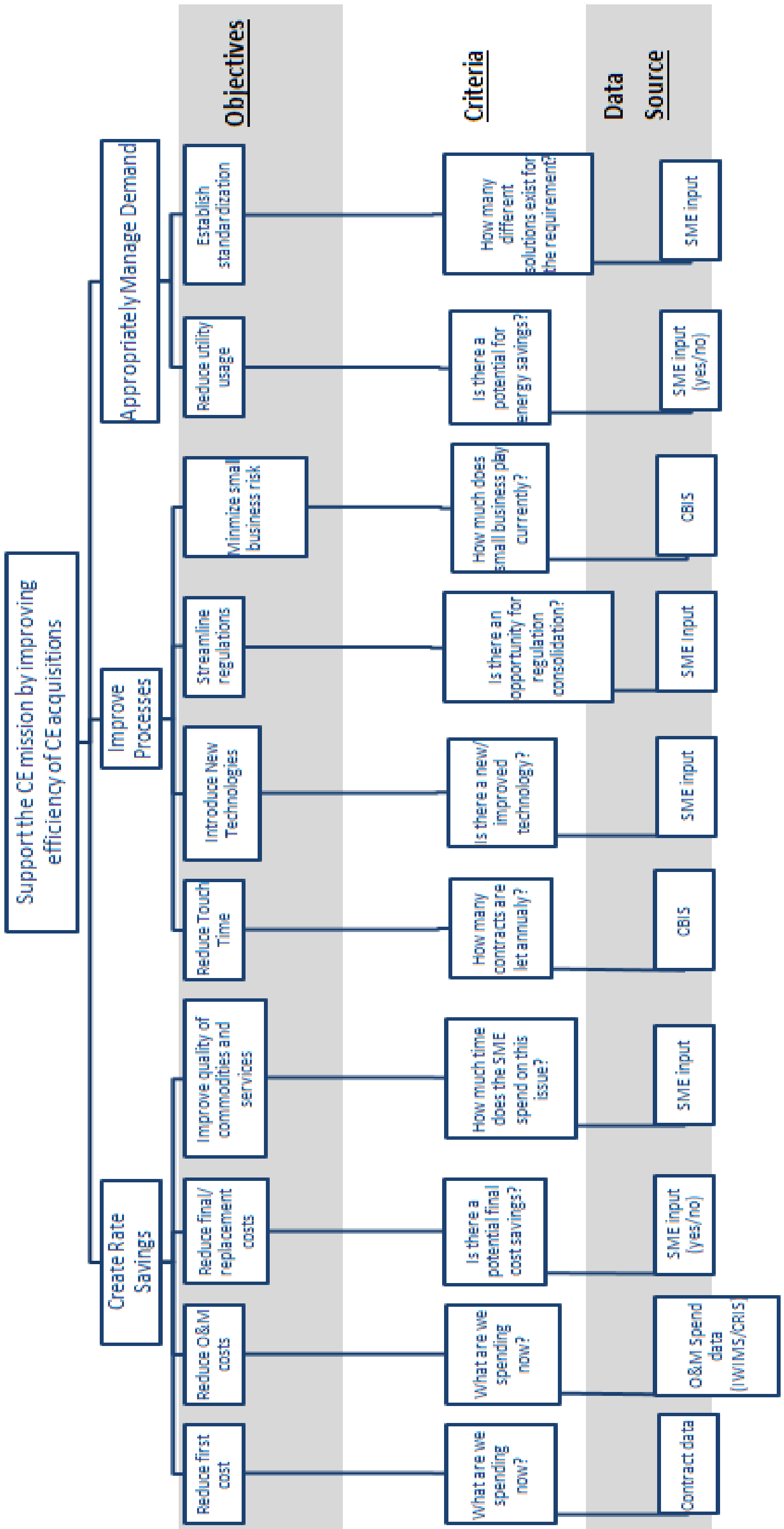
Appendix A. ESG First Iteration Value Hierarchy



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Appendix B. Subject Matter Expert Questionnaire Template

Strategic Sourcing Opportunity Assessment Research Questionnaire

Purpose: Current methods in use to assess strategic sourcing opportunities focus primarily on accounting records and fail to account for the full spectrum of strategic sourcing objectives. This research effort will result in a decision support tool that will better assist engineers in comprehensively evaluating strategic sourcing opportunities. This questionnaire is part of a research study that will ask you about your professional opinions related to specific commodity or service areas with strategic sourcing potential. All answers to these questions will be recorded in a manner as to not directly associate them with your name. In the final report, any data gathered will be attributed to "Experts in the Career Field."

Participation: Your participation in this data collection is greatly appreciated and desired. Though your participation will be extremely helpful to this research, please remember that it is COMPLETELY VOLUNTARY.

Whether you decide to participate or withdraw from the interview will have no impact upon your relationship with your unit, the United States Air Force, or the Department of Defense.

Confidentiality: Remember that ALL ANSWERS ARE ANONYMOUS and that no one other than the researchers will see the data provided.

Instructions:

- Base all of your responses on your own professional experiences, thoughts, and knowledge
- There is no "right" answer. Be sure to state your professional opinion

Contact Info: If you have any questions, comments, or concerns about this survey, please contact Capt. Andrew Myers using the information below.

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Additional Background:

The model being used in this project currently consists of eleven evaluation measures related to the established objectives of the strategic sourcing program. For your information, the objectives are metrics are provided in the following table:

Objective Name	**Evaluation Measure**
Create Rate Savings	
Reduce first costs	Current annual spend for this alternative
Reduce O&M costs	Current annual O&M spend for this alternative
Reduce final/replacement costs	SME evaluation for a potential final cost savings
Improve quality of commodities and services	SME evaluation of current quality problems
Improve processes	
Reduce touch time	Total number of annual contracts for this alternative by type
Leverage new technology	SME evaluation of new technology potential
Streamline regulations	SME evaluation of current regulations
Minimize small business risk	Total percentage of all annual contracts for this alternative that are given to a small business
Manage Demand	
Reduce utility expenses	SME evaluation of resource savings potential
Establish standard solutions	SME evaluation of number of solutions in use for this requirement
Establish COLs	SME evaluation of COL feasibility (*service contract areas only*)

Four of these objectives lend themselves to direct, quantitative measurement based on existing data sources. The other seven objectives, while still important aspects of a comprehensive evaluation of strategic sourcing opportunities, do not. This questionnaire attempts to capture an indirect, qualitative evaluation of specific strategic sourcing opportunities for these seven objectives based on your expert opinions. There is also a question at the end asking you to provide any additional commodities or services that you think would benefit from strategic sourcing. If you have any questions, please don't hesitate to shoot me an e-mail at andrew.myers@us.af.mil. Thanks for your time and support for this research effort!

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Questions:

1. One element of analyzing the total life-cycle cost impact of strategic sourcing is the final cost. These costs include demolition, disposal, environmental remediation, and other related expenses. Regarding the strategically-sourced solution that you feel would be the most effective at efficiently meeting requirements, final costs would be reduced by an amount that is:

Negligible (0-2%), Marginal (3-5%), Moderate (5-10%), Significant (10-25%), or Dramatic (26%+)

2. An optimal strategic sourcing solution should strive to improve the quality of the commodity or service being procured. Regarding your feelings on CURRENT quality issues present in this commodity/service area, quality-related problem are brought to your attention:

Never, Rarely, Occasionally, Often, Constant

3. Strategic sourcing presents an opportunity to rapidly leverage new technologies across the entire Air Force that will improve efficiency. Do you feel there is a new, currently untapped technology related to this commodity/service area that can be utilized to improve efficiency?

Yes/No

4. In your opinion, do regulations, published guidance, and/or standards related to this commodity/service area require updating or consolidating?

Yes/No

5. Regarding your opinion of the optimal strategically-sourced solution for this commodity/service area, this solution would reduce utility usage/costs by an amount that is:

Negligible (0-2%), Marginal (3-5%), Moderate (5-10%), Significant (10-25%), or Dramatic (26%+)

6. One way strategic sourcing can generate efficiencies across the Air Force is by standardizing the commodities/services that we are using to meet requirements. Regarding your experience with CURRENT acquisitions related to this service/commodity area, how many different types of solutions are currently used for this particular application?

1, 1-4, 5-10, 11+

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7. Regarding your opinion of the optimal strategically-sourced solution for this commodity/service area, COLs could result in efficiency improvements that are:

> Negligible (0-2%), Marginal (3-5%), Moderate (5-10%), Significant (10-25%), or Dramatic (26%+)

8. Do you know of any commodities or services that would be great candidates for a strategically-sourced solution? If so, please describe your idea below and fill out an additional questionnaire evaluating it.

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