Air Force Institute of Technology
AFIT Scholar

Theses and Dissertations   Student Graduate Works

3-21-2019

Investigating Schedule Length of Space and Missile Systems Center Contracts

Loyd A. Bradley Jr.

Follow this and additional works at: https://scholar.afit.edu/etd

Part of the Business Administration, Management, and Operations Commons

Investigating Schedule Length of Space and Missile Systems Center Contracts

THESIS

March 2019

Loyd A. Bradley, Jr., Captain, USAF

AFIT-ENV-MS-19-M-164

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

Investigating Schedule Length of Space and Missile Systems Center Contracts

THESIS

Presented to the Faculty

Department of Mathematics and Statistics

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Cost Analysis

Loyd A. Bradley, Jr., BS

March 2019

AFIT-ENV-MS-19-M-164

Investigating Schedule Length of Space and Missile Systems Center Contracts

Loyd A. Bradley, Jr., BS

Captain, USAF

March 2019

Committee Membership:

Edward D. White, Ph.D
Chair

R. David Fass, Ph.D
Member

Jonathan D. Ritschel, Ph.D
Member

AFIT-ENV-MS-19-M-164
Abstract

Acquisition reform has long been the goal of the Department of Defense to save, recover and redistribute funds in an efficient manner. The Space and Missile Systems Center Program Management and Integration Directorate (SMC/PI) and Acquisitions Center of Excellence (ACE) have shared the same effort and have made strides to better their acquisition processes. Many different angles have been examined to try to discover cost and schedule growth however, little research has been done to find the drivers of schedule length. This research is aimed at finding contributing factors to the length of schedule of the pre-acquisition process. By using Fisher's Exact test and contingency table analysis programs were explored to find what factors contribute to the length of schedule. The results of this analysis show significance can be found in the contract's type, strategy and the phases in which a program is in. Additionally, the research shows significance with programs that waive stages.

Acknowledgments

The biggest thank you goes to our almighty Creator. Without Him nothing is possible. I would especially like to thank Dr. White for his guidance beyond the process of creating this work. His brilliance, kindness, and patience are all things that every student should have the opportunity to experience. While statistical knowledge was passed, the talks about life beyond research were the most impressionable.

Additionally, I would like to my Air Force Academy friends and family, the men of Omega Psi Phi Fraternity Incorporated, Central State University, and my classmates for assisting me through this process. Finally, I would like to thank my parents for the sacrifices they made to ensure I have the opportunities of a lifetime. Nothing great is ever accomplished without the help of others.

Loyd A Bradley, Jr.

Table of Contents

List of Figures

List of Tables

Investigating Schedule Length of Space and Missile Systems Center Contracts

I. Introduction

Background

In today's ever-changing fiscal environment and with the new government administration in place, the focus to have a fast and more efficient acquisition process is inevitable. Acquisition reform has long been the goal of administrations to save, recover and redistribute funds in an efficient manner. The Space and Missile Systems Center Program Management and Integration Directorate (SMC/PI) and Acquisitions Center of Excellence (ACE) have shared the same effort and have made strides to better their acquisition processes. Recently, the focus has become to find time savings in the pre-award phase in an effort to save resources over the entire acquisition process.

SMC/PI is currently in search for ways to eliminate unproductive processes and bureaucracy and improve tradecraft in acquisition of services (Rodriguez, 2016). In support of the Better Buying Power (BBP), research has been conducted within the SMC/PI office to improve these areas. The Rodriguez (2016) findings of this research documents in addition with ways to improve the processes.

While research was conducted to improve the SMC's acquisition process, to date there has not been documented research conducted to find what drives the length of the request for proposals (RFP) process. A comprehensive model that is able to predict the amount of time it takes to award a contract has the potential to save the Department of Defense (DoD) a significant amount of time, money and resources. Making leadership more aware of unproductive and bureaucratic processes that inhibit the early acquisition

strategy has the potential to eliminate wasteful processes and increase the speed of the process.

Purpose of Research

The purpose of this research is to investigate the phases that contribute to length of the contract award process, provide useful information to eliminate unproductive processes, and reduce the pre-acquisition timeline. Currently the early contract award process has a total of four phases prior to the contract award (CA). Figure 1 shows the phases of the pre-acquisition process.
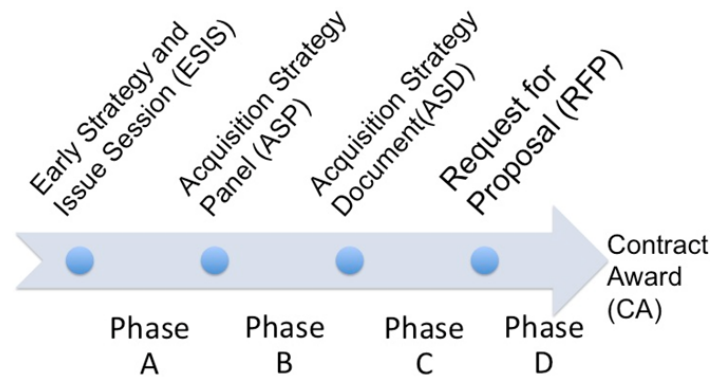
Figure 1: Pre-Acquisition Process

The contract award process breaks down the process into different phases in an effort to best select the company to perform work. The Early Strategy and Issue Session (ESIS) is a series of informal meetings between the leadership involved and the acquisition team. The purpose of these meetings is to develop the acquisition process (OUSD (A&S), 2013). Phase B is when the leadership formally reviews and approves the acquisition strategy going forward. During Phase C, the strategy document is developed, and during phase D the request for proposal is released to the public to begin bidding on the contract.

Research Objectives

It is important to note that the DoD has legal processes in place that require an acquisition process to be completed. Therefore, the processes established have reason and are not likely to be eliminated. Findings serve as opportunities to evaluate where excessive time is being spent within the processes. The research objectives are ultimately meant to identify areas that could save the DoD time in the pre-acquisition process.

The main objective of this research is to investigate possible factors associated with the length of time of the contract award phases. Once the predictive factors are determined, recommended factors to limit the time to award a contract will be established.

Research Question #1

What are the factors that contribute the length of schedule leading up to the RFP? Which of these factors add on the most time? Are there alternative options to accomplish the same goal while saving time and resources i.e. waving phases?

Research Question #2

If there are factors that contribute to a lengthy process, what additional time do these factors add to the Department of Defense's acquisition process?

Methodology

By investigating the findings of SMC/PI, we first best replicate their findings given a different but similar data set. Acknowledging the differences in data sets, we are able to replicate some, but not all of their findings. We then look at it from our own perspective, and compare our findings that are both similar and different. To conduct our investigation, we use Fisher Exact Test to interpret results of contingency tables along

with descriptive statistics to best determine the relationship between the different phases and schedule length. The Fisher Exact Test and contingency tables have been used in previous research as a way to interpret and predict things such as cost growth and schedule length. Evaluating the data through this lens allowed us to investigate the length of future contract award processes. We use methods similar to previous research that was used to identify predictors of a cost growth of a program by Scott Kozlak (2016).

The data evaluated is provided by SMC/PI. There are 75 contracts that have been through the complete contract award process and have been awarded to various entities. There are, however, limitations to data because of the possible sensitive nature of a given contract. The data is provided in the Appendix A.

Assumptions/Limitations

We made two key assumptions for our research. First, all contracts that are a part of the data have followed the contract award process previously mentioned. Second, not all of the contracts awarded have been presented in the data due to the sensitive nature of offices' contracts. We use all of the data available and present significant findings that are useful for the conclusion of this research.

Overview of Thesis Chapters

Chapter one, the introduction, documents and summarizes the basis for the research. It gives a background of the problem with the research problems and the methods that will be used to conduct the research. In chapter two we discuss the defense acquisition system to give the reader an understanding of the acquisition process. We also discuss the research of SMC/PI along the reasoning for their research which ultimately influenced our investigation. In chapter three we describe our methodology to include a

4

summary of the data, data sets and test used in chapter four. In chapter four we present

our results. Lastly, we discuss the findings and factors that influence the timeline in

chapter 5. Based on findings, a recommendation is made to show where the most time

could be saved in the pre-acquisition phase.

II. Literature Review

Chapter Overview

This chapter includes five sections, starting with a review of the acquisition process with an emphasis on the early phases of the contract award system as mentioned in the introduction. Next, we examine the DoD acquisition process in order to understand the significance of the pre-acquisition award process. The next two sections entail a review the Better Buying Power (BBP) initiative in conjunction with the findings by SMC in support of the BBP initiative. Finally, we conclude by reviewing different approaches to evaluate the data by Fisher Exact Test to explain contingency tables.

Defense Acquisition System

The Department of Defense acquisition process is a system that the government uses to acquire goods and services. By definition, the Defense Acquisition System (DAS) is, the management process by which the Department of Defense provides effective, affordable, and timely systems to the users, [and it] exists to manage the nation's investments in technologies, programs, and product support necessary to achieve the National Security Strategy and support the United States Armed Forces (DoDI, 2017).

The governing document for the defense acquisition process is the Department of Defense Instruction (DoDI) 5000 series, but the pre-acquisition phase is not included in this document. The pre-acquisition phase falls within overall acquisition process but is detailed in a subsequent section. We first highlight the overall process before focusing on the pre-acquisition process. The acquisition process includes various organizations, five major areas, and three milestone reviews.

In the coming paragraphs the organizations involved, along with the phases of the acquisition process and the milestones are detailed as explained by the DoDI 5000.2 (DoDI, 2017). The instruction applies to OSD, the Military Departments, the Office of the Chairman of the Joint Chiefs of Staff and the Joint Staff, the Combatant Commands, the Office of the Inspector General of the Department of Defense, the Defense Agencies, the DoD Field Activities, and all other organizational entities within the DoD. The first major area, Material Development Decision (MDD), constitutes the start of the pre-system acquisition phase. During the MDD the user needs are assessed along with available the science and technologies. These serves as analysis of alternatives (AoA) for the Major Decision Authorities (MDA). The Initial Capability Requirements document (ICD) is developed to identify and validate the projected mission needs of the user. Simultaneously, the Defense Science and Technology (S&T) Program is working to provide the users with "superior and affordable technology" to ensure the user has the top capabilities. Their mission is to also reduce the risks of promising technologies before they are assumed in the acquisition process. Once the ICD is developed and alternative technologies within the DoD are explored, the decision is made to move the next step in the DAS.

After the MDD completes the AoA the decision then directs the execution of the Materiel Solution Analysis Phase (MSA). The MSA is the entry point to the acquisition process, but does not constitute the official initiation of a project. The purpose of this phase is to conduct the analysis and other activities needed to choose the concept for the product that is desired to be acquired. The minimum funding that is required for this phase is normally used to analyze and select an alternative for materiel development.

Prior to the completion of this phase the DoD Component combat developer prepares a concept of Operations/Operational Mode Summary/Mission Profile. Once the DoD Component has completed the analysis necessary to support the decision, the first major milestone is embarked on. Milestone A approves the program entry in to the Technology Maturation and Risk Reduction phase – the official start of a program.

The Technology Maturation & Risk Reduction (TMRR) phase also falls within the pre-system acquisition phase. The TMRR attempts to reduce the technology risk and determine the appropriate technology systems that will be part of the new system. During this step the requirements are refined, costs are validated and reviews of the systems technology are conducted. It is also the phase in which leadership reaches a decision to release a RFP. However, before a RFP can be implemented, the systems acquisition process must be approved. The systems acquisition is considered the process of developing concepts into producible and deployable products that provide capability to the user. While trying to provide capabilities to the user is the main goal, the best valued solution is also a top priority. This includes exploring possible modifications to current systems or equipment if they will adequately provide the capability. Once it is determined that there are no existing systems within the military/allied nations or it is more cost efficient to produce another system, leadership can justify the production of a new system. The second major milestone, Milestone B, then provides authorization to move to the next phase which includes the RFP.

The third step in the DAS program, Engineering and Manufacturing Development (EMD), begins the program initiation and is considered the formal start of a program. EMD is a test trial of the system that is to be developed before it goes into production.

The prototype will be tested and evaluated to ensure an affordable and executable process along with a successful integration of the new system. Once reliability, availability, maintainability and sustainment of the news system is demonstrated the production and deployment of the new system begins.

Once Production and Development (PD) is started several issues of mass production can be revealed. During this step improvements or redesigns can still be implemented. In an effort to manage the exposure of the DoD and cost there are two parts to PD: Low Rate Initial Production (LRIP) and Full Rate Production (FRP). During LRIP the minimum quantity of the system are produced for the initial operational test and evaluation (IOT&E). Once testing of the initial deployments are complete the next step is FRP. Before FRP starts the results of the IOT&E are considered along with an independent cost and manpower estimate. Once FRP starts the weapon system is fully developed and sustainment of the product starts.

The Operations and Support (O&S) is the last stage of the DAS. Once this phase is entered the system is then managed by the end user. The main focus now becomes the operation and proper execution of "the system in the most cost-effective manner possible". Studies of the current system are consistently evaluated to help better improve the system in the form of modifications, upgrades and future increments. Once the system has reached the end of its life, it is also the responsibility of the program manager (PM) to properly dispose the system. Figure 2 displays the DAS to include the five major

areas, and three major milestones and major decision points.
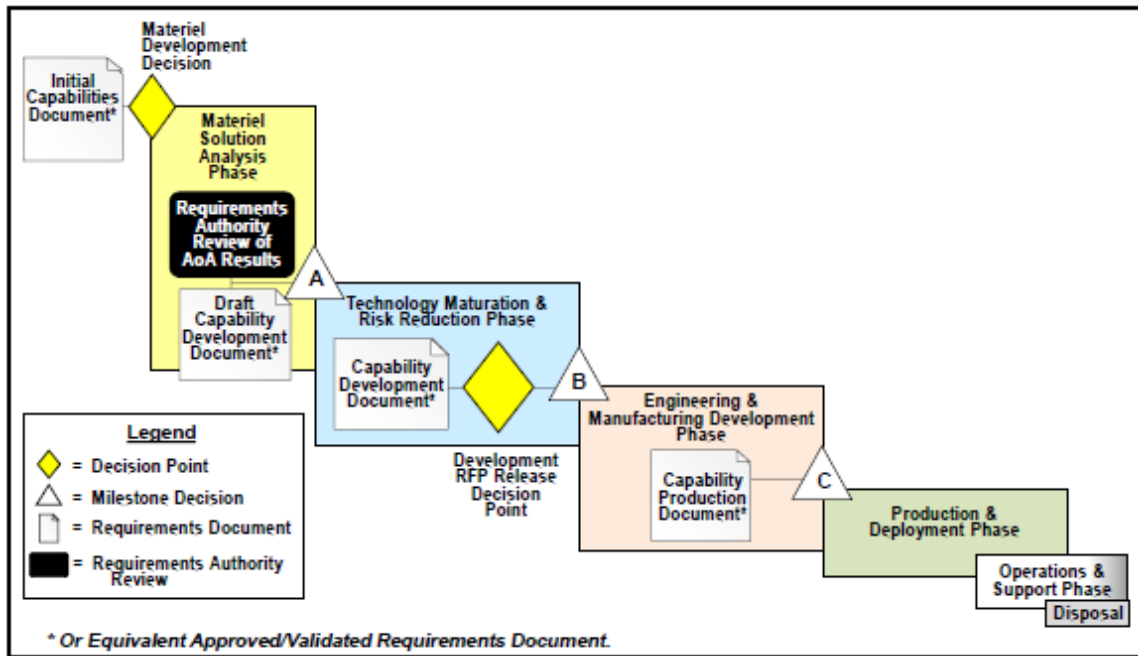
Figure 2: Defense Acquisition System

Early Stage Acquisition Strategy

To best understand the focus of the Early State Acquisition Strategy, we must

understand the aim of addition of positions and models to the acquisition process

provided by Air Force leadership. The first Air Force Annual Report on the Acquisition

of Services provided the history of the Air Force's approach to better the acquisition

process (Fanning, 2014). To improve the acquisition processes, Congress first requested

the DoD to provide more oversight of acquisition processes.

> In 2003, Congress requested DoD provide management/oversight of services
> acquisition. The AF established the Program Executive Officer for Combat
> and Mission Support (PEO/CM) who was the acquisition authority for
> services acquisition >$100M or >300 Full-Time Equivalents (FTEs)
> (Fanning, 2014).

In 2007 the Air Force continued the efforts of advancing the acquisition process by

introducing the four pillars of acquisitions: define the right requirements, involve people, provide accountability and develop processes. These four pillars were designed to go in conjunction with the previously established initiatives to improve the overall acquisition processes.

In addition to the four pillars, leadership developed a six-element tradecraft that is used early as a part of the acquisition phase to provide a transparent process and assist government employees in making the proper assessments before awarding a contract to an outside entity. What was once considered a closed looped process is now defined into six key elements. The elements included the Requirement Approval Document (RAD), Early Strategy and Issues Session (ESIS), Acquisition Strategy Panel (ASP), Source Selection Process, Annual Execution Review (AER) and the Health Assessments. Each of the six phases play a significant role in the acquisition of a project and determine the priority of a contract. We focus on the first four elements as they are the pre award phase of the contract. The latter two elements are conducive to ensuring the contract is being performed to the standard agreed upon between all parties involved and to refine the government award process (OSD).

The RAD serves as a requirement review process that that allows leadership to identify and stratify potential projects. Programs that are new or recurring that qualify for the RAD process have a total value of $150k or more (Defense Acquisition University [DAU], 2018).

Once the commanders, Major Command (MAJCOM) and Air Staff leadership rank the request, the top projects move to the ESIS phase. During the ESIS phase the leadership begins to interact with the acquisition teams that will carry out the duties of

the project. This is the time where the "initial approach, strategy considerations, lessons learned, best practices, and process changes potentially impacting the acquisition strategy development" are determined. After the informal discussions the ASP begins the formal process for awarding a contract. During the ASP a formal strategy is developed in accordance to the Federal Acquisition Regulations (FAR). Once the formal strategy is developed the contract is then taken to the source selection process. Here the request for proposal is developed and placed on various outlets for companies to bid for the given project.

Better Buying Power

Better Buying Power (BBP) was launched in September 2010 by then-Under Secretary Ashton B. Carter and Frank Kendall in support of President Obama and Secretary Gate's priorities for the acquisition professionals. At the time of the start of the BBP the DoD was in a fiscally constrained environment. The goals was to "deliver better value to the taxpayer and warfighters by improving the way the Department does business" (Carter, 2010). The direction of the undersecretary of defense was to "DO MORE WITHOUT MORE". Thus, various mandates were laid out in the memorandum for accomplishing such goal. To enforce the new mandates the Business Senior Integration Group (BSIG) was established. BSIG consist of all DoD relevant acquisition and related leadership. The group meets once per month to ensure the implantation of BBP (Kendall, 2015).

The focus areas of the BBP to accomplish the overall goal were to target affordability and control cost growth, incentivize productivity and innovation in industry,

promote real competition, improve tradecraft in services acquisition, and reduce non-productive processes and bureaucracy.

SMC chose to focus on the latter two objectives in their programs. To improve tradecraft in service acquisition the BBP started with changing the governance of acquisition services. Secretary Carter directed to the Component acquisition Executives (CAEs) to create a senior manager for each component of acquisition services. These senior managers were to be general officers or SES equivalent. Their job was to "be responsible for governance in planning, execution, strategic sourcing and management of service contracts" (Carter, 2010).

Next, the acquisition leaders were tasked with coming up with a uniform way to classify different types of services. The primary categories that were mandated are: "Knowledge-Based Services; Electronics and Communications Services; Equipment Related Services/ Medical Services; Facility Related Services; and Transportation Services" (Carter, 2010). This system was used to better classify acquisition programs and create basic consistency throughout the services.

After the uniformity was confirmed Secretary Carter continued by focusing on the causes of "poor" tradecraft in services acquisition. At the time of the publishing of the BBP first memorandum, acquisition services had increased approximately 400% in the past decade (Fanning, 2014). It was imperative to ensure that all departments were on the same accord with processes and paperwork. The first directive to improve this area was for the senior managers to use standard templates for documents such as Performance Work Statements (PWS). Next, he wanted to strengthen the market research to best understand the various industry's capabilities and market prices to ensure the DoD was

getting a fair price for the goods and services that were to be acquired. Finally, for this effort he wanted to increase the involvement of small business participation for providing services to the DoD. Including small businesses in theory would create an environment of innovation. The directive was for the "OSD Office of Small Business Programs to review acquisition plans for the services acquisitions exceeding $1 billion, and to be members of the Office of the Secretary of Defense (OSD) peer reviews of services acquisitions" (Carter, 2010).

The final area SMC chose to focus on in their report was the effort to reduce non-productive processes and bureaucracy. It is noted in the memorandum that there a number of low-value added processes in the form document requirements. These requirements could significantly slow down acquisition productivity. Secretary Carter demanded that they "be aggressively identified and eliminated". To assist with this effort, he first began by directing the senior managers to reduce the number of OSD level reviews. Due to the increase of acquisition services in the prior year, "OSD staff reviews required more than 100,000 labor-hours to complete" (Carter, 2010). The top-level management of these projects took the decision making away from the Senior Acquisition Executives (SAEs), and Program Managers (PMs). Secretary Carter recommended that the same level of oversight could be achieved through establishing status reports and informal staff contacts rather than complete reviews. The expectation of OSD was to remain cognizant and an appropriate level of understand of the programs, but not to a point of over excessiveness in an effort to relieve the chain of command from management responsibility.

To further the effort of eliminating bureaucracy, the elimination of low-value-added statutory processes was then addressed. The Nunn McCurdy review process, a process established in 1982 that requires DoD to report to Congress for Major Defense Acquisition Programs (MDAP) that have cost overruns, was questioned. While Secretary Carter supported the intentions of the Act, he recommended that the process to be more streamlined. It was calculated that in 2010 that evaluations for six programs exceeded $10 million and 95,000 hours of overhead labor. The cost of conducting the research outweighed the benefit of the additional knowledge that was gained. The decision was still made to continue the programs that required the overview, thus little value added with lessons learned. As a result, he ordered to target specific oversight processes to reduce cost associated with what was described as "unnecessary overhead burdens" (Carter, 2010). All statutory requirements were still to be followed, but how compliances was adhered to would be altered for efficiency.

In continue to draw down on bureaucracy Secretary Carter ordered to reduce the volume and cost of congressional reports by half and reduce non-value added overhead imposed on industry. In the everchanging acquisition environment there were numerous processes that did not evolve with the time. The lack of advancement of process has imposed extra cost for industry. Some of the fault for this was because of DoD regulations. The direction was to survey industry to better prioritize processes and recommend an efficient way forward.

Since the publishing of the first BBP initiative, two more memorandums have been released. The most recent BBP 3.0 has similar focus, but with a few additional initiatives. The enhanced focus has a high emphasis on innovation and technical

excellence (Fanning, 2014). The concern of technology superiority being at risk is what drove the production of BBP 3.0. It can be expected that more initiatives will be produced in later years with enhanced focus on increasing efficiency in the acquisition process.

SMC Assessment/Findings

In support of the BBP, SMC conducted a study to attempt to improve its pre-award acquisition process. This section is in reference to the study and findings of SMC as it relates to their programs (Rodriguez, 2016). First, SMC sought to eliminate unproductive process and bureaucracy. To find the root causes, SMC used the follow material to gain data: 1) ACE October 2014 metric deep dive; 2) ACE metrics tracker; 3) DAU process analysis review; and 4) 2016 PID identification of top 5 root causes with proposed corrective action. The final BBP focus area was improving tradecraft in acquisition services to include project and program acquisitions. This was evaluated by, reviewing current ACE workshops and training to determine the types of DAU learning tools that could benefit and supplement ACE workshops and training.

The study was conducted by using multiple regression to understand the correlation and relationship between 16 independent variables. In an attempt to keep similar language throughout chapters, many of these variables are parallel to our research variables. There was a total of 148 lines of data from 33 separate Air Force programs explored in their research. The dates of the programs ranged from 2014 to May 2016. Using statistical analysis, SMC was able to derive histograms and other graphs that showed relative frequency of occurrence of items with respect to the overall total item occurrence.

In the studying of the data there were multiple qualitative findings that helped indicate possible interruptions and delays to the pre-acquisition process. Findings lead the researchers to focus on 7 key causes: "inefficient scheduling/planning; lack of clear guidance; lack of recourses; lack of document priorities/timing & awareness; staff disagreement/misalignment; lack of (or) inefficient training; and lack of experience/familiarity and turnover". The qualitative aspects of SMC/PI could not be replicated because qualitative information was not provided.

SMC/PI had multiple findings through quantitative analysis. It was determined that the longest duration during the pre-award phase occurred between the ASD to contract award phase. It was also found that the majority of the delays happened in Phase C (ASD to RFP) based on their results. The following results were also found in the analysis:

1. Decision Authority; the 0.55 value is positive indicating that level of approval authorization proceeds in the same direction as the number of days.

2. Dollar Value Level; the 0.48 value is positive indicating that the dollar value proceeds in the same direction as the number of days.

3. Estimate Delay; the 0.36 value is positive indicating that the estimated delay proceeds in the same direction as the number of days

In the first finding the decision authority that is reference is the level of the Acquisition Category (ACAT). The higher the ACAT level, the more likely the length of schedule will be longer.

While these findings were proven to be indictive of what could be causing schedule delays, the research was not used to investigate the phases that could be used to

forecast the pre-acquisition schedule leading up to the RFP. In the subsequent chapter Ms. Rodriguez research is replicated to confirm findings and explore other factors that could have an effect on the length of the pre-acquisition phase using a different methodology.

III. Methodology

Chapter Overview

The purpose of this chapter is to describe our data collection and methodology used in our research. In this chapter we give background and analyze the methodologies used in the SMC research. We then explore the multiple different data sets and explain how they have been normalized. Finally, we make clear the steps performed in our data collection and analysis and give the reason behind our choices.

Data Collection

In order to analyze the total length of a program's schedule, reliable data that contains program schedule information was obtained. In a previous study pertaining to schedule length, the SMC used similar data provided for their study. The data came directly from the same office so it is deemed to be a credible source of the given data. This gives us the confidence that the source is reputable and provided accurate information. To our knowledge, there is no better source of this program's particular acquisition data.

Data Summary

The data provided by SMC consist of all awarded contracts. Due to the sensitive of their mission and the systems being obtained we are not certain of exactly what type of system is being acquired. To respect the sensitivity of the systems, they are labeled as programs 1 through 75. The programs that were evaluated are separated by acquisition categories (ACAT), service acquisition categories (SCAT), technology projects, technology demos, and acquisition projects. A sample of the raw data provided is located in Appendix B.

The ACAT programs range from levels I through III. Acquisition programs are placed into categories based on the criteria as defined in the DoDI 5000.02. ACAT I programs are Major Defense Acquisition Programs (MDAPs) that have planned cost of more than $480 million or procurement of more than $2.79 billion. ACAT I programs have two subcategories, ACAT IC and ACAT ID (DAU, 2018). Both of which are in the analyzed data provided by SMC. The subcategories are in reference to the Milestone Decision Authority (MDA) for the ACAT program. For ACAT 1C programs, the MDA is the component acquisition executive (CAE) and for ACAT ID the MDA is the Defense Acquisition Board (DAB) (DAU, 2018). ACAT II programs do not meet the criteria for an ACAT I program and have total expenditures of more than $185 million, or for procurement of more than $835 million (DAU, 2018). Finally, ACAT III programs are programs that do meet the criteria for ACAT II or above. SCAT programs follow the same criteria but are designated for service contracts.

The contract type and strategy are also defined for each of the programs. The type of contracts are broken up into two categories: competitive or sole source. Competitive contracts are contracts that multiple parties can bid on. The majority of the programs listed are competitive contracts. A sole source contract is a contract that does not have a competitive process for bidders. The contract strategies are broken up into several categories: Fixed Price (FP), Firm Fixed Price (FFP), fixed-price incentive firm target (FPIF), Cost-Plus-A-Fixed-Fee (CPFF), Cost-plus-incentive-fee (CPIF), Cost-plus-award-fee (CPAF), General Services Administration (GSA) and a mixture of the strategies listed.

To help with the predictive factors and give a timeline of events, the Kick-off or "go ahead", ESIS, ASP, ASD, RFP and Contract award dates are provided. Some of the programs have one or more of the steps to contract award waived or are not applicable to the program. The most up-to-date information was requested from SMC to include as much details as possible about the programs.

The 75 programs studied have various characteristics similar and different from that of the data analyzed by SMC. From the 75 programs we derived 8 different data sets to study. Many of the programs 75 programs were not able to be used in the study because of missing dates of phases. Figures 3-5 display the breakdown of the 75 total programs by SCAT/ACAT Category, Contract Type and Contract Strategy. Later we describe the descriptive statistics used in the 8 data sets derived from the original 75 programs.
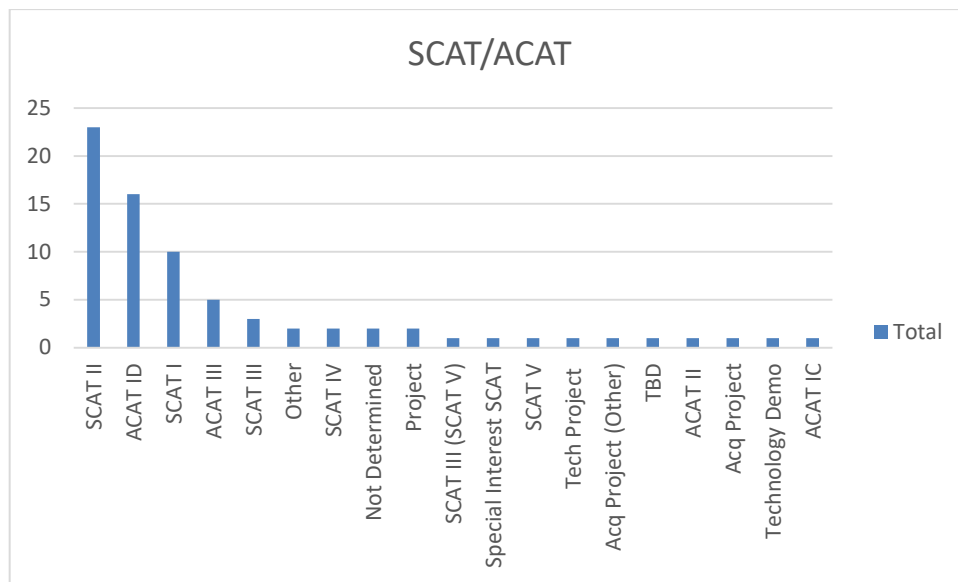
Figure 3: Service Category/Acquisition Category
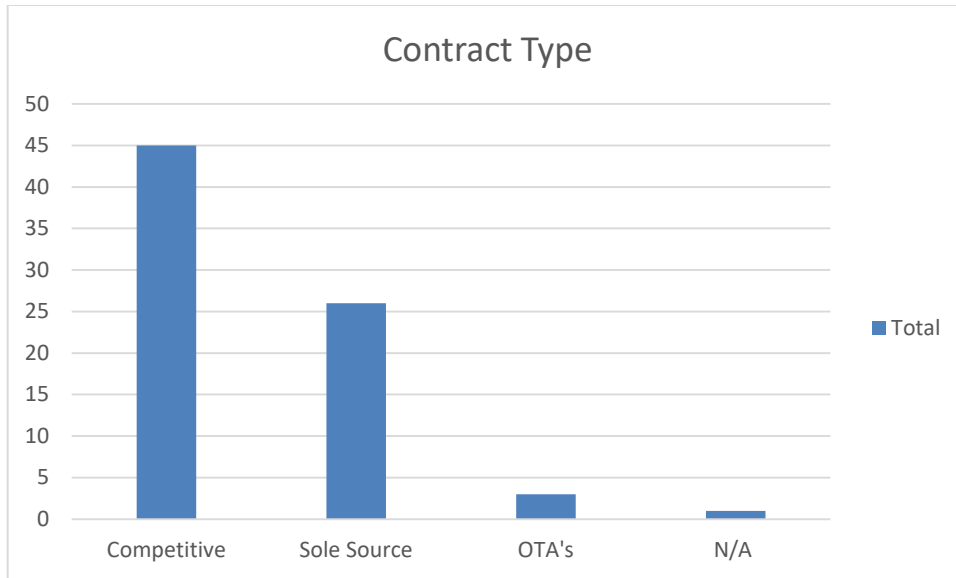
Figure 4: Contract Type

Figure 5: Contract Strategy

Limitations

SMC has provided the data that is available to release from their office. However, there are several limitations to the data provided. First, we are limited to the data that they can provide. Due to the sensitivity of projects we are not provided with all programs that

have been completed by SMC. The data provided earliest kickoff date was in August 2008. If earlier dates were provided more data could be analyzed to enhance the conclusions of this thesis. While we assumed that all of the contracts have followed the pre-acquisition phases, some of the projects have had steps waived or are not available for various reasons. The kickoff stage was not examined by SMC and is not an official part of the pre-acquisition phase. In addition to the official pre-acquisition phases, the "kickoff date" for each program is given. This limits the knowledge of some of the programs that were provided. Also, in the data provided, the specific service or item being purchased are not defined. Therefore, no correlation can be made between the specific commodities that are purchased. We are also limited to what is assumed to be all space related services and commodities.

Variables

In the study conducted by SMC there were a total of 16 independent variables used as predictor variables. The dependent variable used in the study are a total number of days it takes to award a contract from the first phase. The independent variables used in the SMC research are as follows:

1. Directorate: Each program is classified into 11 groups describing the type of program (i.e. Global Positioning System, Satellite, Ground System, etc.).

2. Decision Authority: The Decision Authority identifies the highest level of authorizing organization for program approval known as Milestone Decision Authority (MDA).

23

3. DV Level: The Dollar Value Level classified each program's contract dollar value in 23 different levels with dollar values ranging to over ten trillion dollars.

4. ACAT/SCAT: Each program is designated an Acquisition or Service Category based on being classified as a major system or service, dollar value, and MDA.

5. Contract Strategy: Each program's contract is identified as a sole source or a competitive contract.

6. Contract Type: Each program's contract is classified into 8 different contract types with one of the categories identifying the use of a combination of contracts.

7. Phase A Days (ESIS to ASP): Phase A Days identifies the number of days between the ESIS and the ASP.

8. Phase B Days (ASP to ASD): Phase B Days identifies the number of days between the ASP and the ASD.

9. Phase C Days (ASD to RFP): Phase C Days identifies the number of days between the ASD and the RFP.

10. Phase D Days (RFP to CA): Phase D Days identifies the number of days between the RFP and the Contract Award.

11. Total Days (Start to CA): The Total Days identifies the number of days from the ESIS to Contract Award.

12. ESIS Conducted: In some instances, the ESIS was not held which is indicated by a zero value.

13. ASRB Conducted: In some instances, the ASRB was not held which is indicated by a zero value.

14. Delay Cat: Each delay is classified into 41 different types of delays specific to the organization.

15. Phase: The Phase identifies the phase where the program delay occurred.

16. Est Delay: The Estimated Delay identifies the number of days for program delay identified.

   To evaluate the findings of SMC using a different, but similar data set, we replicated their research using similar variables. Of the 16 variables used in their research we were able to use a total of 8 with the data provided to us. The 9 variables that duplicated were variables 4-12. The other variables could not be duplicated because the data for those variables were not made available in the data set we were provided to analyze.

   Similar to the replicated test, we used similar independent variables to examine the data using a different methodology. The independent variables used in our research are defined as follows:

1. ACAT/SCAT: Each program is designated an Acquisition or Service Category based on being classified as a major system or service, dollar value, and MDA.

2. Contract Strategy: Each program's contract is identified as a sole source or a competitive contract.

3. Contract Type: Each program's contract is classified into 8 different contract types with one of the categories identifying the use of a combination of contracts.

4. Phase A Days (Kickoff Date to ESIS): Phase A Days identifies the number of days between the Kickoff and the ESIS.

5. Phase B Days (ESIS to ASP): Phase B Days identifies the number of days between the ESIS and the ASP.

6. Phase C Days (ASP to ASD): Phase C Days identifies the number of days between the ASP and the ASD.

7. Phase D Days (ASD to RFP): Phase D Days identifies the number of days between the ASD and the RFP.

8. Total Days (Start to RFP): The Total Days identifies the number of days from the Kickoff to RFP.

9. ESIS Waived: In some instances, the ESIS was waived which is indicated by the word "waived" and thus given a zero value.

10. ASP Waived: In some instances, the ASP was waived which is indicated by the word "waived" and thus given a zero value.

11. ASD Waived: In some instances, the ASD was waived which is indicated by the word "waived" and thus given a zero value.

We have three dependent variables that we use in the test of the independent variables. All three responses were used separately and tested against all independent variables. The dependent variables are:

1. Mean Total Days: The mean total days of all dates available for the given programs.

2. Median Number Days: The median total days of all dates available for the given programs

3. 75th Percentile Total Days: The 75th percentile of the total days of all programs available for the given programs.

The mean, median and 75th percentile of total number of days are derived from the given data set that is being tested. These three dependent variables are the same for data sets that begin with the same phase. For example, all data sets that begin with Phase A have the same mean, median and 75th percentile days. The same applies for other data sets. The 75th percentile is used because it serves as a natural and consistent breaking point in all data sets. Since we are interested in programs that are spending a long time in phases the 75th percentile will show correlation, if any, with programs that running long. All variable are defined in Appendix C.

We further discuss the findings, comparisons of the histograms and correlation matrix of the replicated research in chapter 4 along with the examination of data using a different methodologies and variations of the data set.

Data Sets

Missing data in the stages dictate the data sets. Stages are considered the kickoff, ESIS, ASP, ASD and RFP while the time in between the stages are referred to as phases. To clearly identify the differences of the stages and phases referenced in this research, Figure 6 was developed. The phases reference the days that it takes to transition from one stage to the other. Within the original data set there are numerous programs that do not have all of the dates available for each of the stages. Therefore, programs that do not have all information were not included in the initial evaluation. Missing dates in the kickoff or "go-ahead" date, or any of the pre-acquisition dates will result in removal from the data set. By standardizing this key information, we removed some variability from the results.

The standardization of the data left us with less data to analyze than originally provided, but provided a more accurate assessment of the data available.
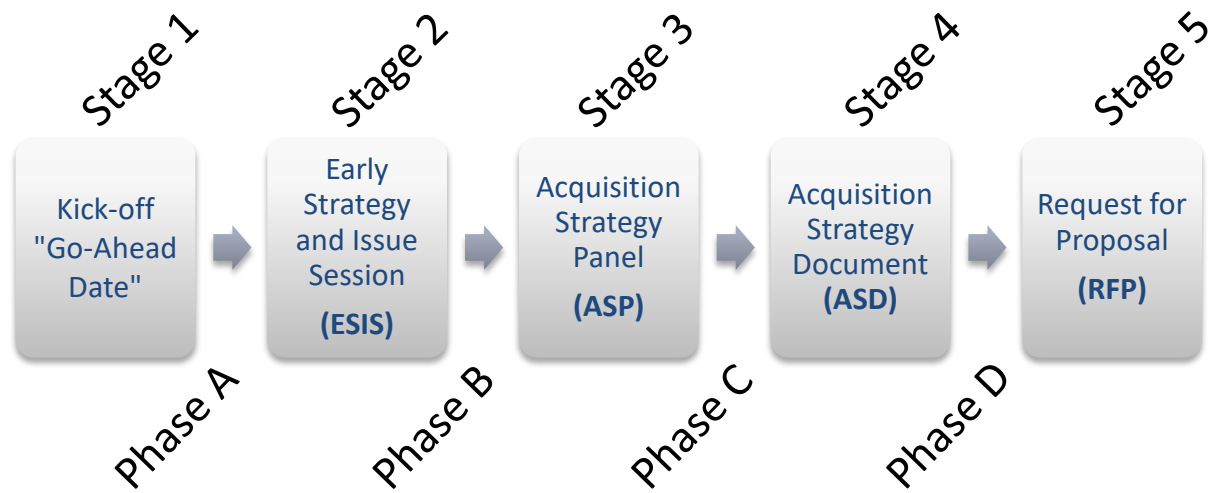
Figure 6: Definition of Stages and Phases of Pre-Acquisition Process

When standardizing the data we removed programs that had missing dates in the stages and noted the stages that had waived data. The stages that had waived data were given a time of zero days in the particular stage. The Kickoff stage has a total of 14 missing dates and two dates that were waived. The majority of the missing days came in the ESIS stage with a total of 32 programs missing dates. This accounted for 42.7% of the 75 programs and for 55% of the all programs missing days. The ESIS also had six days that had the stage waived. Next, the ASP stage had a total of nine programs missing dates and six programs waived. The ASD stage had three missing dates, but had the programs with the most waived stages with a total of 13. Finally, the RFP had no dates missing. Table 1 shows how many dates were missing from the provided data set for each of the stages.

Table 1: Missing Days of Data by Stage

Stage	# of Missing Days	% of Missing Days
Kick-Off Date	14	18.6%
ESIS	32	42.7%
ASP	9	12.0%
ASD	4	5.3%
RFP	0	0%

In total, of the 75 programs, 43 had missing dates and 26 had waived dates. 11 of the 43 programs with missing dates had two or more stages missing dates. Of the 19 programs that had stages waived, only four had two or more waived stages. There were no trends of characteristics that were more likely to have dates missing. Figure 7 displays which stages made up the 26 waived dates by percentage. However, there are a total of three SCAT III programs, all of which were missing both the ESIS and ASP stages. We did find trends in the stages that had waived data. SCAT II and ACAT ID programs account for 52% of the 75 programs, but only account for 22% of programs with stages waived. All other findings were consistent with the proportion of SCAT/ACAT, contract type and strategy.
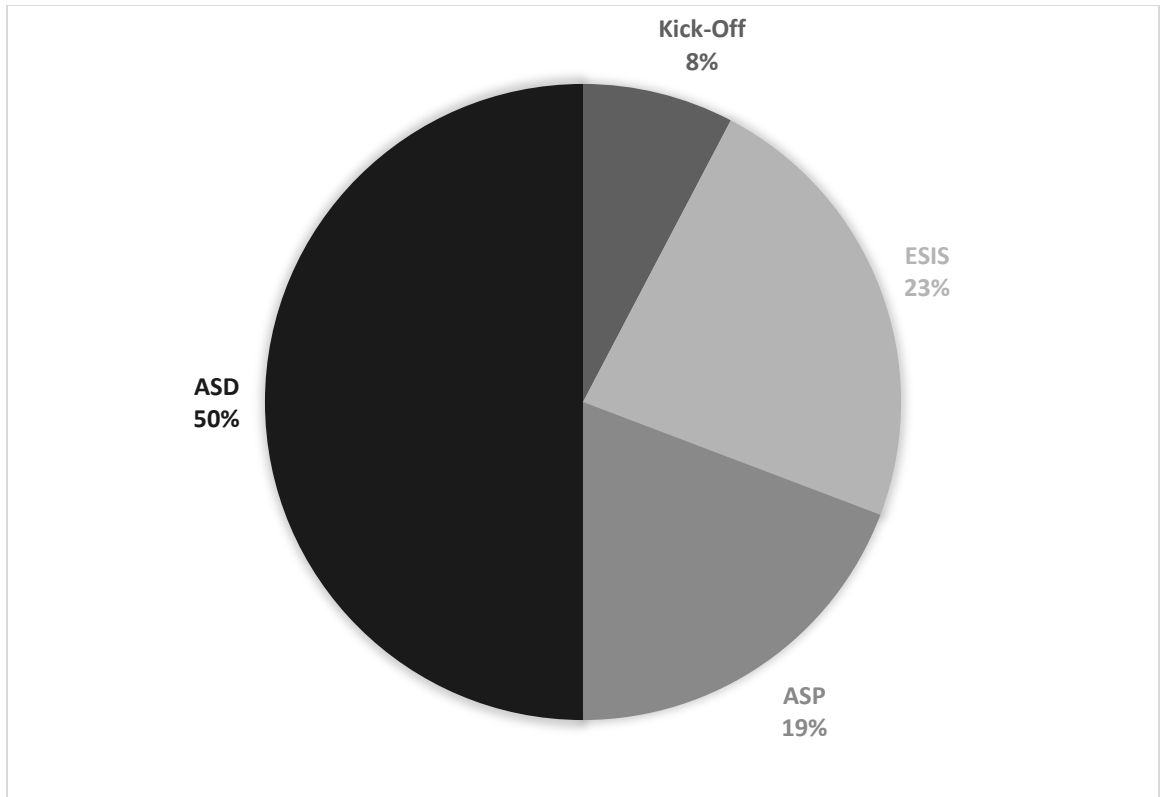
Figure 7: Stages Waived by Percentage

To explore the various independent variables and their relation to the median, mean or 75th percentile of the total days, eight data sets were established. These data sets included all combination of phases, in sequence, to test against the dependent variables. All sets of data had either a date for each phase or an indication that phase was waived – there are no phases without a date of completion. Along with the data sets of phase sequence, a data set was established to replicated the experiment of SMC, which equate to our Phases B through Phase D.

Finally, the eighth data set created were Phase A through D with no waived data included. Each of these data sets are along with the descriptive statistics are explored in chapter 4. The descriptive statistics cover the amount of programs in each data set along

with the various numbers of contract types, strategies and other independent variables.

The combinations of the eight data sets are displayed in Figure 6.

1. Phase A_Phase D
2. Phase A_Phase C
3. Phase A_Phase B
4. Phase B_Phase D
5. Phase B_Phase D
6. Phase C_Phase D
7. SMC Simulation
8. All Dates No Waived

Figure 8: Data Set

Methodology

Lastly, we discuss the process to identify drivers of length of schedule for the pre-acquisition phase based on length of each phase. A similar approach was used in a previous thesis by Kozlak (2016) as he examined Cost Growth Factors (CGF). Step 1: identify various categories throughout the data. Step 2: we convert any significant continuous variables to categorial variables. Step 3: we analyze the categorical variables to identify which are significant using the Fisher's Exact Test. Step 4: finally, if useful, we use odds ratios to calculate the odds of the significant of the categorical variables.

Simple Correlation

Simple correlation also proved to be valuable in this research. The sample size, small in nature, lends itself to be further evaluated using simple histograms and tables to

interpret data. Comparison of mean days of categories of means helped confirm findings through the Fisher's Exact Test. The evaluation of these graphs are included in the research and is further discussed in Chapter 4.

Fisher's Exact Test

Fisher's Exact Test is an analysis of contingency tables to determine if the independent variable is a predictor of the dependent variable. Since this test is typically used on small sample sizes, the data sets fit into the appropriate use of the test. The Fisher Test uses the null hypothesis that proportions are the same; it then calculates the probability of getting the observed data (McDonald, 2009).

While the Fisher Exact Test supports both one tailed and two tailed hypothesis tests, this research focuses on using one-tailed hypothesis test to suggest if the categorical factor increase the chances of the length of schedule. The null hypothesis states that the categorical variables do not predict the length of schedule. We use an alpha of 0.10 to disprove the null hypothesis. We also highlight tests that are significant at an alpha of 0.05 and 0.01. We use asterisks to separate our significant findings based on the p-value. P-values that are below the 0.10 are denoted by one asterisk, p-values below 0.05 are denoted by two asterisks, and p-values below 0.01 are denoted with three asterisks signifying strong association.

Summary

In this chapter, the summary of the data was discussed to include the source, standardization, limitations. Also, a view of our variables along with the definitions that are being used in chapter four were explained. Finally, discussed the methods we used to examine the data set by using simple correlation and the Fisher Exact Test. In chapter 4,

we explain the results of our analysis and examine the factors contributing to the length

of schedule using the methods discussed in this Chapter 3.

<center>**IV. Analysis and Results**</center>

Introduction

Chapter 4 starts with the presentation of descriptive statistics of the various data sets with all dates available. Next, we compare similarities and differences of our research to the findings of SMC. Then we present the data analyzed through the lens of the Fisher Exact Test and contingency tables. Finally, we present the total analysis of the results.

Descriptive Statistics

Descriptive statistics provides insight into the data associated with the analysis. The descriptive statistics shown are a summary of each data set. All data sets include only phases with all dates available or the status of waived. The data with all dates available were used to investigate and draw conclusion on significant data that have an effect on the length of the pre-acquisition phases leading up to the RFP. The conclusions drawn from the complete data are further used to investigate and draw conclusions about programs with incomplete data. As previously mentioned, there are a total of 75 programs provided to examine. Using the 75 programs, 8 data sets were established. The number of programs vary in the data sets based on the dates available in the phases.

First, the descriptive statistics are displayed by the total amount of programs in each data set along with the mean number of days those contracts spent in the phases covered by the data set. Then, we take a look into the breakdown of each data set by the number of ACAT/SCAT, Contract Type, and Contract Strategy that are in that particular data set. Tables 2-5 display the number of programs examined in the given category. Followed by each data set is brief commentary on the data's descriptive statistics.

<center>34</center>

Table 2: Data Set Descriptive Statistics of Total Days

	Number of Programs	Mean of Total Days	Median of Total Days	75th Percentile Total Days
Phase A_Phase D	58	469	420	605
Phase A_Phase C	54	352	286	470
Phase A_ Phase B	51	285	237	396
Phase B_Phase D	42	284	217	422
Phase B_Phase C	40	163	144	217
Phase C_Phase D	65	199	144	258
SMC Simulation	23	336	267	495
All Dates No Waived	20	473	467	645

It is important to note again that the majority of dates missing were in the early stages. This is why we see more programs available to evaluate in the latter phases. We see that the most dates missing are in the kickoff and ESIS stages (Phase A). This then had an effect on the number of programs available for all data examined starting with Phase A. Once Phase A was no longer being evaluated, we see an increase in the programs available to test. As expected when we simulated the SMC data and use only programs that have all dates and no waived dates, we see a significant decrease in the number of programs examined. SMC dates are from Phase B to the contract award. In our data sets we stop one stage prior to the contract award.

Table 3: Data Set by SCAT/ACAT Programs

	SCAT I	SCAT II	ACAT III	ACAT ID
Phase A_Phase D	8	22	4	9
Phase A_Phase C	8	21	4	8
Phase A_Phase B	8	21	4	7
Phase B_Phase D	6	11	4	8
Phase B_Phase C	6	12	4	7
Phase C_Phase D	9	22	5	13
SMC Simulation	5	9	3	2
All Dates No Waived	5	9	1	3

Table 4: Data Sets by Contract Type

	Competitive	Sole Source	OTA	N/A
Phase A_Phase D	32	26	1	1
Phase A_Phase C	30	22	1	1
Phase A_Phase B	28	21	1	1
Phase B_Phase D	25	13	3	1
Phase B_Phase C	23	13	3	1
Phase C_Phase D	39	22	3	1
SMC Simulation	14	8	0	1
All Dates No Waived	11	8	0	1

Table 5: Data Sets by Contract Strategy

	FFP	CPFF	FPIF	CPIF	FFP/CPFF
Phase A_Phase D	18	6	5	5	3
Phase A_Phase C	16	6	5	5	3
Phase A_Phase B	13	6	5	5	3
Phase B_Phase D	15	5	3	2	3
Phase B_Phase C	14	4	3	2	3
Phase C_Phase D	20	8	5	5	4
SMC Simulation	7	2	2	2	0
All Dates No Waived	6	2	1	2	0

Because of some programs are being examined multiple times, we find that the breakdown of SCAT/ACAT, Contract Type, and Contract Strategy breakdowns are similar. The specific category, type and strategy that are displayed are the top types that appeared in the original data set.

SMC Findings Comparison

The replication of the SMC data was done using our methods previously described. It is important to note that while a similar approach was used to analyze the data, there was more data to analyze in the SMC research. SMC used a total of 63 program, while we analyzed 23 programs. Because of the data available we were able to duplicate 9 of their 16 x-variables. The y-variable of total days was still used in their

multiple regression analysis while we used an mean and median of total days to test for significance.

We start by comparing the descriptive statistics of both data sets. Similar to the SMC data, we have more contracts that use competitive contracts as the contract strategy in oppose to the sole source strategy. However, in the data set provided to us we did not have any contract types labeled indefinite delivery or indefinite quantity. These two contract types were the dominate strategies in the SMC data. There were also no occurrences of Cost-Plus Incentive Fee, Fixed Price or Fixed Price Incentive Fee in their data set. These contract types dominated our data set. Finally, SCAT I has the most occurrences in the SMC data set while SCAT II has the most occurrences in our data sets. Despite using data with different occurrences, we are still able to compare findings. If the findings are significant, they should hold true in both experiments. A comparison of the histograms can be found in Appendix A.

In the SMC examination, all variables proved to indicate low to moderate relationships between the independent variable and the total days to award the contract. They attribute the findings to the low number or programs that were tested through multiple regression. SMC found that decision authority and dollar value of the program had positive trends with total number of days. While SMC used multiple regression, we were able to confirm some of their findings. Given the definition of ACAT and SCAT categories we are able determine the decision authority to infer approximate dollar amount of the program. In the following sections we will show that the SCAT level had a positive trend with the total amount of days of a program.

Simple Correlation

   A total of 368 test were run producing 368 Fisher-Exact test, mosaic plots and

contingency tables. There are a total of 53 significant findings totaling 15% of all test

run. Of the 53 findings, 49% of the findings were as a result of the program being a

Service Contract, competitively bid or a Firm Fixed Price Contract. A total of 41% of the

56 findings occurred in Phases C and D. All of the programs that showed significance

when compared to the exceeding the mean total days had P-values below 0.05. This

indicates that Phases C and D have a strong correlation with how a long a program will

take until the RFP.

Fisher's Exact Test

   Using the Fisher's Exact Test, we tested for statistical association between

categorical variables (x) and the dependent variable (y). In the research three independent

tests were done to investigate the categorical variables. We used the mean, median and

75th percentile of total number of days as independent variables to test the categorical

variables for significance. In the cases where the median fell within 15 days of the mean,

similar results were found. To further test for significance, the 75th percentile of the total

amount of days were also tested. The potential explanatory factors of the schedule length

are measured by using a significance level of 0.1 (P-Value < 0.10). To test for

significance, we first had to determine at what percentage we would analyze the data.

Initially, we used quartiles to examine data to find if there were any significance given

our selected alpha. After examining the quartiles in each phase, if there were significant

breaking points, they were further analyzed for significance. Tables 6-8 indicates which

variables found to be significant given the chosen alpha. Columns marked with one

asterisk are significant at an alpha of 0.1, columns with 2 asterisks are significant at an alpha of 0.05, and the columns marked with 3 asterisks have a p-value less than 0.01.

Table 6: Significant Factors for Length of Schedule of Mean Total Days by Data Set

	Phase A_Phase D	Phase A_Phase C	Phase A_Phase B	Phase B_Phase D	Phase B_Phase C	Phase C_Phase D	SMC Replication	All Data Available
Category 1								
Service Category (SCAT)			*					
Competitive Contract						**		
Sole Source Contract								
Firm Fixed Price		***			*			*
Any Cost Plus						*		
Waived ASP								
Waived ASD								
Phase A 1st Quartile								
Phase A 2nd Quartile								*
Phase A 3rd Quartile								
Phase B 1st Quartile								
Phase B 2nd Quartile								
Phase B 3rd Quartile		*						
Phase C 1st Quartile				*		***		
Phase C 2nd Quartile								
Phase C 3rd Quartile								
Phase D 1st Quartile								
Phase D 2nd Quartile				*				***
Phase D 3rd Quartile	**					**		

Table 7: Significant Factors for Length of Schedule of Median Total Days by Data Set

	Phase A_Phase D	Phase A_Phase C	Phase A_Phase B	Phase B_Phase D	Phase B_Phase C	Phase C_Phase D	SMC Replication	All Data Available
Category 1								
Service Category (SCAT)								
Competitive Contract						***		
Sole Source Contract						**		
Firm Fixed Price		***	*				*	*
Any Cost Plus								
Waived ASP								
Waived ASD								
Phase A 1st Quartile								
Phase A 2nd Quartile								*
Phase A 3rd Quartile								
Phase B 1st Quartile								
Phase B 2nd Quartile								
Phase B 3rd Quartile		*			*			
Phase C 1st Quartile					**	***		
Phase C 2nd Quartile					*			
Phase C 3rd Quartile				*				
Phase D 1st Quartile						**		
Phase D 2nd Quartile							*	***
Phase D 3rd Quartile	**					**		

Table 8: Significant Factors for Length of Schedule of 75th Percentile Total Days by Data Set

	Phase A_Phase D	Phase A_Phase C	Phase A_Phase B	Phase B_Phase D	Phase B_Phase C	Phase C_Phase D	SMC Replication	All Data Available
Category 1								
Service Category (SCAT)	**							
Competitive Contract								**
Sole Source Contract								*
Firm Fixed Price						*	*	
Any Cost Plus								
Waived ASP								
Waived ASD						*		
Phase A 1st Quartile								
Phase A 2nd Quartile								
Phase A 3rd Quartile			*					
Phase B 1st Quartile								*
Phase B 2nd Quartile	**							**
Phase B 3rd Quartile		***						
Phase C 1st Quartile	*			**		***		
Phase C 2nd Quartile								
Phase C 3rd Quartile								
Phase D 1st Quartile						**		
Phase D 2nd Quartile							*	**
Phase D 3rd Quartile	**			*		***	*	

To further understand the significance of the P-value we review the results and identify if the results are 'left' or 'right' tailed tests. For each of the test that have significance, we identify the independent variables tail and if the p-value showed significant in a two tailed test. Tables 9-11 display the significant results. Columns marked with an "L" indicated left-tailed significant, while an "R" represent right-tailed significance.

42

Table 9: Significant Factors for Length of Schedule of Mean Total Days by Data Set with Tail

	Phase A_Phase D	Phase A_Phase C	Phase A_Phase B	Phase B_Phase D	Phase B_Phase C	Phase C_Phase D	SMC Replication	All Data Available
Category 1								
Service Category (SCAT)			R					
Competitive Contract						R		
Sole Source Contract								
Firm Fixed Price		L			L			L
Any Cost Plus						L		
Waived ASP								
Waived ASD								
Phase A 1st Quartile								
Phase A 2nd Quartile								L
Phase A 3rd Quartile								
Phase B 1st Quartile								
Phase B 2nd Quartile								
Phase B 3rd Quartile		R						
Phase C 1st Quartile				L		L		
Phase C 2nd Quartile								
Phase C 3rd Quartile								
Phase D 1st Quartile								
Phase D 2nd Quartile				R				R
Phase D 3rd Quartile	R					L		

Table 10: Significant Factors for Length of Schedule of Median Total Days by Data Set with Tail

	Phase A_Phase D	Phase A_Phase C	Phase A_Phase B	Phase B_Phase D	Phase B_Phase C	Phase C_Phase D	SMC Replication	All Data Available
Category 1								
Service Category (SCAT)								
Competitive Contract						R		
Sole Source Contract						L		
Firm Fixed Price		L	L				L	L
Any Cost Plus								
Waived ASP								
Waived ASD								
Phase A 1st Quartile								
Phase A 2nd Quartile								L
Phase A 3rd Quartile								
Phase B 1st Quartile								
Phase B 2nd Quartile								
Phase B 3rd Quartile		R			L			
Phase C 1st Quartile					L	L		
Phase C 2nd Quartile					R			
Phase C 3rd Quartile			L					
Phase D 1st Quartile						R		
Phase D 2nd Quartile							R	R
Phase D 3rd Quartile	R					L		

Table 11: Significant Factors for Length of Schedule of 75th Percentile Total Days by Data Set with Tail

	Phase A_Phase D	Phase A_Phase C	Phase A_Phase B	Phase B_Phase D	Phase B_Phase C	Phase C_Phase D	SMC Replication	All Data Available
Category 1								
Service Category (SCAT)	R							
Competitive Contract								R
Sole Source Contract								L
Firm Fixed Price						L	L	
Any Cost Plus								
Waived ASP						L		
Waived ASD								
Phase A 1st Quartile								
Phase A 2nd Quartile								
Phase A 3rd Quartile			R					
Phase B 1st Quartile								L
Phase B 2nd Quartile	L							L
Phase B 3rd Quartile		R						
Phase C 1st Quartile	L			L		L		
Phase C 2nd Quartile								
Phase C 3rd Quartile								
Phase D 1st Quartile						R		
Phase D 2nd Quartile							R	R
Phase D 3rd Quartile	R			R		L	R	

Finally, we look at the p-value results from the different test. It is noticeable that a lot of the p-values are similar. This is due to similar programs being analyzed and a small number of permutations. Tables 12-14 display the P-values of each significant test.

Table 12: Significant Factors for Length of Schedule of Mean Total Days by Data Set with P-value

	Phase A_Phase D	Phase A_Phase C	Phase A_Phase B	Phase B_Phase D	Phase B_Phase C	Phase C_Phase D	SMC Replication	All Data Available
Category 1								
Service Category (SCAT)			0.0797					
Competitive Contract					0.0474			
Sole Source Contract								
Firm Fixed Price		0.0053			0.0649			0.0704
Any Cost Plus						0.0686		
Waived ASP								
Waived ASD								
Phase A 1st Quartile								0.0894
Phase A 2nd Quartile								
Phase A 3rd Quartile								
Phase B 1st Quartile								
Phase B 2nd Quartile								
Phase B 3rd Quartile		0.0918						
Phase C 1st Quartile			0.0649			0.0028		
Phase C 2nd Quartile								
Phase C 3rd Quartile								
Phase D 1st Quartile								
Phase D 2nd Quartile				0.0577				0.0054
Phase D 3rd Quartile	0.0325					0.0133		

Table 13: Significant Factors for Length of Schedule of Median Total Days by Data Set with P-value

	Phase A_Phase D	Phase A_Phase C	Phase A_Phase B	Phase B_Phase D	Phase B_Phase C	Phase C_Phase D	SMC Replication	All Data Available
Category 1								
Service Category (SCAT)								
Competitive Contract						0.0054		
Sole Source Contract						0.0366		
Firm Fixed Price		0.0053	0.0680				0.0770	0.0704
Any Cost Plus								
Waived ASP								
Waived ASD								
Phase A 1st Quartile								
Phase A 2nd Quartile								0.0894
Phase A 3rd Quartile								
Phase B 1st Quartile								
Phase B 2nd Quartile								
Phase B 3rd Quartile		0.0918			0.0603			
Phase C 1st Quartile					0.0153	0.0039		
Phase C 2nd Quartile					0.0683			
Phase C 3rd Quartile				0.0508				
Phase D 1st Quartile						0.0418		
Phase D 2nd Quartile							0.0736	0.0054
Phase D 3rd Quartile	0.0325					0.0179		

Table 14: Significant Factors for Length of Schedule of 75th Percentile Total Days by with P-value

	Phase A_Phase D	Phase A_Phase C	Phase A_Phase B	Phase B_Phase D	Phase B_Phase C	Phase C_Phase D	SMC Replication	All Data Available
Category 1								
Service Category (SCAT)	0.0169							
Competitive Contract								0.0298
Sole Source Contract								0.0511
Firm Fixed Price						0.0636	0.0793	
Any Cost Plus								
Waived ASP						0.0799		
Waived ASD								
Phase A 1st Quartile								
Phase A 2nd Quartile								
Phase A 3rd Quartile			0.0676					
Phase B 1st Quartile								0.0726
Phase B 2nd Quartile	0.0990							0.0163
Phase B 3rd Quartile		0.0067						
Phase C 1st Quartile	0.0816			0.0233		0.0004		
Phase C 2nd Quartile								
Phase C 3rd Quartile								
Phase D 1st Quartile						0.0490		
Phase D 2nd Quartile							0.0595	0.0139
Phase D 3rd Quartile	0.0335			0.0700		0.0086	0.0886	

Summary

Overall, our analysis generated significant results. Table 7 through Table 14 provide valuable information on what factors influence longer or shorter times to the RFP. As one would expect, the closer we get to the RFP, the more predictive our model becomes. The many findings in the Phase C to Phase D validate this claim. It is also important to note the significance of competitive and firm-fixed price contracts. These programs consistently revealed significant results over the many tests. Also, when the

time in Phase A exceeds 15% of the total time it was likely that the overall program will exceed the median number of days of all programs. Finally, in Phase D significant results were found when time in this phased exceeded 15% of the total time it is likely that the overall program will exceed the mean time to the RFP. Chapter 5 gives a conclusion of our results and provide recommendations going forward for both SMC and future research.

V. Conclusions and Recommendations

Chapter Overview

The major findings in this research was done by identifying the statistically significant variables associated with length of schedule. Chapter 5 revisits these significant results as they relate to research questions addressed in Chapter 1. Finally, the chapter concludes with recommendations for future research on this topic of schedule length of the pre-acquisition phase.

Research Questions Answered

1: What are the factors that contribute the length of schedule leading up to the RFP? Which of these factors add on the most time? Are there alternative options to accomplish the same goal while saving time and resources i.e. waving phases?

According to our analysis, programs that were a SCAT, were a competitive contract. and used the dominate strategy of firm-fixed price. SCAT programs took longer to award while other programs did not show significance. Competitive contracts are also an indicator of getting to the RFP slower than that of the other contract types. Firm-fixed price contracts contributed to quicker process to the RFP while other contract types did not show significance.

While we were able test all of the waived phases, there were little to no significance in the time it took the programs to RFP if the program had a stage waived. Waiving the ASD seemed to be most helpful to reaching the RFP stage quicker while waiving other phases did not make a significant based on our set alpha.

2: If there are factors that contribute to a lengthy process, what additional time do these factors add to the Department of Defense's acquisition process?

The factors that contribute to a lengthier process are programs that use the competitive contract type. Competitively bid contracts had a mean of 667 days while contracts that bid with different methods have a mean of 220 days. It was also determined that spending more time in phases C and D caused for a program to take longer to make it to the RFP.

Recommendations for Future Research

We recommend several areas for future research. First, our study examined data that contained only SMC data. We presume that these programs consisted of all space related program. This same research can be conducted on other platforms to include, but not limited to: Land, Vessels, Aircraft and other Space programs. A combination of these programs can be explored and compared to find similar finding of this research. Second, as previously mentioned, the SMC report was able to incorporate qualitative data to their research. Using qualitative data, they were able to have what seems to be valuable data that can help improve the pre-acquisition phase going forward. This is shown by the recommendations of specific trainings to put in place to address such issues. Follow-up on their implementation of such programs can also be explored. Finally, further analysis can be done programs if more prominent information is released. The type of programs and dollar amounts would have been helpful to examine possible trends. The signing of a non-discloser agreement (NDA) might be necessary to acquire such information, but would likely prove to be valuable to research.

Final Thoughts

This thesis examined the length of phases of the pre-acquisition process. To our knowledge there have not been studies in this particular area. This might be due to the

fact that the pre-acquisition process has not be heavily explored in the likes of the entire acquisition process has been. With more information and studies, we will likely be able to save many resources if time is properly allocated to this particular part of the acquisition process. Acquisition reform is typically at the forefront of new administrations initiatives and the study of the pre-acquisition phases could likely provide many savings of resources that have been sought.
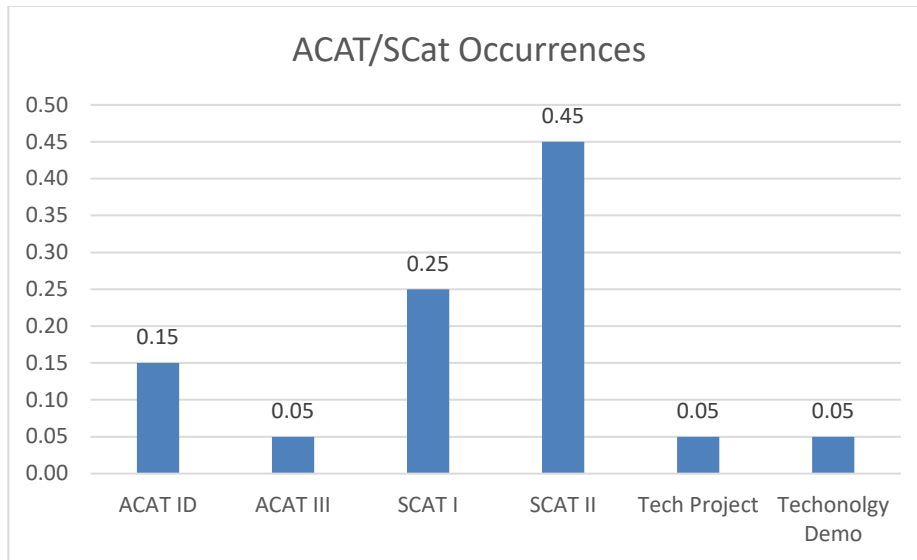
Appendix A

**Figure A1: SMC ACAT/SCAT Data**
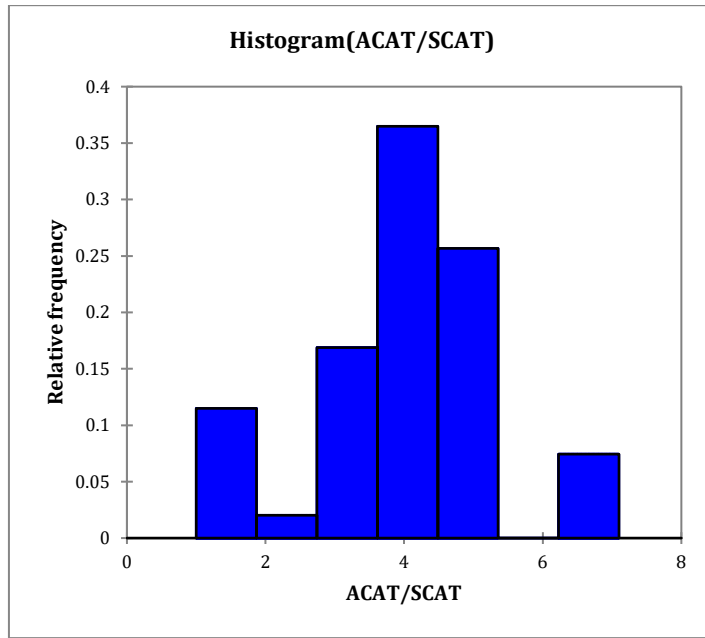
ACAT/SCAT

1. ACAT ID
2. ACAT II
3. ACAT III
4. SCAT I
5. SCAT II
6. SCAT III
7. Other

Figure A2: SMC Simulated ACAT/SCAT Data Occurrences

The SCAT I Category occurred most frequent as shown in the SMC histogram. SCAT II data had the most occurrences in our data. The SCAT III Category was not present in the final combined data set that was analyzed by either SMC or our data. Two Technology occurrences are show in the second graph, but it is unknown what occurrences fall into the "other" category of the SMC data set.
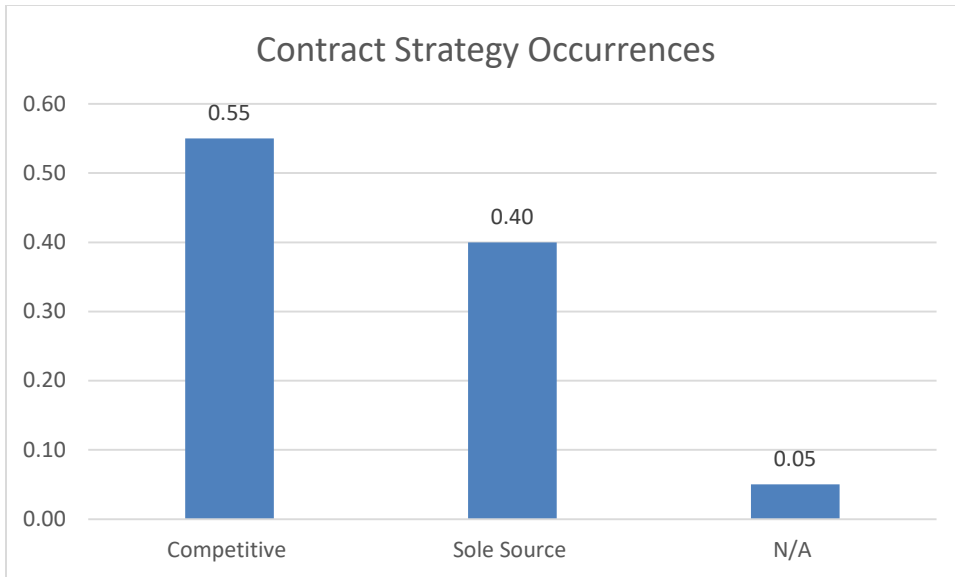
## Figure A3: SMC Contract Strategy Data
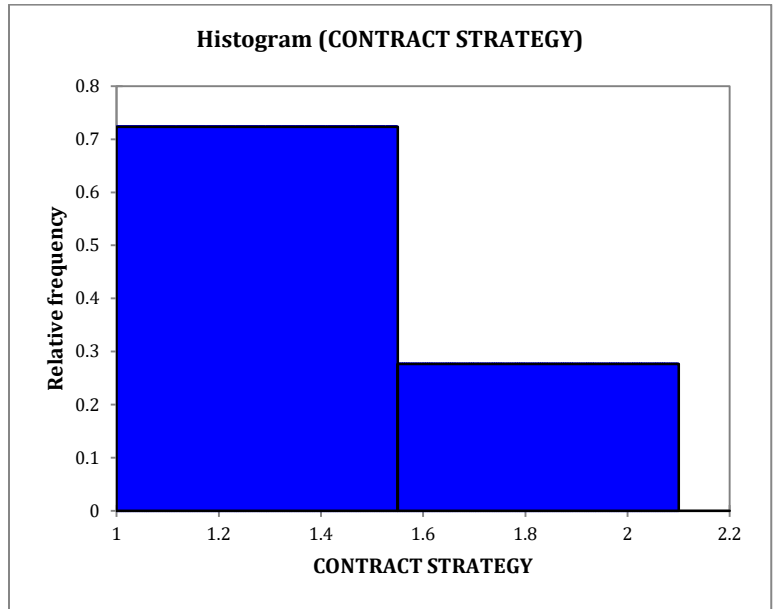
Contract Strategy

1. Competitive
2. Sole Source

Figure A4: SMC Simulated Contract Strategy

For both data sets, competitive strategy had the most occurrences followed by Sole Sources. Our data set had one unknown occurrence while SMC did not have any unknown occurrences in their data set.

Figure A5: SMC Contract Type

Histogram (CONTRACT TYPE)
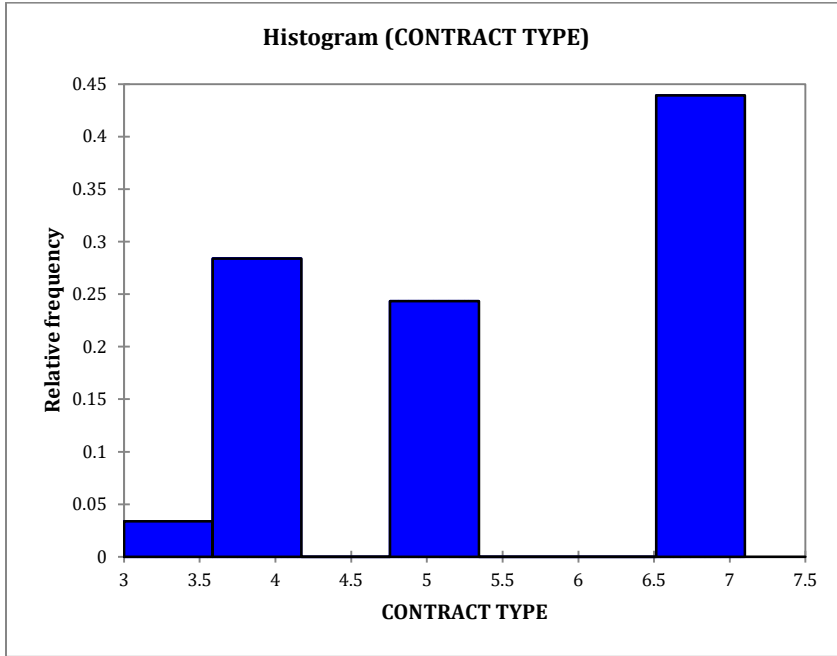
Contract Type

1. Cost Plus
2. Cost Plus Fixed Fee
3. Cost Plus Incentive Fee
4. Firm Fixed Price
5. Fixed Price
6. Fixed Price Incentive Fee
7. Indefinite Delivery, Indefinite Quantity

In this category occurrences were the most different between data analyzed by SMC and the data provided for this research. In the SMC data, Indefinite Delivery and Indefinite Quantity had the most occurrences while there were none provided in our data set. There were also no Cost Plus Fixed Fee, Fixed Price or Fixed Price Incentive occurrences in the SMC data set.

Figure B1: Sample of Raw Data

Status	Program	ACAT / Svs Cat	Type (Competitive or Sole Source)	Dominant Contract Strategy: Fixed Price (FP) / Cost Reimb (CR)	AS Kickoff/ Go-Ahead (KO)	ESIS	ASP (Pre-ASP for ACAT I) ACTUAL / CURRENT FORECAST	ASD/Plan Sign-off by PEO ACTUAL / CURRENT FORECAST	RFP Release ACTUAL / CURRENT FORECAST	Projected Contract Award Dates ACTUAL / CURRENT FORECAST
Completed/Awarded	Program #1	ACAT ID	Competitive	FFP	N/A	N/A	5/30/17	Waived	6/29/17	3/14/18
Completed/Awarded	Program #2	Not Determined	Competitive	CPFF	N/A	3/30/16	Waived	4/21/16	11/4/16	2/22/18
Completed/Awarded	Program #3	SCAT IV	Competitive	CPFF		Waived	8/15/17	Waived	10/25/17	2/8/18
Completed/Awarded	Program #4	SCAT IV	Competitive	BAA - FFP/CPFF	TBD	N/A	3/3/17	Waived	5/22/17	12/19/17
Completed/Awarded	Program #5	ACAT IC	Competitive	FFP	N/A	9/2/16	Waived	10/18/16	1/24/17	11/9/17
Completed/Awarded	Program #6	Project	Competitive	FFP	6/10/15	9/3/15	1/23/17	Waived	7/12/17	11/9/17
Completed/Awarded	Program #7	ACAT III	Competitive	FFP/CPFF		Waived	12/12/16	Waived	4/24/17	10/30/17
Completed/Awarded	Program #8	ACAT ID	Competitive	FFP	N/A	12/18/15	1/14/16	Waived	9/29/16	6/29/17
Completed/Awarded	Program #9	SCAT II	Competitive	FFP/CPFF	6/15/15	12/22/15	Waived	7/28/16	2/10/17	4/28/17
Completed/Awarded	Program #10	SCAT III (SCAT V)	Competitive	FFP	10/17/16	12/1/16	N/A	N/A	12/16/16	3/31/17
Completed/Awarded	Program #11	ACAT ID	Competitive	FFP	N/A	12/18/15	5/9/16	Waived	8/3/16	3/14/17

Appendix C

Table C1: Summarized Research Variables

Variable	Source	Type	Description
Program	Given	Categorical	Program that is being evaluated
Category	Given	Categorical	Service/Acquisition Category or Tech
Category I	Given	Binary	Service and Acquisition Category I programs given a value of 1. All other programs given a value of 0
Service Category I	Given	Binary	Service Category I programs given a value of 1. All other programs given a value of 0
Contract Type	Given	Categorical	i.e. Competitive/Sole Source Contract, Other Transaction Authority
Competitive	Given	Binary	Competitive programs given a value of 1. All other programs given a value of 0
Sole Source	Given	Binary	Sole Source programs given a value of 1. All other programs given a value of 0
Contract Strategy	Given	Categorical	Dominate Contract Strategy i.e FFP, CPIF, CPFF
FFP Only	Given	Binary	Only FFP programs given a value of 1. All other programs given a value of 0
Any Cost Plus	Given	Binary	Any programs with Cost Plus are given a value of 1. All other programs given a value of 0
Waived ASP	Given	Binary	DV for MILCON cost estimate value from last reported SAR of < $10M and < $50M
Waived ASD	Given	Continuous	Program cost estimate value from last reported SAR in Fiscal Year 2018 unit of millions
Phase A Days	Derived	Binary	Number of days between Kickoff and ESIS stage
Phase A 1st Quartile	Derived	Continuous	The time a Phase A program spends in the first quartile in relation to other programs.
Phase A 2nd Quartile	Derived	Continuous	The time a Phase A program spends in the second quartile in relation to other programs.
Phase A 3rd Quartile			The time a Phase A program spends in the third quartile in relation to other programs.
Phase B Days	Derived	Continuous	Number of Days between ESIS stage and ASP stage
Phase B 1st Quartile	Derived	Continuous	The time a Phase B program spends in the first quartile in relation to other programs.
Phase B 2nd Quartile	Derived	Continuous	The time a Phase B program spends in the second quartile in relation to other programs.
Phase B 3rd Quartile			The time a Phase B program spends in the third quartile in relation to other programs.
Phase C Days	Derived	Continuous	Number of Days between ASP stage and ASD stage
Phase C 1st Quartile	Derived	Continuous	The time a Phase C program spends in the first quartile in relation to other programs.
Phase C 2nd Quartile	Derived	Continuous	The time a Phase C program spends in the second quartile in relation to other programs.
Phase C 3rd Quartile			The time a Phase C program spends in the third quartile in relation to other programs.
Phase D Days	Derived	Continuous	Number of Days between ASD stage and RFP stage
Phase D 1st Quartile	Derived	Continuous	The time a Phase D program spends in the first quartile in relation to other programs.
Phase D 2nd Quartile	Derived	Continuous	The time a Phase D program spends in the second quartile in relation to other programs.
Phase D 3rd Quartile	Derived	Continuous	The time a Phase D program spends in the third quartile in relation to other programs.

Bibliography

Carter, A.B. (2010) Office of the Under Secretary of Defense. Better Buying Power: Guidance for Obtaining Greater Efficiency and Productivity in Defense Spending. Retrieved from https://www.acq.osd.mil/fo/docs/USD_ATL_Guidance_Memo_September_14_20 10_FINAL.PDF

Defense Acquisition University (DAU). (2018). Acquisition Category (ACAT). Retrieved from https://www.dau.mil/acquipedia/Pages/ArticleDetails.aspx?aid=a896cb8a-92ad-41f1-b85a-dd1cb4abdc82

Defense Acquisition University (DAU). (2017). Business and Enterprise Systems (BES) Process Directory – BPD. 21 July 2018.

Department of Defense Instruction (DoDI). (2007). The Defense Acquisition System 5000. Retrieved from http://acqnotes.com/wp-content/uploads/2014/09/DoD-Instruction-5000.02-The-Defense-Acquisition-System-10-Aug-17-Change-3.pdf

Fanning, E.K. (2014). Air Force Annual Report on the Acquisition of Services. Office of the Under Secretary of Defense for Acquisition, Technology and Logistics https://www.acq.osd.mil/dpap/sa/docs/learnmore/Services_Annual_Report_2013_-_Air_Force_-_11Feb2014.pdf

Kendall, F. (2015). Office of the Under Secretary of Defense. Implementation Direcive for Better Buying Power 3.0 – Achieving Dominant Capabilities through Techinical Excellence and Innovation. Retrieved from https://www.acq.osd.mil/fo/docs/betterbuyingpower3.0(9apr15).pdf

Kozlak, S.J. (2016). Predicting Cost Growth Using Program Reviews and Milestones for DoD Aircraft. (Unpublished Master's Thesis).

McDonald, J.H. (2009). *Handbook of Biological Statistics* (2nd ed.) Sparky House Publishing, Baltimore, Maryland.

Rodriguez, Y. (2016). *Space and Missile System Centers: Predictive Study using Multiple Regression for the Interdependencies of characteristics leading to Contract Award*. Unpublished manuscript.

The Office of the Under Secretary of Defense for Acquisition, Technology and Logistics. (2013). Air Force Annual Report on Acquisition. Retrieved from https://www.acq.osd.mil/dpap/sa/docs/learnmore/Services_Annual_Report_2013_-_Air_Force_-_11Feb2014.pdf

REPORT DOCUMENTATION PAGE

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From – To)*
21 Mar 2019	Master's Thesis	21 Aug 2017- 21 Mar 2019

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Investigating Schedule Length of Space and Missile Systems Center Contracts	
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
Bradley, Jr., Loyd A., Captain, USAF	N/A
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S)	8. PERFORMING ORGANIZATION REPORT NUMBER
Air Force Institute of Technology Graduate School of Engineering and Management (AFIT/EN) 2950 Hobson Way, Building 640 WPAFB OH 45433	AFIT-ENV-MS-19-M-164

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
Barbara J. Baker, Division Chief, Acquisitions Center of Excellence Space and Missile Systems Center Los Angeles AFB, CA 90245 COMM: 310-653-1534 DSN: 633-1534 Email: Barbara.baker.3@us.af.mil	SMC/PID
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for Public Release; Distribution Unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

Acquisition reform has long been the goal of the Department of Defense to save, recover and redistribute funds in an efficient manner. The Space and Missile Systems Center Program Management and Integration Directorate (SMC/PI) and Acquisitions Center of Excellence (ACE) have shared the same effort and have made strides to better their acquisition processes. Many different angles have been examined to try to discover cost and schedule growth however, little research has been done to find the drivers of schedule length. This research is aimed at finding contributing factors to the length of schedule of the pre-acquisition process. By using Fisher's Exact test and contingency table analysis programs were explored to find what factors contribute to the length of schedule. The results of this analysis show significance can be found in the contract's type, strategy and the phases in which a program is in. Additionally, the research shows significance with programs that waive stages.

15. SUBJECT TERMS
Pre-Acquisition Process, Schedule Length, Fisher's Exact Test, Contingency Tables

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
					Edward D. White, AFIT/ENC
a. REPORT	b. ABSTRACT	c. THIS PAGE	UU	70	19b. TELEPHONE NUMBER *(Include area code)*
U	U	U			(937) 255-3636, x 4540 (edward.white@afit.edu)