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Analysis of Pollution Prevention Business Case Analyses

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ANALYSIS OF POLLUTION PREVENTION BUSINESS CASE ANALYSES

THESIS

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Abstract

The purpose of this research is to improve the Business Case Analysis (BCA) process in the context of pollution prevention. The research will inform guidance, training, and policy recommendations. Using grounded theory methods allowed us to gather qualitative data directly from participants actively involved in pollution prevention projects. In addition to answering several research questions, the results of the research informed the design of a tool to help government and contractor personnel agree on what constitutes a high-quality BCA. This research has implications for DoD decision making and future research studies in environmental cost analysis.

Dedication

I would first like to thank my friends and family for getting me through everything from school to the pandemic. You know who you are and I appreciate you and thank you for everything you have done for me. To my research advisor, Dr. Robert D Fass, for his valuable guidance, words of encouragement, and mentorship throughout this process. I truly enjoyed working with you and I could not have completed this milestone without you. I would also like to thank my committee members, Dr. Jonathan D. Ritschel and Colonel Robert M. Eninger for their expertise and advice. To my girlfriend thank you for being incredibly supportive especially through the rollercoaster of 2020. I would not have made it this far without your love, encouragement, and keen eye for details. You pushed me to be my best ever since the beginning and I truly appreciate it, thank you.

Erwin A. Spencer Jr.

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I. Introduction

1.1 Background

The Acquisition Environmental Integration Branch (AEIB) provides support to the Air Force Life Cycle Management Center's weapon system programs by implementing environmental considerations into the systems engineering processes, ensuring compliance in accordance to environmental laws set forth by the Environmental Protection Agency (EPA), and pursuing cost saving, environmentally-friendly processes and technology. The AEIB is tasked with monitoring various weapons systems within the Air Force and identifying ways to reduce negative environmental impacts associated with weapon systems production and sustainment.

The AEIB is comprised of environmental experts and engineers. While they are able to ascertain that contractors are meeting the requirements of contracts, they do not have the financial expertise needed to conduct a business case analysis, which leads to the content within a contract. A business case analysis is critical in ensuring the Air Force is getting the best possible value out of the contracts.

"A Business Case Analysis (BCA) provides a best-value analysis that considers not only cost, but other quantifiable and non-quantifiable factors supporting an investment decision" (DoD, 2017). BCA best practices can help improve the efficiency (CDC, 2019) and confidence of the content within all contracts moving forward.

The Pollution Prevention Act of 1990 was enacted to increase interest in pollution reduction and prevention and source reduction in America through economical changes in production, operation, and choice of raw materials. It is the United States' policy that pollution prevention and reduction should begin with its source when possible. If pollution is inevitable, waste should be recycled in an environmentally safe manner. When it cannot be recycled, then environmentally safe measures should be taken to treat the waste. Opportunities for source reduction are often unrealized due to limitations imposed by prevailing regulations, industrial resources, and an industry emphasis on treatment and disposal. Methods of source reduction include modifications to equipment, technology, or procedure, reformulation or redesign of products, or improvements to maintenance, organization, training, inventory, or cleaning.

In order to better allocate funds, it is important that the Air Force find cost-saving measures in every aspect of its operations. It is no less a priority when it comes to the AEIB when looking to improve environmental protections when managing Air Force weapons systems.

1.2 Problem Statement

There are two purposes to this research. The first is to explore, clarify, and improve the BCA process for pollution prevention projects. This research will help the AEIB in the future when a new project is received and a BCA is created or the review of the BCA is done. When finished with the research, the AEIB will be able to determine the true cost savings from the various pollution prevention actions taken. With all of the

information provided, the AEIB will not only have a better understanding but knowledge that will be shared throughout the Department of Defense.

The second purpose of this research is to conduct a thorough review of the current best practices for BCAs and make policy recommendations based on them for the DoD. From this research, the AEIB will be able to ensure best practices are being implemented when engaging with projects. These best practices will further strengthen the knowledge of the AEIB when future systems are being tasked for maintaining or disposal. With enough analysis of the above-mentioned procedures there is hope for implementation for not only future AEIB projects but for projects throughout the Air Force as well.

1.3 Research Objectives/Questions/Hypotheses

1. How can business case analyses for pollution prevention be designed to meet the government's needs?
2. To what extent do current business case analyses for pollution prevention projects meet regulatory guidance?
3. To what extent do business case analyses for pollution prevention projects follow best practices?
4. What potential policy changes would improve business case analyses for pollution prevention?

1.4 Methodology

A thorough analysis was conducted from the data provided by the Acquisition Environmental Integration Branch (AEIB). The AEIB provided previously recorded Business Case Analyses (BCAs) and Cost Benefit Analyses (CBAs). Additionally, ten members of the AEIB were interviewed which provided historical context on how BCAs are typically handled in the office.

The Grounded Theory Method was the key method used to populate a group consensus or opinion based on the interviews. Once all the interviews were conducted, the responses were aggregated. These responses were used to create a table of themes and codes to capture the underlying problem. The process is meant to generate the group's true consensus.

This research may help to enable the AEIB and other DoD offices to better assess the BCAs they receive or create in house. This research will impact the way the DoD, the Air Force, and the AEIB handle future evolving regulations and environmental concerns.

1.5 Scope/Limitations

Two primary factors impacted the scope and depth at which this research could explore. One limitation was the inability to evaluate all aspects of the lifecycle cost. This report only covers the early stages of a project or proposal; more specifically, it impacts the evaluation of proposals and reward of contracts. The operations and support portion will not be within the scope of this research. The following research is meant to be a building block for future research conducted on the operations and support portions of the lifecycle cost.

Furthermore, there is a limited number of BCAs and CBAs available through the AEIB impacted the level of accuracy of the analysis. This is an area that will grow further in the future and could allow for more accurate research.

II. Literature Review

2.1 Chapter Overview

The DoD has numerous continuous improvement processes in place for the acquisitions of weapons and systems. These processes have been adapted over time to comply with new laws and regulations. The Acquisition Environmental Integration Branch's main role is to manage and oversee these processes being enacted. In recent years, they have been challenged with prolonging the lifespan of aging aircraft in a bid to control costs or find environmentally friendly methods of disposing with the last generation's fleet of aerial systems. The difficulty of this task is compounded by today's heightened global environmental awareness and more rigorous regulatory standards from the Environmental Protection Agency and the Occupational Safety and Health Administration.

2.2 Regulations

There are several regulations to note when understanding what processes must be involved when disposing or replacing parts of dated aerial systems. Executive Order 13423 regulates Hexavalent Chromium. Hexavalent Chromium is used for electroplating, welding, and chromate painting (CDC, 2019). Hexavalent Chromium is highly toxic and exposure can cause risk to personnel's health (Verma & Balomajumder, 2020). The Molecular Medicine Reports states that the toxic element can be released into the environment through the soil, sea water, fresh water, and even drinking water. Studies of

the negative health effects range from acute to chronic. One study showed significant renal deterioration which then resulted in the use of hemodialysis (Wu, et al., 2019).

The AEIB is aiming to find an environmentally friendly alternative to hexavalent chromium while keeping it cost effective. They are working against budget constraints while adhering to numerous regulations designed to keep workers and the environment safe:

> It is DoD policy to minimize hexavalent chromium (an anti-corrosive) in items acquired by DoD (deliverables and construction material), due to the serious human health and environmental risks related to its use. Executive Order 13423, section 3, paragraph (a) requires that the heads of agencies reduce or eliminate the acquisition and use of toxic or hazardous chemicals. Executive Order 13514 requires that the heads of agencies are responsible for reducing and minimizing the quantity of toxic and hazardous chemicals and materials acquired, used, or disposed of (acq.osd.mil).

Another important act to note is the Clean Air Act (CAA). It was created to establish regulations over air pollution. It was enacted to allow the National Ambient Air Quality Standards (NAAQS) to be enforced. It ensures the protection of the public. Nellis AFB in Nevada began implementing the Employee-vehicle Certification and Reporting System. This came in response to a particular section of the Clean Air Act stating "118 (d), privately-owned vehicles operated by federal employees on federal facilities be in compliance with the emission standards for the vehicle inspection and maintenance

program area wherein the federal installation as a way to keep the environment safe" (nellis.af.mil, 2014).

To help regulate the importation, production, and disposal of chemicals such as polychlorinated biphenyls (PCBs), asbestos and hexavalent chromium, the Toxic Substance Control Act (TSCA) was created in 1976. It gave the Environmental Protection Agency (EPA) authority to lay out rules and regulations when handling various chemicals. In 2016, the TSCA was amended by the Lautenberg Act to give the EPA even more responsibility and more power. These changes gave the EPA more responsibility to review new chemicals and implement the risk determination process. Nevertheless, the "Defense Department (DOD) has not provided specific guidance on the identification and replacement of PCB items, each service has been free to establish its own program" (gov.info.gov).

Due to the environmental and health risks from events such as the Gold King Mine spill, Congress passed the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (Holmes, 2019). This Comprehensive Environmental Response and Liability Act has three parts. The first is meant to retroactively remedy all of the damages that have previously been done. The second part of this act encourages a timely cleanup and places the responsibility for the costs of the cleanup onto those that were responsible for the contamination. Lastly, safe handling of hazardous materials and waste was encouraged to prevent future events from occurring. Hundreds of millions of dollars are allocated for cleanups by the EPA. The allocated amount of funding is

estimated to be less than what is actually needed, which the CLERCLA is supposed to help with by holding all parties present and past responsible for the contamination. This gives more power to the EPA in terms of who and how to deal with all parties responsible for the contamination.

2.3 Economic Analysis to Comparative Analysis

Economic analysis is a painstaking endeavor. “Proper use of the economic analysis approach yields an impartial comparison of competing alternatives to achieve the objective by weighing the costs, benefits, and uncertainties (including risks) for each alternative” (AFMAN65-501, 2018, p. 3). There are multiple studies of cost and benefits such as business case analysis, cost benefit analysis, and analysis of alternatives. Formerly, these all fell under the umbrella of “Economic Analysis”, but now they are referred to as “Comparative Analysis” as shown in Figure 1. When making resource decisions, comparative analysis is used to better inform decision makers. As resources become scarce, the importance of a comparative analysis becomes clearer. A comparative analysis is able to display all of the costs and benefits of competing systems or alternatives.

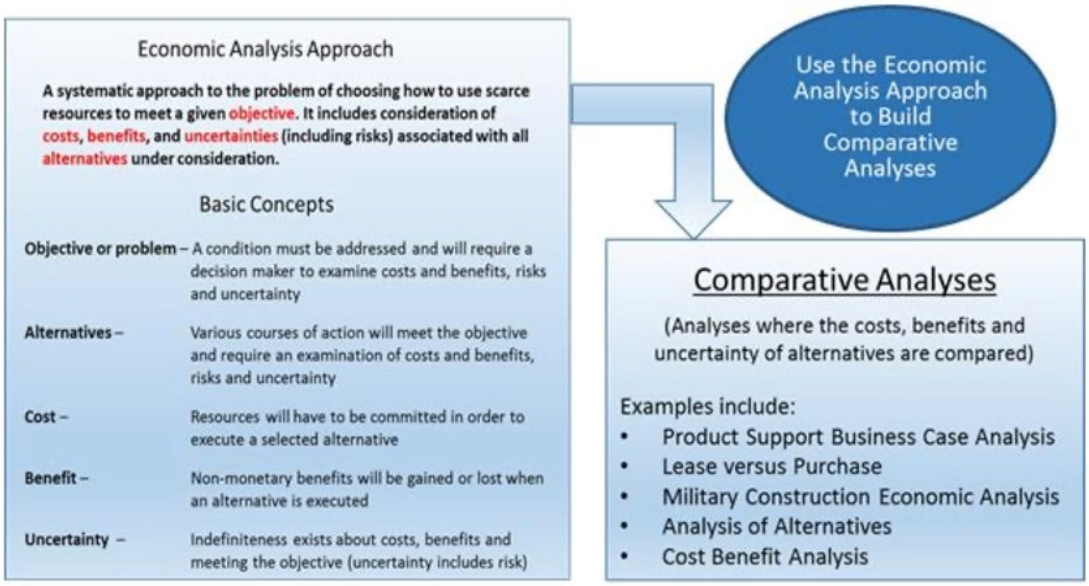

Figure 1: Economic Analysis Approach and Comparative Analysis (Air Force Instruction 65-501, 2019)

There is not one single "way" that comparative analysis can be done for all systems. Rather, "analysis will require a tailored approach to fit the project." (AFMAN65-506, 2019, p. 8). All of the basic elements of a comparative analysis need to be included. Each of these sections should be tailored to meet the needs of the analysis. Some sections will be more in depth than others.

Each section of the comparative analysis has unique elements. The *background* should be used to inform decision makers on the process and how this will impact current operations. It is where the foundation is created for further analysis because without a strong foundation all of the analysis moving forward can be difficult. This is where the root cause will be brought to the forefront. After discovering this as well as the key performance indicators, a plan can be established to move forward for completing the analysis. The *assumptions* that are indicated will help ensure defensible conclusions

further in the analysis. “Assumptions are key parameters where the values and circumstances must be estimated because reliable knowledge is lacking. Without assumptions, analytical models would not be able to produce useful conclusions.” (AFMAN 65-506, 2019, p.8). The *alternatives* are represented two different ways, the status quo or non-status quo. This means either the current state of affairs within a project will be kept and the project moves forward, or the project takes the route of non-status quo and the analysis goes in another direction. The latter is what is expected, but is not always the case after a comparative analysis is officially conducted. The *cost, benefit, sensitivity, and risk analysis* are all separate but intertwined depending on the project. *Cost analysis* takes into account costs, savings, and even revenue in respect to each alternative. *Benefit analysis,* unlike cost analysis, deals with the non-monetary attributes of the alternatives put forth. *Sensitivity analysis* helps to show the results when the variables are tested on each alternative. The two types of *risk analysis* are quantitative or qualitative. Based on the type of data being analyzed, both types of risk analysis may be required. The final section is the *summary and comparison of alternatives*. This is where all of the analysis and research yields results and a decision is made to either move forward with the status quo or one of the alternatives proposed (AFMAN 65-506, 2019, p. 9).

2.4 Business Case Quality Framework

The healthcare industry is required to constantly develop ways to allocate constrained resources. England’s National Health Service (NHS) faced this problem and

developed a method to evaluate business cases in the context of health care. The overall goal was to create a framework that had objectives that were Specific, Measurable, Achievable, Realistic, and Timely (SMART). Figure 2 illustrates the seven quality indicators that were created. When glancing at the framework no sequential order is prevalent, which was done on purpose because according to Linton et al. "the 'purpose' of a proposed change in practice should be clear throughout a business case, not simply at the beginning" (Linton, Coast, Williams, Copping, & Owen-Smith, 2019, p. 6).

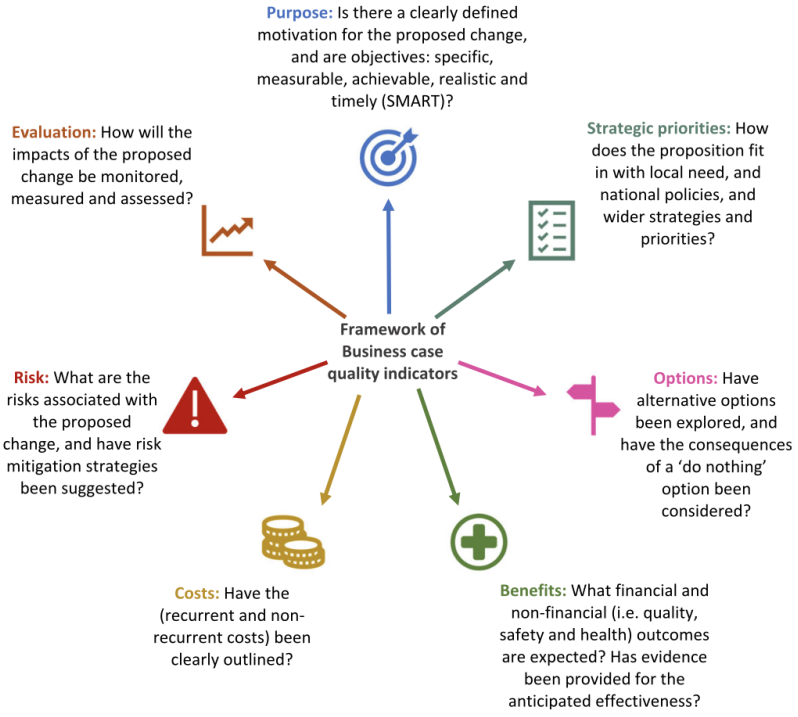

Figure 2 Framework of Business Case Quality Indicators (Linton, Coast, Williams, Copping, & Owen-Smith, 2019)

2.5 The Grounded Theory Method

The Grounded Theory method was used to inform this research. According to Joseph A Maxwell, qualitative research should not be as restrictive as more traditional forms of research (Maxwell, 2012). Grounded Theory allows researchers to venture outside of the traditional research of empirical data. The most important element to the less strict research method is theoretical sampling. Theoretical sampling is defined as "the process of data collection for generating theory whereby the analyst jointly collects, codes, and analyzes his data and decides what data to collect next and where to find them, in order to develop his theory as it emerges" (Glaser & Strauss, 1967). Using this method will allow a researcher to develop common themes and trends. This process ultimately helps the researcher go in a certain direction based off of the data gathered.

2.6 Hexavalent Chromium

Numerous studies have shown the harmful effects of hexavalent chromium on personnel. The Molecular Medicine Reports states that the toxic element can be released into the environment through the soil, sea water, fresh water, and even drinking water. Studies of the negative health effects range from acute to chronic. One study showed significant renal deterioration which then resulted in the use of hemodialysis (Wu, et al., 2019).

2.7 Human Wealth

Bargouthi & Mariegive (2016) insight about the human wealth aspect and it's importance. Damage by hexavalent chromium impacts human health if it is inhaled or

ingested. These damages can be tracked one of two ways using the wealth approach, direct and indirect. Direct damages from the pollution are represented by the cost of medical treatment, decrease in income, loss of productivity, and even loss of life. Indirect damages are represented through the extent of damages in human wealth from decreased agricultural production well as livestock (Barghouthi & Marie, 2016). This is important to note because not only do hazardous material affect an individual's health but can also be tracked to hurting individuals financially. These costs are not only a burden to the individuals but to the organizations' footing the bill.

The Army has created a way to estimate the rough cost of medical treatments for individuals through the Medical Cost Avoidance Model (MCAM). It is a tool that can be utilized by prevention program developers in order to track medical expenses with specific diagnoses and procedures associated with hospitals within the United States. MCAM created a cost model (Equation *(1)*) and each of the five components are explained through Figure 3:

$$C_t = C_c + C_h + C_l + C_f + C_d \qquad (1)$$

Cost Component	Definition	Description
C_c	Clinic cost	Outpatient treatment
C_h	Hospital cost	Inpatient treatment
C_l	Lost time cost	Time away from work due to clinic visits, hospital stays, assignment to quarters, convalescent leave, and the limited ability to perform.
C_f	Fatality cost	Insurance and gratuity pay
C_d	Disability cost	VA compensation disability

Figure 3: The MCAM Medical Cost Components, Definitions, and Descriptions (AMEDD Journal, 2014)

The medical treatment which consists of clinic and hospital costs calculates the average cost per diagnoses based on stays at the hospital or clinic visits. The lost time cost calculates the time away from work based on hospital stays or clinic visits, directed quarters, convalescent leave, and even limited ability of work. The fourth cost is fatality cost, which was calculated using the insurance and gratuity pay for military service members. The final factor within the equation is disability costs through Veterans Affairs (VA). This was determined by the amount paid to Veterans monthly for permanent disabilities.

2 .8 Business Continuity Management

Business Case Analyses (BCAs) are an aid to help decision makers compare the business impacts, risks, and sensitivities. Business Continuity Management (BCM) is used to identify internal and external threats and risks, and the potential impact to the business at hand (Torabi, Soufi, & Sahebjamnia, 2014). The definition given by the International Organization for Standards is,

> Holistic management process that identifies potential threats to an organization and the impacts to business operations those threats, if realized, might cause, and which provides a framework for building organizational resilience with the capability of an effective response that safeguards the interests of its key stakeholders, reputation, brand and value-creating activities (Torabi, Soufi, & Sahebjamnia, 2014, p. 310)

The six elements included within a BCM is are illustrated in Figure 4. This process can ensure a comprehensive understanding of an organization and their most important processes. This understanding ensures the BCM program is established according to their objectives.

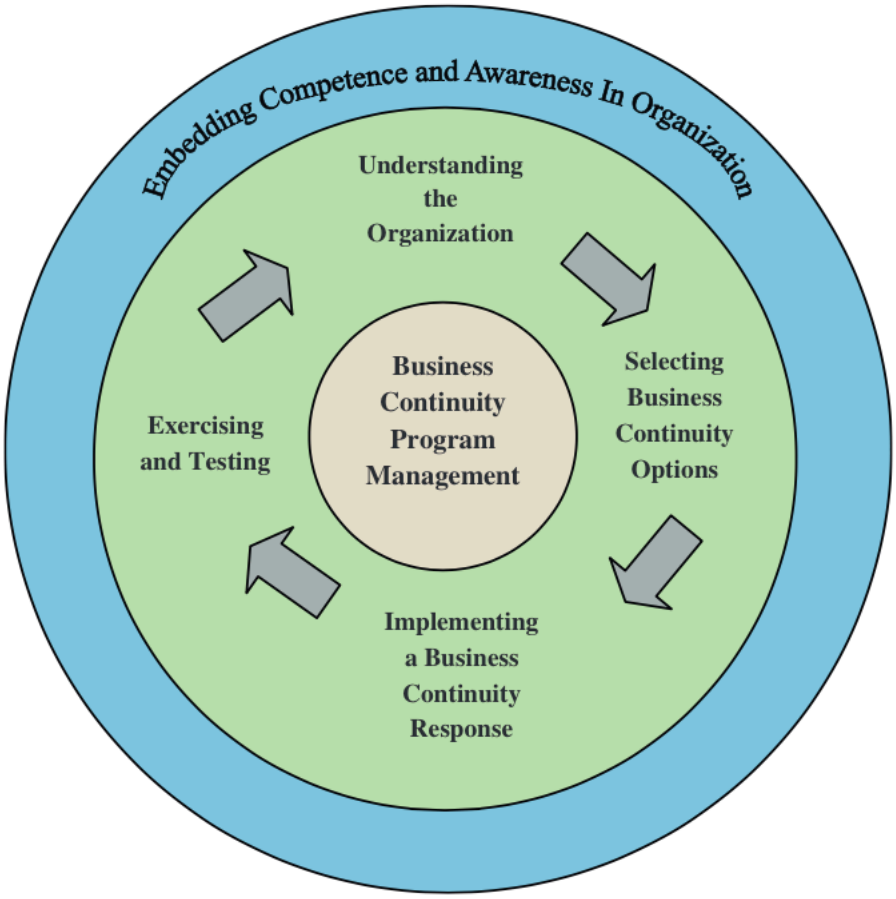

Figure 4: The lifecycle of a Business Continuity Management (Torabi, Soufi, & Sahebjamnia, 2014)

2.9 PS-BCA Guidebook

Business Case Analysis does not have its own DoD guidebook but there was one created in 2011 specifically for Product Support Business Case Analyses (PS-BCA). Many of the elements within this guidebook can be useful for all BCAs BCAs according to this guidebook are a structured methodology that aids decision makers in a way that compares all alternatives. They also examine the mission and business which consist of financial and non-financial impacts. There are risks and sensitivity assessments that are examined through BCAs as well. This is different from decision support analysis because

of the breadth of information it takes into account with stakeholders and decision makers, and the holistic assessment of the effects from the decision made. A BCA gives the decision maker an analytic, standardized, and objective foundation on which dependable decisions can occur. The components that are seen within the PS-BCA can be viewed within Figure 5 and explanation of each component can be located in Table 1.

Figure 5: BCA Element Components (DoD Product Support Business Case Analysis Guidebook, 2011)

Table 1

Business Case Analysis Components

Component	Definition
Executive Summary	This section summarizes the mission and business impacts, risks, and sensitivities. The executive summary also addresses other important sections to help with understanding the BCA moving forward.
Introduction	The introduction lays out the background and reasoning for conducting a PS-BCA. This section also brings to light the issue at hand that's being supported by the analysis. The problem statement falls under this section which should include an objective description of the desired outcome. A clear and concise problem statement can be a useful reference to come back to throughout the research.
Assumptions and Methods	This is where the assumptions and methodology used throughout the analysis will be. These two assumptions should be explored early within the research.
Alternatives	Alternatives are important when deciding if sticking with the status quo will suffice for the mission or opting for the new system being presented. It is important for this section to remain unbiased to truly see the best option possible.
Risk and Sensitivity Analysis	Risk analysis is done to establish the risks and the plan for mitigation. Sensitivity analysis is done to obtain different values for the repetitions done for the analysis. These results are then compared and the effects of costs and benefits sensitivity to change are documented.
Conclusion, Recommendations, and Implementation	These three sections are all connected and help with bringing the analysis to a close. The conclusion helps to compare the baseline to all the alternatives presented. This will allow for a clear recommendation or even an explanation for further research. The recommendation and implementation are both based on the best business decision moving forward. It is a balancing act of mission impact and cost effectiveness.
Summary	This specific section allows for an insight on the Product Support Business Case Analysis guidebook. This guidebook is geared towards Product Support but it can be applied when conducting smaller scale BCAs. The PS-BCA guidebook has plenty of useful information that can be transposed onto a BCA. Having a stand-alone guidebook for BCAs in theory should help with the submission of "good" BCAs. This would then in theory help the DoD with more effective ways of spending tax dollars.

III. Methodology

3.1 Chapter Overview

One of the purposes of this research is to explore, clarify, and improve the BCA process for pollution prevention projects. This chapter discusses the origin of the data and clarifies the approach selected to assess the data. The qualitative data was retrieved through ten interviews of personnel from various offices with experience ranging from one year to 15 years or more. These interviews allow for detailed insight in their processes in dealing with Business Case Analyses (BCA). This chapter will provide a detailed explanation of the grounded theory method used. The chapter will also go into detail and explain the data set, sources, and how all of the data was prepared for proper use.

3.2 Grounded Theory

The Grounded Theory method is a way to develop a theory, framework, or model by analyzing data in an exploratory manner. The theory emerges from the relationship with the data collection and data (Goulding, 2002). Figure 6 displays the grounded theory framework for a visual representation. Ground Theory allows the researcher to find commonalities within the gathered data. The design of Grounded Theory works with finding the "why." It identifies the significance of the research. The first step in grounded theory is to gather valid data to be able to process and code (see Table 2 for a coding example). The question the researchers used was "How can business case analyses for pollution prevention be designed to meet the government's needs?"

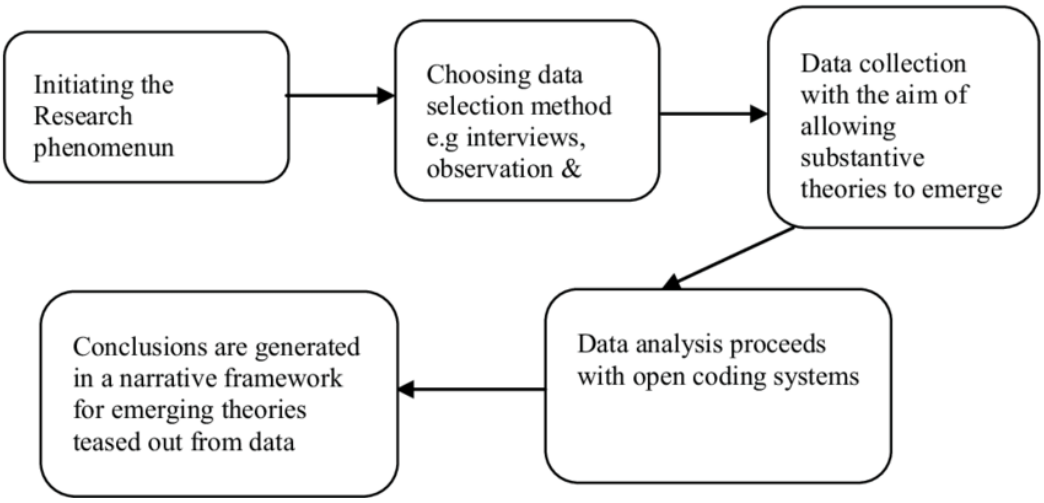

Figure 6: A Schematic Framework of Grounded Theory (Glaser, Strauss 1967)

The participants in this research were from various program offices within Wright Patterson Air Force Base (WPAFB) that have worked with BCAs or the Acquisition Environmental Integration Branch (AEIB). Sourcing from various offices provided a range of current employees with differing experiences, including some that have moved between multiple departments. This allowed for diversified insight on processes and procedures between different branches. After analyzing all of the interviews, there were several themes that emerged which will be discussed in depth in the Analysis and Results section. Table 2 illustrates an example of how the data was gathered and coded for each question and helps to visualize how the grounded theory method was implemented.

Table 2

Grounded Theory Coding Example

#	What reference or guidebook do you have for BCAs? Do you believe this guidance is sufficient?	Code	Subcode
22	The old office specifically for that document I know there's an Air Force manual in an Air Force instruction pull it up that is the basis I would hope my office uses that but I don't know so it's AFMAN 65-501 and then AFI 65 -506	Continuity	Guidance
23	Yeah are they sufficient have I read them no would I assume there's sufficient I mean at you typically if we're following AFI it's usually what we need so I would say I'm enlightened that it's an AFI and not just some random citation if that makes sense	Continuity	Guidance
1	I have nothing but they sent out a whole bunch of stuff over the last couple of days	Continuity	Guidance
4	When I was over there I don't remember seeing any type of guidance	Continuity	Guidance
7	I don't believe that we have a reference for a guidebook	Continuity	Guidance

3.3 Institutional Review Board

The research done contained human subjects which fell under the Institutional Review Board (IRB) according to the Protection of Human Subjects or 32 Code of Federal Regulations (CFR) part 219. This policy is in place to ensure all rights of the personnel involved with the research are protected. Such protections included anonymity to ensure no retaliation occurs from higher leadership or personnel within the company (32 CFR 219,.101, 2018). After further review the IRB was able to determine that the research had earned the exemption from human experimentation requirements this according to the policy located in 32 CFR 219. The exemption determination is included in Appendix A.

3.4 Cost Tool

The interviews helped inform the design of a BCA tool to better serve the contractors and government employees. The BCA tool iteratively improved with each interview that was recorded and analyzed. This tool serves as guidance for contractors to follow to ensure all criteria are met to the branches standard. It can be used for continuity purposes and for labeling BCAs and CBAs as excellent or poor. This may allow for more communication between the government employees and the contractors to alleviate miscommunication and misinterpretation. This weighted analysis tool may be able to fit any future projects with the adjustments of emphasis on one section or another.

Figure 7 shows one section that will be discussed to be calculated while Figure 8 provides the entire layout of the tool. How government personnel would complete the background section as show is to first determine the weights of each section which is based on the specific project and the importance of each section for that project. For step two the personnel would read the background and determine if it was complete, and if not, ask for more details and clarification. This step is repeated for each section to ensure the proper details are included. For step three, a score would be given for the background by the personnel based off of the rubric for scoring. The tool then calculates a weighted total. Step two and three would be repeated until all sections of the tool are filled out resulting in an overall weighted score. This score can then be used to determine a goodness of fit within the parameters set by the branch. At this point, any discrepancies between all parties can be settled until the score of the BCA/CBA is adequate enough for the branch.

Sections	Completed	Page # (s)	Weight(Percentage)	Score out of 10	Total	Why Not
Background: Is the purpose and motivation cearly defined for the proposed change and are the objectives SMART: Specific, Measurable, Achievable, Realistic, and Timely.	X		0.05	8	0.4	

Figure 7: Background Section BCA/CBA Tool

BCA/CBA Score						
Sections	Completed	Page # (s)	Weight(Percentage)	Score out of 10	Total	Why Not
Background: Is the purpose and motivation cearly defined for the proposed change and are the objectives SMART: Specific, Measurable, Achievable, Realistic, and Timely.	X		0.05	8	0.4	
Strategic Priorities: Does the analysis fit in with local need and national policies and regulations?	X		0.1	7	0.7	
Options: Have alternatives options have been explored and the "status quo" has been considered?			0.15	0	0	The alternative is the only route.
Evaluation: How the impact of the proposed changed will be monitored, measured and assessed has been explained?			0.1	0	0	**Still in the early stages of of evaluating**
Cost Analysis: Have the costs been analyzed and outlined?	X		0.2	8	1.6	
Benefit Analysis: Are the non-monetary attributes explained?	X		0.15	9	1.35	
Risk Analysis: Have the risks and mitigation strategies been properly analyzed?	X		0.2	5	1	
Summary: Have the results of the proposed change and status quo have been clearly defined?	X		0.05	6	0.3	
Additional Comments			1.00	43.0	5.4	

Figure 8: BCA/CBA Tool

3.5 Conclusion

This chapter presented the methodology that was used for this specific research. The results of these methods were used to provide a detailed analysis on the discrepancies between government expectations and contractor deliverables. The interviews conducted and the qualitative study conducted will be shown in the following chapter.

IV. Analysis and Results

4.1 Chapter Overview

The purpose of this chapter is to provide analysis results based on research questions and the methodology outlined in Chapter III. The interview questions will be presented along with responses from the personnel who participated in the interviews. These interviews as discussed in Chapter III were conducted between December 2020 and January 2021.

4.2 Quantitative Data

The Acquisition Environmental Integration Branch (AEIB) provided a collection of historical Business Case Analyses (BCA) received by previous contractors. However, given the limited number of cases available, this research cannot provide a holistic and accurate representation of BCAs. As a result, this research took a more qualitative study approach.

4.2 Qualitative Data

As discussed in the previous chapter, the interview process was semi-structured allowing for open ended conversation. Multiple personnel from within the AEIB had their answers recorded, transcribed, coded, and sub-coded by identifiable themes based on context from each interview. Interview responses were delineated into a total of 228 sentences. Table 3 lists the top-level themes that emerged and enumerates their reoccurrences. The top three concerns from the personnel were *Contracts*, *Costs*, and *Data*. *Costs* were defined as any statement indicating that personnel wanted to see a more

detailed cost breakdown with regards to total calculations presented in BCAs. *Contracts* were described by poorly written contracts that resulted in inadequate deliverables and communication breakdown. *Data* was identified as the lack of accessibility to information necessary for personnel to properly work. All personnel interviewed are former or current employees for the AEIB which provides the research with a breadth and depth of knowledge and experience levels.

Table 3

Top-Level Codes/Themes

Theme	*Total*
Contract	70
Costs	59
Data	31
Continuity	25
Teamwork	19
Program	24

4.3 Questions and Subcodes

Table 4 further breaks down the top-level codes into subcodes ordered from most to least frequently mentioned. Analyses of questions and subcodes aids in redesigning BCAs to meet government needs. *Details*, *Communication*, and *Guidance* were the three most repeated themes and sub codes within the research. Interviewees often wanted more details from the BCA and the contractors themselves. More *details* could have resulted in a more comprehensive product and given AEIB personnel better background information to aid in designing pollution prevention plans. Disconnect in *communication* was another

common theme mentioned. Frequent and clear communication could lead to more accurate deliverables and address unforeseen issues at their inception. The customer needs to be able to clearly voice their needs and the contractor needs to be able to fully understand what is being asked of them. *Guidance* is another key factor regarding BCAs. Without proper *guidance*, the proper language needed to garner the desired product will not be present.

Table 4

Subcodes

Subcode	*Total*
Details	84
Communication	38
Guidance	20
Technology	10
Savings	9
Time	9
Benefit	8
Knowledge	7
Minimum	7
ROI	5
Safety	5
Quality	4
Responsibility	4
Disclosure	3
Efficient	3
Impact	3
Schedule	3
Alternatives	2
PPE	2
Resources	2

Interview Questions Answered

Table 5

Responses Question 1 Sample

What do you think should be included in a Business Case Analysis (BCA) for your branch?		
Response	**Theme: Costs**	**Sub Code: Details**
you know you have just waste disposal costs, but the changes are with if this changes you know with protective gear those costs	8	8
not only the cost of the materials that we're replacing but it could be like labor hours associated		
Response	**Theme: Data**	**Sub Code: Safety**
from our reports they are very short I mean if some of that data is there, but I think we need more details you know I'm saying	2	4
I think we just need more details		
where those costs are coming from rather than it seems like a back of the napkin kind of thing		

Two major themes were quickly revealed at the beginning of the interviews. According to Table 5, eight personnel spoke of *costs* and two personnel spoke of *data*. *Costs* in this case were referring to various costs within a BCA that interviewees believe should exist. Examples include *personal protective equipment*, *cost risks*, and *expenditure* required to be compliant with various regulations. Based on responses given to question 1, it can be seen that existing BCAs do not comprehensively delineate all required *costs*. The second theme was data. With regards to data, the majority of responses correlated to how much data is or is not received in a BCA. Oftentimes, the interviewee would like significantly more data than what is provided. They believe the amount of data provided is insufficient to work with. This leads to the development of the sub-code *details*. As seen in Table 4, the *details* sub code has 84 of the 228 references.

This means it makes up over 37% of the sub codes total. The next most mentioned sub-code is *communication* with 38 of the 228 references. It accounts for 16% of the total sub codes. Table 6 explains why previous BCAs lacked sufficient *details*.

Table 6

Responses Question 2 Sample

What reference or guidebook do you have for BCAs? Do you believe this guidance is sufficient?		
Response	**Theme: Continuity**	**Sub Code: Guidance**
I don't remember seeing any type of guidance	15	13
I don't believe that we have a reference for a guidebook		
None		
So I don't think there was any specific guidebooks but it was basically you had to have a return of investment you know less than five years or so		
Response	**Theme: Costs**	**Sub Code: ROI**
a lot of program offices have their own cost reduction initiative	3	3
the way they calculated it was the money we put into it we had to generate a theoretical savings and then it had to come out to you know within five years		

The one response that stood out was "None." Personnel typically have no guidance or template to work with when it comes to creating a BCA. Lack of *continuity* was a common theme. Employees must start from scratch each time they are asked to create a BCA. All they have to reference is what is verbally shared with them. This was the third most common top-level code for any of the questions throughout the interview.

Another common theme was *costs*. Offices often come up with their own cost reduction initiatives and are written off as "better than nothing." When it came to *costs*, a five-year *ROI* was consistently referenced. It is assessed that the interviewees are referencing the AFPAM63-123 Section 1.4*, When to Conduct a PS-BCA which* states, "A revalidation of previous PS-BCAs is statutorily required if five years or more will span between milestones." The fact that this was the only portion of the AFPAM 63-123 specified could mean personnel simply read this section and passed it on via word of mouth.

Table 7

Responses Question 3 Sample

Are the BCAs you have seen complete? If not, what are they missing?		
Response	**Theme: Costs**	**Sub Code: Details**
We just don't know what goes behind the numbers	9	13
So they might give you the final results of a BCA like hey you're going to save 200 million dollars		
Response	**Theme: Data**	**Sub Code: Savings**
we don't see the data that goes into that number	8	5
Lack of details of how costs are calculated		

Costs were brought up again in question three. It was gathered that the majority of the coded themes came back to cost with data directly behind it. *Costs* include manpower,

travel, and cost savings. With regards to *data*, interviewees felt they were not receiving enough data required to sufficiently perform their duties. They wanted more *details* which resulted in a new sub code. Interviewees say, "we don't see the data that goes into that number." They reiterated that they were presented with a final number but were never provided a detailed breakdown of how those final numbers were calculated and what factors went into them. This led to an additional subcode, *savings*. The *savings* sub code relates to both *costs* and *data*. Interviewees were unable to see *savings* due to lack of data regarding *cost* breakdown.

While the next few questions are related to experiences when working with contractors, each question received differing responses. Table 8 will display challenges in relation to contractors, Table 9 will show frustrations felt by personnel, and Table 10 shares their views on products delivered from contractors. Finally, Table 11 will propose potential solutions to table 10 about how to rectify problems with deliverables received from contractors.

The main theme from question four was *costs*. Contractors often mismanaged their time or utilized miscalculated numbers. They would often not reveal that they were behind schedule until the last possible minute. Another recurring theme is *data*, or rather, the lack of *data*. Contractors would provide totals or final numbers, but would not delineate calculations and individual *costs*. Furthermore, a sub code of *communication* was created to categorize interviewee frustration over inefficient *communication* with contractors as they often failed to respond to questions in a timely manner. Through each interview it can be seen personnel are frustrated by these problems. Delays, lack of *detail*,

and poor *communication* all add additional *costs* that could have been managed had there been better *communication* and transparency.

Table 8

Responses Question 4 Sample

What are the challenges you face when it comes to contractors?		
Response	**Theme: Costs**	**Sub Code: Communication**
they don't want to answer questions because we don't we don't have a line item for them to charge against	9	5
towards the end you need an extension you know and it was you could almost predict it right for every project		
Response	**Theme: Data**	**Sub Code: Details**
Yeah I haven't done this in a little bit but yeah they're hesitant to share data	5	4
Between government and contractors we are unable to get data needed to make informed decisions		

Moreover, the frustration from the personnel is a result of poorly worded contracts and minimal effort placed into products that barely meet the requirements. Contracts are often misinterpreted by contractors. Program offices need to improve the wording of their written contracts, but are challenged by their limited financial backgrounds. This, coupled with poor *communication*, results in tense working relations between program offices and contractors. The sub codes of *communication* and *details* encompasses these frustrations. Historically, communication between government

personnel and contractors is either very tense or non-existent. The lack of *communication* results in key *details* not being shared further adding to the frustrations. This leads to the question of whether or not contractors deliver what is asked of them.

Table 9

Responses Question 5 Sample

Can you explain a time where you were frustrated with a contractor and the product they delivered or didn't deliver?		
Response	**Theme: Contract**	**Sub Code: Details**
government person has to be very very clear and concise in what we're asking for and what kind of products we're asking for from them to deliver	9	7
So I believe that they deliver the minimum that they can to be acceptable by the contract		
Response	**Theme: Data**	**Sub Code: Communication**
All of the data and information that we aren't able to get sometimes	5	6
just with the information that they will give us sometimes		

Several personnel have explained that contractors usually only deliver what was explicitly asked. They have no incentives to provide the best possible product. As seen in Table 10, *contract* is a main theme for the interview responses. It was coded 24 times or just over 10% of the total top-level codes. It is problematic that contractors only provide explicitly what is asked of them. If BCAs were conducted in house, any deliverables that

are missing would be accounted for or identified during the process. If BCAs are still contracted out due to its lengthy process, it is important that details be specific and comprehensive so as to provide everything that could possibly be necessary. As it stands, BCAs are suffering because details are not specific enough and contractors cannot be held accountable for what is not asked. Other problems that occur are miscommunication and misinterpretation of verbiage. *Details*, *communication*, and the *contracts* themselves are all areas that need to improve in order for a smooth flowing process for all parties involved.

Table 10

Responses Question 6 Sample

Do you believe that all contractors deliver what is asked from your office or the AF? Why or why not?		
Response	**Theme: Contract**	**Sub Code: Details**
In many cases what we said in the contract might be interpreted differently	24	13
Yeah it all goes back to like the contract language		
So there's two sides to this I think they try to most of the time deliver what is asked of them but sometimes I do feel there is miscommunication		**Sub Code: Communication**
Any discrepency is due to lack of details in RFP		10
So in my experience they deliver what asked for in the contract no more and no less		

Question seven allowed the personnel to give their own opinion on what they feel should occur in order to ease the frustration and allow for a smooth flow of communication. Two main themes of *contracts* and *teamwork* were evident according to Table 11. The personnel want more detailed products and efficient communication

between AEIB personnel and contractors. It is recommended that AEIB personnel clearly identify what they would like to see in the BCAs and CBAs they are contracting out as a team. They should then set up an initial meeting with their contractor to ensure their contract is interpreted properly. Furthermore, regular check-ins should be carried out to catch any miscommunications early on. A clearly written contract can not only greatly improve *teamwork*, but also enhance overall understanding on both sides. *Communication* is the biggest part of teamwork and necessary for establishing those relationships between contractors and government employees. The personnel interviewed want improved and frequent *communication* to avoid further miscommunications in the program life cycle.

Table 11

Responses Question 7 Sample

Is there something specific that your office or the AF should change to rectify this with the contractors?		
Respponse	**Theme: Contract**	**Sub Code: Details**
Like a technical review or whatever you want to call it between the contractor and the government to review every single line item in there to understand the intent and to interpret what is expected from either side	21	16
The contractor could read it in one way and we could read it totally different way so yeah we I think that we have to have that meeting and make sure that the contract is clear to everyone		
Response	**Theme: Teamwork**	**Sub Code: Communication**
there's some topics that I think if we had more regular interaction with the contractor we might improve getting what we want	5	11
Then communication wise something needs to be established better		

An inquiry on in-house BCAs was included to gain insight from personnel on whether or not they would be capable of conducting a BCA and whether or not they are necessary. Most agreed that they would be beneficial if done correctly and could be done if everything was available, especially if it made their jobs easier. Most wanted to be able to see the details of the numbers and where they originated. From a certain aspect, the interviewees believe revenue is more important to the contractors than accurately portraying the cost and benefits of pollution prevention to the government.

Table 12

Responses Question 8 Sample

Do you believe conducting in house (your office) BCAs would be beneficial? Why or why not?		
Response	**Theme: Program**	**Sub Code: Details**
Yes, if the resources with the expertise are available	13	7
I think it would be beneficial one is we would have independent verification of you know the process you know the algorithm behind the BCA it would be a government one that we could account for everything into		
Response	**Theme: Data**	**Sub Code: Benefit**
Yes I do, on two different levels one it'd give the project managers experience with doing it and too 'cause it will help validate the information that was given to us by the contractors	5	4
Having a look at where the numbers come from would be helpful		

The final question asked all personnel to identify what they wanted to see in future BCAs. The two main themes are *costs* and *contracts*. Personnel want to see exact costs and their breakdowns. They also want them to be clear and concise. The answers to this question may help inform a template or tool for future use.

Table 13

Responses Question 9 Sample

If you could construct a BCA what would you include that you typically don't see?		
Response	**Theme: Costs**	**Sub Code: Details**
How do you get to these numbers kind of thing versus just the back of a napkin oh this material costs this much	13	13
Cited Data Sources		
Response	**Theme: Contracts**	
So these numbers come out of nowhere and there's no real explanation of where they get the numbers just kind of like these are numbers right	5	
it's just the detail in the in the line items		

4.4 Summary

The analysis and results were a qualitative study that used the Grounded Theory method to breakdown all the interviews and locate recurring themes throughout. All of the personnel interviewed are current or former employees of AEIB. These interviews provided insight from personnel both directly and indirectly working with BCAs. The key takeaways from the interviews were that personnel are not provided with the important tools or guidance to ensure they can properly navigate a BCA. The frustrations that occur between the government employees and the contractors may decrease with simple guidance that ensures clear communication. The details exchanged from the BCAs to the government employees is nonexistent in the personnel's eyes. The numbers being given for costs or even data do not go in depth to help with understanding of why or

where the numbers came from. The government personnel want to do their job to the best of their ability but believe that they are being held back because of the quality of BCAs that are being created. Key points such as details, communication, and guidance are all the main factors with the increasing frustration from the government personnel working on projects.

The results discussed above are results using qualitative data using the Grounded Theory Method. Quantitative data was provided via an Air Force Life Cycle Management Cost database where possible trends for the current processes could be identified. However, with a limited sample size, it is impossible to draw any concrete conclusions from that data. The qualitative data consisted of ten interviews where the results were coded to show trends and then clustered together around the specific questions to identify possible emerging themes from the panel of subject matter experts. The results from both of these methods were utilized to create a list of possible options for the Air Force to choose from in order to optimize its return on investment. Those conclusions and recommendations will be discussed in the next chapter.

V. Conclusions and Recommendations

5.1 Chapter Overview

This chapter will discuss the overall conclusion and recommendations gathered from the qualitative data and grounded research method. The significance of the research, future research suggestions, and recommendations on policy changes based on analysis from the research will be discussed.

5.2 Research Questions Answered

The research conducted answered the following questions:

1. How can business case analyses for pollution prevention be designed to meet the government's needs?

The research determined that government oversight of BCAs and CBAs lack specificity. Personnel do not have the background knowledge necessary to properly and effectively approve whether or not BCA and CBA products meet government requirements. Training, Use of the BCA tool, and BCA guidance such as use of the AFMAN 65-506 may greatly improve the positive outcomes that personnel are seeking.

2. To what extent do current business case analyses for pollution prevention projects meet regulatory guidance?

The current regulatory guidance being met by pollution prevention projects was concluded to be non-existent. Based off of the Business Case Analyses presented to the researchers there were missing sections that should have been included and

the level of detail was bare minimum. The interviews gave the researchers more insight about how the personnel do not have a template of real guidance to go off of when going over BCAs.

3. To what extent do business case analyses for pollution prevention projects follow best practices?

There were no best practices for pollution prevention BCAs based off the research. Through the insight of the AFMAN 65-506 what is suggested and even necessary when conducting BCAs were not being implemented. The researchers intend to facilitate the use of best practices through the recommended policy changes.

4. What potential policy changes would improve business case analyses for pollution prevention?

A tool was created along with an in-depth training guide to help the government obtain more accurate BCAs. The analytical tool numerically quantifies parts of a BCA to aid personnel in objectively judging the effectiveness of a proposed BCA. The application of the tool will ensure quality BCAs are proposed and approved in the future.

5.3 Significance of Research

The significance of this research was the creation and establishment of lasting guidance to aid in the development of comprehensive and accurate BCAs and CBAs. No continuity existed in the past and the AEIB and DoD employees were left with

incomplete verbal advice. Feedback from interviews made it possible to compile and create recommendations on how to write effective contracts, positively communicate with contractors, and source detailed and accurate estimates. The knowledge gained from the research can be used to help position the AEIB engineers and possibly future DoD entities in a more hands-on role when receiving BCAs or CBAs. It can provide the necessary financial background needed to knowledgeably evaluate and utilize BCAs and CBAs. This research can be used as a starting point for future studies as well as provide evidence for the need of policy change.

5.4 Policy Changes

Complacent behavior has led to dated policies requiring change and improvement. The results of this research lead us to suggest a few recommended changes to improve continuity, guidance, effectiveness, and consistency when BCAs and CBAs are used. The first is the hybrid use of the AFMAN 65-506 (Economic Analysis) and the Framework of Business Case Quality indicators as shown in Figure 2. This combined use can be customized depending on the project. The second is the use of a BCA and CBA scoring tool created and optimized through extensive analyzation of the interviews and working with personnel tasked with implementation of the tool. This tool has the potential to decrease any discrepancies and miscommunication between all personnel within a project by enabling reviewers to objectively score each section of a BCA and CBA. The tool is pictured in Figure 8. Furthermore, due to the limited historical data available, all new BCA and CBA endeavors should be well documented and regularly evaluated to enable a living continuity to aid new projects. This will also begin a continual improvement

process. Lastly, to ensure all recommendations are being implemented, a quarterly meeting and training about the policies and procedures will ensure personnel understand and know how to carry out any changes. However, the primary driving and motivating force of all these changes must be leadership if these improvements are to stand.

5.5 Future Research

There are several additional research questions to be answered. As mentioned in section 1.6, this report only analyzes the production stage and more specifically, the evaluation of proposals and reward of contracts based on BCAs and CBAs. It is recommended that future research be conducted on the operations and support portions of the lifecycle cost. Additionally, few existing BCAs were available to evaluate. Thus, as new BCAs and CBAs are created, the process should be evaluated and the process should be continually optimized until positive consistency is seen. A future research project into the human health element is also important to ensure personnel are properly taken care of long after they have worked with the various chemicals. The effectiveness and use of in-house BCAs and CBAs can also be further studied to reduce costs and increase efficiency. Lastly, a review of all recommended changes should be done within the next five to ten years to improve and analyze the effectiveness of changes.

5.6 Final Thoughts

This thesis explored the Grounded Theory Method in order to gather data for training, policy recommendations, and discrepancies with BCAs/CBAs through personnel working closely with these documents. The results of those interviews were discussed and recommendations were put in place. Future research can further determine the

effectiveness of the changes. The research conducted may further benefit the DoD as a whole as well as give a jumping-off point for future research within the realm of Cost Analysis or Contracts.

Appendix

Appendix A

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14. ABSTRACT
The purpose of this research is to improve the Business Case Analysis (BCA) process in the context of pollution prevention. The research will inform guidance, training, and policy recommendations. Using grounded theory methods allowed us to gather qualitative data directly from participants actively involved in pollution prevention projects. In addition to answering several research questions, the results of the research informed the design of a tool to help government and contractor personnel agree on what constitutes a high-quality BCA. This research has implications for DoD decision making and future studies in environmental cost analysis.

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