



**FLEXIBILITY – DESIGNING FOR OPTIONALITY ON WAREHOUSE
MODERNIZATION PROJECTS**

THESIS

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Captain, USAF

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Abstract

The Department of Defense relies upon a vast network logistics facilities and capabilities across the planet. Assets are largely sourced from the Defense Logistics Agency, which is considering a modernization project for their Eastern Distribution Center (EDC). It handles 25% of all materials that DLA supplies, and the facility is antiquated. In order to maximize their investment, flexible options for the modernization should be considered. This research was conducted as a case study of the EDC in order to develop a framework of flexibility for DoD decision makers going forward. This case study gathers subject matter expert knowledge from government and commercial decision makers to develop a framework for DoD managers moving forward into the future.

To my rock, my go-to, my love, my wife.

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Steven T. Lane

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FLEXIBILITY – DESIGNING FOR OPTIONALITY ON WAREHOUSE MODERNIZATION PROJECTS

I: Motivation

Designing a project depends upon constraints, goals, and a myriad other considerations. The overwhelming nature of massive projects is compounded by the similarly varied options available at the onset of said project. The purpose of this research studies the considerations of decision makers as they design large modernization projects. It specifically studies the modernization process at the Defense Logistics Agency.

A report conducted by the Government Accountability Office (GAO) conducted in 2017 stated that, “The Department of Defense (DOD) manages about 4.9 million secondary inventory items, such as spare parts, with a reported value of \$91.7 billion as of September 2015.”(GAO, 2017a, 1). A GAO Study states that DLA generated \$23 Billion in revenues from supply chain services in 2015. The study did applaud efficiency improvements taken by the DLA. However, inefficiencies across DLA’s U.S. distribution centers remain and must be analyzed by the existing authorities. The GAO posited the underutilization of the DLA distribution capability limits effectiveness in the enterprise supply chain. A response to this is the call for modernization from DLA leadership to better utilize their assets (GAO, 2017b).

The current Defense Logistics Agency’s Eastern Distribution Center in Susquehanna, PA boasts \$13 billion of inventory over 770,000 stock numbers. The Eastern Distribution Center (EDC) was designed and built in the 1980s, which is the last time any study was completed for efficient operations. The EDC recently underwent a \$62 million roof project which prolongs the EDC’s life by 30 years. The estimated cost to modernize the warehouse is \$107 million. DLA

hired St. Onge, an engineering consulting firm to conduct a study developing an estimate and possible options to modernize the warehouse(s).

The proposed modernization is a multi-year, multi-million-dollar project to completely overhaul the current warehousing operations. Such projects rarely behave in a manner predicted from the onset. They are subjected to uncertainty at myriad points throughout and this cannot be ignored (de Neufville & Scholtes, 2011). This research will attempt to understand the feasibility of large DoD warehouse technological modernization efforts and implement a flexible approach towards future warehouse modernizations projects. This study seeks to develop a construct to aid DoD leaders implementing flexible design for warehouse modernization projects. The construct will draw on the case of the DLA EDC modernization project focusing on logistical and supply chain technological modernization efforts.

Problem Statement

The EDC's age and outdated technology are hindering operations. A Government Accountability Office (GAO) study in June of 2017 determined that the DoD was underutilizing the distribution capabilities of DLA due to infrastructure issues. DLA has prioritized EDC modernization but has not fully defined the modernization projects or implementation process. The facility modernization will be researched as a case study, learning from DLA and commercial counterparts. This research will identify key considerations for the Air Force and DoD decision makers prior to embarking on modernization efforts.

Research Question

The questions this research seeks to answer is: How can flexibility be designed into warehouse modernization efforts across the Air Force and DoD?

Investigative Questions

Investigative questions that will be further explored are:

What options were present at the onset of the modernization project?

What critical constraints limit flexibility when designing the project?

What risk mitigation steps did you conduct or consider?

What design elements provide flexibility?

What criteria is used in judging flexibility and feasibility of a project?

Summary Outline

The following chapters provide a review of the literature, the methodology used for the case study, the analysis of the data collected, and the research implications. The literature revolves around the flexibility strategies posited by Richard de Neufville and Stefan Scholtes. Their work, *Flexibility in Engineering Design*, guides decision makers through the thought process to consider options when approaching large projects. Complications and unexpected events are certain over time and thus flexible options must be incorporated into project designs (de Neufville & Scholtes, 2011). This assuredly applies to DoD agencies and their efforts to modernize warehouse facilities. The sheer magnitude and longevity of the proposed project ensures complexity throughout execution.

Additional research discusses specific considerations for managers. Information and data systems are key components for design planning. With 55% of costs coming from picking in warehousing, it cannot be ignored and must be a critical factor in planning projects (de Koster, Le-Duc, & Roodbergen, 2007). With an evolving warehouse, new metrics and technology will continuously be available. Managers must consider these beforehand and ensure their design accounts for the systems constraints and capabilities to fully take advantage of modernization. These modernizations drastically alter the current state of affairs, ushering in new knowledge.

New systems require new knowledge. With new knowledge but an incumbent workforce it is imperative to consider implementation of the system and innovation. Argyris and Kaplan write to this effect on implementing new systems and gaining acceptance (Argyris & Kaplan, 1994). Their concepts can also be applied to the initial argument for the need of modernization. Finding the gaps in capabilities and their remedies directly enforce the need for modernization (Argyris & Kaplan, 1994). The literature review will discuss the aforementioned ideas and dive deeper into screening models and development of design options.

A case study is used as the research design. Case research is ideally suited to answer questions like who, what, when, where, why, and how. Case Studies focus on answering the why and how; specific to an instance, scenario, or in this case a government entity attempting to modernize a warehouse technology. The case study centers on five key tenants of design outlined by Robert Yin's *Case Study Research: questions, propositions, units, logic between data and propositions, and the criteria to interpret* (Yin, 2014).

The concepts developed from the data collection and analysis will then be formulated into a construct applicable as an overlay for future warehouse technological modernization

projects for the DoD. The literature demands option consideration prior to design finalization. It certainly proves that the managers and researchers prior to this project understand the tumultuous ground under a project. With the certain uncertainties, a construct framing the design process will prove itself imperative. The Government Accountability Office has declared that leaders can and must do a better job at utilizing the distribution infrastructure under its control (GAO, 2017b). With these concepts in mind, chapter four discusses the data analysis.

The questions being addressed come from a gap of knowledge in the literature as it pertains to DoD agencies. The research question itself focusses on propositions to be gained throughout the process to apply to future projects. The data collected came from interviewing DoD experts and commercial counterparts. The interview responses were qualitatively analyzed through a coding process. Linking propositions to data will provide a framework for decision makers to engineer flexibility into their designs. Finally, the interpretation will decipher the analysis into usable constructs. For these reasons a case study provides the best approach of research.

II: Literature Review

The following chapter discusses the literature relevant to this research. The first segment introduces the industry and frame of competition with a focus on commercial compatibles. The next portion discusses project management and leading discussions from text books and practical guides. From the project management literature stream, it is necessary to narrow the topic to government project regulations and specifically Defense Logistics Agency regulations. The narrowing continues with a discussion on De Neufville's framework for approaching engineering designs in the most flexibility manner possible. The three literature streams are used to identify the problem at hand and to show how the gap in literature surrounding DoD modernization efforts can be approached with flexible design considerations.

Distribution and Innovation

Amazon is where everyone begins when considering logistic innovation and technological involvement. The success of the relatively new company, barely two decades old, cannot be ignored. When approaching this topic, it is the comparison that everyone wants to make or the goal that everyone involved envisioned. Therefore, a moment must be taken to discuss them and the e-commerce industry. The comparison is not unrealistic to the DLA EDC project. Both deal largely with variety. Both rely upon customers long distances away. Both tout a large market share. In 2016 Amazon took 43% of the online retail sales in the United States (Greenough & Camhi, 2017). Naturally there is a difference. Amazon is profit driven and the innovating first mover. In an article on that subject, authors Mellahi and Johnson, highlight the imitation advantage. "In industries such as the e-commerce marketplace characterized by weak intellectual property rights protection, technology interdependence, market and technical

uncertainties, rapid rates of technological innovation, and the swift movement of information, imitation surpasses innovation as a business model (Mellahi & Johnson, 2000, 446).” The industry experts and literature suggest the imitation model as more profitable and safer option.

The threat of obsolescence in a rapidly evolving industry forces imitation and benchmarking methodologies. The technological explosion combined with outsourcing options creates a need. In the case of Amazon the authors noted that there is fairly little to no legal limitations from imitators protecting Amazon and they rely upon their intellectual innovation and speed of innovation to remain ahead of competition (Mellahi & Johnson, 2000). The difference between Amazon and DLA in this arena is the legal protection DLA is provided by procurement laws placed on the DoD. The literature highlights the advantages of a fast moving first mover and the advantages of those following in their footsteps. Both stand to gain from the technological leaps (Mellahi & Johnson, 2000).

Project Management

Project management spreads across all industries and firm types. Project management allocates resources and abilities to meet the objectives of a company or organization. It follows a project from inception to conclusion, managing and directing along the way. There is a large body of literature in this arena, and the primary objective is to successfully complete a project. For this to happen, executives and managers must work with the same definition of success. For decades that definition relied upon three factors, which if met, defined a successful project completion. Those three factors were: cost, timeliness, and performance (Kerzner, 2009; Meredith & Mantel, 2003; Project Management Institute, 2000).

These success factors are managed and measured before, during, and after the project's completion. They are scrutinized and weighted against one another to ensure a balance of success overall is reached instead of suboptimal individual success. Additionally, managers should consider deeper levels of cost, time, and performance measurements (Kerzner, 2009; Project Management Institute, 2000). Managing the project must begin at project selection. This step relies upon the managerial team and executives to realize the gap of capabilities. Once this gap is acknowledged and adequately structured the team can begin project development. Leading texts, such as the *Project Management Book of Knowledge* (PMBOK) produced by Project Management Institute, highlight six phases of development. Those phases are: initiating, planning, executing, controlling, closing, and project-driven organization environment (Project Management Institute, 2000). The phases directly relate to the selection process. Project management begins at the decision that there is indeed a need for a project.

The decision that a project is needed is quickly followed by the decision to formulate a selection model. Selection models compare different options available to the managers and should take into consideration five components; realistic, capabilities, flexibility, ease of use, and cost (Meredith & Mantel, 2003). Merely narrowing the decision on modelling the selection process is not the project itself. Upon consideration and selection of the model, the executive or manager uses the model to produce a project.

Project management continually develops and relies upon the Project Management Maturity Model (PMMM). This model allows a framework for managers to overlay upon their firm or organization to assess the level at which their business operates. The five levels are: common language, common processes, singular methodology, benchmarking, and continual

improvement (Kerzner, 2009). These are in order from level one to five but do not rely upon a firm progressing in that order with strict borders to the levels. An organization may very well maneuver between the levels based upon current state of affairs. These levels however, are a gauge for the organization to determine its successfulness in project management abilities. These firms understand the necessity of project success, selection, and sustainment. They are driven by profit margins and stockholders however and not mandates from congress or government regulations. That world requires another lens and narrowing of literature. It requires a discussion on DoD regulations governing the Defense Logistics Agency.

Department of Defense Regulations

The Defense Logistics Agency produces a strategic plan directing the efforts and focus of the agency. The current strategic plan is set for 2015-2022 and directs five core focus areas: warfighter first, people and culture, strategic engagement, financial stewardship, and process excellence (Busch, 2014). These guiding principles fall into the three categories mentioned in project management of cost, timeliness, and performance. More specifically to this research, process excellence and financial stewardship are considered. These two focus on affordable solutions and continued accountability, cost, while always improving; finding smarter ways to do things, timeliness (Busch, 2014).

DLA is not self-governing however. This strategy must fall under the regulations and governance that DLA itself falls under. The Federal Acquisition Regulation (FAR) defines the processes by which federal agencies must act when procuring or hiring contracted services. DLA aligned their guidance to the FAR and published it as, Defense Logistics Acquisition Directive, or DLAD. The DLAD was last updated on 3 August of 2017. This living document provides

guidance and regulatory actions for the DLA community to ensure FAR/Federal Government compliance. This document provides strict adherence to procurement procedures. The DLAD outlines the necessary adherence but does not address the deviations from the contracts once they are in place. There is no specification for flexible options post-award. Through a scrutiny of the document it is apparent it was authored with contract execution as the end-state rather than the end goal of capability received. Nowhere in the document does it discuss the options to deviate from the specified purchased service or good dependent upon changes in the future state.

Furthermore, the FAR governance demands that efforts in acquisitions should include at the minimum:

“more efficient and effective use of resources to design and develop or produce quality systems. This includes ensuring that only necessary and cost-effective requirements are included, at the most appropriate time in the acquisition cycle, in solicitations and resulting contracts for the design, development, and production of new systems, or for modifications to existing systems that involve redesign of systems or subsystems.”
(Subpart 7.1 -- Acquisition Plans, 2017).

The guidance clearly dictates that the most effective use of resources be utilized and continues later in the regulation discussing the repair and renovation of federal buildings. The FAR recognizes the importance of modernization and renovation efforts. The FAR does not translate to the DLAD level with this intentionality. The regulations that DLA modernization fall under include acquisition of information technology, thereby competing construction requests against software requests.

The FAR also stipulates a termination for convenience clause that is unlike typical contract law. The termination for convenience may be enacted at any time for the sole purpose that it is in the best interest of the government. There are stipulations and provisions that are necessary but the root of the clause is this, “Termination for Convenience is defined in the FAR

as the exercise of the government's right to completely or partially terminate performance of work under a contract when it is in the government's interest (Contract Termination, 2009)." The FAR outlines the specific language to include in the contract in order to ensure these rights. It can be found in full in the *FAR 52.249-1 -- Termination for Convenience of the Government*. The FAR is too vast to summarize completely but these considerations pertained particularly to the interests of this research for consideration. The following section discusses the principles of a flexibly designed engineering effort.

Flexibility in Engineering Design

Flexibility in engineering design refers to the underlying necessity to plan for future states. The idea is based on Richard de Neufville and Stefan Scholtes' (2011) book that asks engineers to understand the ranges of possibilities that must be considered when developing large scale designs. Their theory combats what they call, the flaw of averages. This "refers to the concept that it is not correct to calculate the average value of a project based on its performance under average conditions" (de Neufville & Scholtes, 2011, 11). Unexpected occurrences will happen, forecasts are always wrong; always. This concept of uncertainty is not a new one. Risk and uncertainty have been developed constructs since the 1920's by F.H. Knight (Knight, 1921). Uncertainty and risk continue to plague large scale projects. Alessandri et al. delineate the difference between risk and uncertainty. They posit that risk lies in the quantitative realm of planning while uncertainty in the qualitative (Alessandri et al., 2004). How then do designers plan flexibility into their plans in order to shift during the execution of the design? The de Neufville text develops a different approach when estimating outcomes. Instead of using an

average, a range of options must be considered and should result in a range of options along the way.

Typically, the forecaster and the end user differ on the belief of necessity for a project. They view options differently and weight them accordingly. Because of this difference “success” in design varies dependent on the stakeholder even if nothing were to “go wrong.” This is not the case however because things will go wrong, which compounds the effect of misalignment. Even on known projects such as roadways and rails, de Neufville points out that costs tend to be off by 20%, which only further complicates projects with vastly varying unknowns like technological modernizations (de Neufville & Scholtes, 2011). A range of options should be considered to cover the variability. This is flexibility in engineering design.

Flexibility comes in different forms, one of which is a phasing approach. They suggest phasing funding to avoid high commitments upfront and take advantage of real time value of money, deferring certain costs and assessing the best time to spend. A fixed phasing plan though still depends upon successful forecasting, which assumes accuracy when accuracy cannot be assumed. Additionally, flexible designs permit but does not require expansion. “A flexible design positions the system so that it can expand when it makes sense to do so but does not commit managers to expansion if the actual situation that occurs does not justify greater capacity” (de Neufville & Scholtes, 2011, 11).

The phasing approach relies upon an evaluation of cash flows at each stage of the project. The present value of money is used because typically projects are occurring or proposed in the present. Net present then refers to the difference between revenue and expenses. Therefore, “NPV is the amount we can withdraw from the company bank account today so that the end-of-

life contribution of the project will allow us to pay back the accrued debt of our withdrawal at the end of the project” (de Neufville & Scholtes, 2011, 199). The next stage is determining the discount rate at which these evaluations should be calculated. The government undoubtedly has a mandatory discount rate in place and both de Neufville and Alessandri texts assume given discount rates by firm owners or board of directors (Alessandri et al., 2004; de Neufville & Scholtes, 2011). Alessandri et al. postulate that these quantitative methods are only a portion of understanding hesitancy towards large capital investments. The qualitative nature of uncertainty and irrationality plays into the decision makers considerations. The differing levels of uncertainty are described in their article; essentially with greater perceived uncertainty there is greater hesitancy and different models than DCF’s should be considered.

A consideration of “real options” tends to float nicely along with financial analysis. The concept of real options has been developed since the 1990’s and continues to garner respect for appropriately deciding on courses of action affiliated with financial decisions. The idea by Scholes and Black won them the Nobel Prize in economics in 1997. The real options then are opportunities for a manager or decision maker to take future actions based upon events occurring within the firm or environment (Benaroch et el., 1999; Khan et el., 2017). The argument that technology is ripe for such a scenario continues to be made. The literature on real options heavily relies upon economic studies and rational behavior of managers. The application of real options to technological investments deals with literal investing as opposed to physical investment through purchasing technological advancement.

The idea of real options theory and valuation appears to fit the construct of flexibly designing engineering projects focused on technological advancement. However, this is an

incorrect leap. De Neufville and Scholes debunk the application of real options to engineering design. The financial world relies upon replicable portfolios and a market for the options. Whereas the option to extend a building or stop short on construction are not financial assets to be traded. They discuss at length the incongruencies between the two in Appendix F of their text and conclude, “although financial options pricing is a conceptually appealing theory, it is typically not suited for a valuation of options in the kind of technology projects dealt with in this book (de Neufville & Scholtes, 2011, 272).”

Scoring Model of Flexible Projects

Flexibility designed into projects appears imperative, however, a model to judge that flexibility has yet to be discussed. In an article from the *European Journal of Operational Research*, Nelson postulates such a model for manufacturing modernizations. The article begins by discussing the necessary understanding of interdependencies of projects, risk involved with capital investments, and quantification of non-economic benefits (Nelson, 1986). These overarching categories break into subcategories of interest. He divides the score into five separate areas. The model relies upon input from the selection firm for weights of each category, but his initial model has a maximum of one point per attribute. The attributes are: technology assessment, equipment evaluation, workload elasticity, cost-to-budget ratio, and the net present value (Nelson, 1986).

The model scores each of these categories individually from $0 < x < 1$. As mentioned the interested firm can raise or lower a category based upon their end goal. This however provides the user the ability to compare projects seeking investments on a quantitative scale. The qualitative nature of inputs relies upon the expert users and owners of each category. A note on

the additive model, Nelson defends its use by citing Moore and Baker (1969) who showed adequately that the additive model best represents project selection scoring models.

Each of the five categories contain well defined parameters. The first is technology assessment. It relies upon “project identification and project evaluation” (Nelson, 1986, 347) where each must be judged. The first is based off lacking abilities at the location. The second relies upon a technology emphasis matrix which derives a score based off the benefit that technology provides. The emphasis defines the state of the technology within the industry on a scale from obsolete to emerging. An additional component of technology is weighted into the overall technology score. The impact that the technology provides brings into consideration the range of benefits that are non-economic in nature. Nelson created five binary considerations. If each is present the impact score is thus weighted higher. This discussion of technological scoring provides a rough structure to comparing and developing a scoring model for flexible technologically heavy modernizations.

Summary

The chapter began wide in project management and narrowed the focus to project management under the constraint of government regulations. This guidance layers bureaucracy to the options and methods to a certain degree but does not eliminate the possibilities of creative and flexible design options. Creating options dictates criteria for comparing options. Nelson’s article provided a rough structure to begin understanding the importance of technology and interdependence of modernization efforts. The culminating scoring model provided points to a quantitative option for a largely qualitative comparison. Flexible designs require flexible comparisons to best compare non-economic benefits while including the end goal of the firm.

Flexible design options suggested by De Neufville counter the flaw of averages and certain uncertainty. The literature suggests common themes or ideas to seek when questioning responders. It provides a framework for the researcher to begin. Which areas will be similar in commercial industry contrasted against the certain differences of government work? Furthermore, the literature suggests gains from flexibly designing modernizations and should be implemented if possible in the government arena. If the exact methodology suggested in literature proves unable to be implemented, then the researcher will seek to adapt to the government's version of flexibly designing. The purpose of the research is to frame the decision makers' considerations in DoD warehouse projects and their management from design to execution.

III: Methodology

Introduction

The research design for this thesis is a case study. Research attempts to answer questions like who, what, when, where, why, and how. Case Studies focus on answering the why and how; specific to an instance, scenario, or in this case a government entity attempting to modernize a warehouse. The case study centers on five key tenants of design outlined by Robert Yin's *Case Study Research*: questions, propositions, units, logic between data and propositions, and the criteria to interpret (Yin, 2014). The case study relied upon three elements of data: interviews, observations, and historical or archival data surrounding the project.

The questions being addressed come from a gap of knowledge in the literature as it pertains to DoD agencies. The research question itself focusses on propositions to be gained throughout the process to apply to future projects. Linking these propositions to data will provide a framework for decision makers to engineer flexibility into their designs. The interpretation will decipher the analysis into usable constructs. For these reasons a case study provides the best approach of research. Within the case study research design, semi-structured interviews were used to collect qualitative data.

The raw data was collected through interviews, observations, and historical documentation. It was organized and structured in preparation for analysis by systematically typing and storing the transcripts of interviews. The observations were broken into sections based upon location. The historical documentation likewise received preparatory scrubbing and sorting. The data was then read to frame the researcher's mind. After reading the coding effort began and was conducted in Excel. The themes and codes came from the reading of the data. The

codes were then assigned and interpreted. The interpretations and further explanation of this effort continues in the next chapter.

Interview Background

Evaluation style interviews were the primary structure utilized in the research. In these interviews, “the researcher learns in depth and detail how those involved view the successes and failures of a program or project (Rubin & Rubin, 1995, 122).” The knowledge sought was highly experiential and particular to the interviewee’s personal experiences on projects. Questions were developed to hear thick descriptions, those that go beyond surface knowledge of observation and are derived from the experience (Rubin & Rubin, 1995). This experience sharing allowed the researcher to deduce meaning and repeatable lessons from another’s experience.

Respondent Selection

The data collection of the research came from semi-structured interviews. These interviews included engineers designing the DLA EDC warehouse modernization, DLA management, industry comparable personnel, and observations from site visits. The experts interviewed all worked modernization efforts for their perspective organizations. They ranged from project managers to industrial engineers and operational managers. Each person was interviewed in person or over the phone. Transcripts of the interviews are held by the researcher. Each one is anonymous and only differentiated by government or commercial respondent. Table 1 provides the stakeholder group breakdown as well as the organization the individuals come from. The site visits included the DLA EDC, an Amazon Fulfillment Center, and a P&G Mixing Center.

Table 1: Interview Breakout

Commercial	Government
9	8
P&G	DLA
Kohl's	NASA
Huskey Refinery	
Best Buy	
Elder Beermen	
Eddie Bauer	
Northrop Grumman - NNS	

Respondents were professionals involved in large scale modernization projects. Specifically, those seeking to include innovative technologies into their designs. Respondents were contacted through mutual connections, site visits, and from the sponsoring organization. The projects were either directly working on a distribution center or a multi-million/billion-dollar project that took place over several years. Considering the timeline and large-scale budget were imperative to drawing conclusions from sources outside the distribution and warehousing field. For example, the respondent from Northrop Grumman Newport News Shipyard worked modernization projects and procurement for aircraft carriers for 30 years. The object is different, but the considerations of obsolescence and investment were similar. Each project took a decade and had to consider flexible options developing throughout the life of the project.

Data Collection

The interviews took place in two manners, either over the phone or in person. The interviews were recorded and transcribed. The interview questions and script are in Appendix A. The questions were developed from literature, site visits, and previous qualitative studies of similar sorts. The interview questions were vetted across several mentors to determine

effectiveness. An example question is, “Did you consider flexible options?” The intention behind this question was to determine if the respondent built in different scenarios. If so, how did they accomplish this? Or what did they consider to be a flexible option? Answering these subsequent questions allows the researcher to deduce points of flexibility. From these points of flexibility, one can compare across organizations to determine similarities and differences.

A list of codes was developed based off the common themes and ideas from either literature or the interviews. The code list started at 35 codes and 5 overarching themes. The codes were pilot tested on four of the interviews, two commercial and two government. The pilot test consisted of fully coding each of the four interviews. Each interview was stored in Microsoft Word and coded using the comments function. The portions of the interviews that were coded were then divided into segments within an Excel workbook based upon said coding. The pilot coding process allowed verification of existing themes within the data. Evaluation from an outside reviewer confirmed the integrity of the coding. The discussion from the pilot process allowed the researcher to consolidate similar or redundant codes and condense the larger codex into one more accurately predicting indicators for analysis.

After the four selected interviews were coded, one of the piloted interviews was coded by the advisor. The researcher and advisor compared results. Upon comparison thirteen codes were eliminated and then condensed down to three overarching themes. After this the original piloted interviews were recoded. The data collection was codified and assembled in Microsoft Excel. It was then analyzed to deduce common themes and considerations to the interview questions. Questions revolved around the following themes: options available, options considered, regrets of dismissed options, successes of options taken, constraints of designs, and

what could have been accomplished better. These showed the concepts necessary for considerations when approaching a warehouse modernization to provide flexible options throughout the project.

The seventeen interviews were recorded and transcribed. They were then coded and four were pilot tested. Upon completion of this pilot a final list of 22 codes in three themes were defined and selected. The code list can be seen in Appendix B. Each code was developed based upon either literature suggesting it or from a commonly referenced topic heard in the initial interviews. The codes' nomenclature was developed by the researcher and a brief description of its intent is listed beside it. Additionally, three overarching categories were assigned to group the codes under common themes. These themes will guide the rest of the chapter's discussion. The breakout of themes can be seen in Table 2.

Table 2: Themes

Theme 1 (7 Codes)	Theme 2 (8 Codes)	Theme 3 (7 Codes)
Design Elements	Environment of Organization	Executability
Codes having to do with the physical design considerations.	The organization's views and goals; their operating mentality when approaching new modernization projects	Considerations that functionally describe whether the project will be successful based off criteria and how that criteria is developed.
<i>Detailed Design's Elements</i>	<i>Purchasing Power</i>	<i>Pilot Study</i>
<i>Agile Support System</i>	<i>Purchasing Agility</i>	<i>Cost of overages/contingency money</i>
<i>Green Field vs. Reno</i>	<i>Preferred Vendors / sources</i>	<i>Payback Requirements (ROI)</i>
<i>Breaking into Parts/Phases</i>	<i>Single Source Contracting</i>	<i>Cost Cutting</i>
<i>Benchmarking</i>	<i>Regulations</i>	<i>Timeline</i>
<i>Automation Integration</i>	<i>End Goal Alignment</i>	<i>Risk Mitigation</i>
<i>Competitive Advantage</i>	<i>Work Force</i>	<i>Option Comparisons</i>
	<i>Payment Method</i>	

Thematic coverage proved the best organization of thoughts to group together intent behind the interviewees' responses. It gives stages of considerations. Namely, flexibility relies upon three things: the physical design, the organization's environment, and the executability of a design. In the following chapter these concepts will be explored and dichotomized based upon government or commercial similarities and differences.

Chapter IV: Analysis

Introduction

Chapter 4 provides a detailed discussion of the qualitative analysis that took place in the case study. Each code fell under an overarching theme. Themes were defined and analyzed based upon weight given amongst respondents. The total amount of comments from a respondent became the denominator and the numerator was based on the amount of comments from a respondent in a specific code. The percentages developed provide a guiding weight to the codes for analyzing. Additionally, within the theme each code was given a weighted average to determine importance within the code. The following table displays the breakout of comments across the themes from each sector. The percentages within each theme were then weighted within that theme. Weighting the averages normalized across the theme, to give a better perspective in that category.

Table 3: Theme Breakout

Total Comments	Physical Design	Environment of the Organization	Executability
Commercial	40.52%	32.58%	27.26%
Government	35.44%	36.71%	27.37%

Design Elements - Physical Design Considerations

The design elements were a common thread between both government and commercial respondents. Both wish to capitalize on the design stage before hard commitments are made. The total amount of comments was tallied for both government and commercial responders. Each code was given a percentage based upon how many comments that code received overall from the responder type, government or commercial. This percentage can be used as a way of judging “weight” or “importance” to the responders. The higher the percentage, the more apparent

importance. The commercial responders spent 40.5% of their comments in the first theme, while the government responders gave 35.4% of their total comments.

Table 4: Physical Design Percentages

Physical Design Considerations							
Weighted Average	Detailed Designs	Agile Support System	Green Field	Breaking Into Phases	Bench-marking	Competitive Advantage	Automation Integration
Commercial	16.4%	11.0%	9.6%	18.5%	22.6%	6.9%	15.1%
Government	22.9%	7.2%	7.2%	22.9%	15.7%	13.3%	10.8%

The weighted average was calculated based upon the total comments within that theme. Each respondent category was totaled up and divided by the total amount of comments from that sector. For example, there were 24 comments from the commercial sector under detailed designs and a total of 146 comments in Theme One from the commercial sector. Therefore, the percentage was $24/146 = 16.44\%$. The disparity between government and commercial responders also deserves investigation. The detailed design is the first code and first to break the threshold. The commercial responders put everything into their design plans. They consistently discussed adding option upon option into their plan to have the ability later to choose execution or dismissing the component. This contrasts with comments from the government respondents who did not agree that their organizations produced well-designed plans. In fact, one responder went so far as to say, “I am constantly put in a position that I am building buildings today that were poorly planned ten years ago.” This touches on two components, the government is building poorly planned and designed buildings and they were done so over a decade prior to groundbreaking. The lengthened timeline will be discussed later in the chapter.

Structural Elements

The common design elements are: room for growth, redundancy in equipment, change requests or submittals along the way, and overdesigning. When considering a modernization, the commercial industry includes “knock-down” walls that can easily bridge into new facilities, thus building in flexibility to grow later instead of all at once. They also purchase double the land that they think they will need to ensure a large enough footprint; the caveat being a renovation is only utilizing the existing shell. Putting in extra equipment allows the designers to flexibly grow or surge and maintain working spare parts if the flow only requires a single item. Both commercial and government respondent rely heavily upon change orders to adjust during the actual execution of the design. Finally, the commercial sector overdesigns and adds everything they could want to eliminate and streamline along the way. They then continually analyzed the value return for each segment.

The government responders outpaced the commercial sector by percentage in this code, but the responses were negatively correlated. The government responders consistently repeated the lack of proper detail and the inability of contracting officers. The government respondents felt limited by the rapidly replaced contracting officers and lack of specific expertise. One responder stated, “We have a contracting office that has no idea what we need.” Their frustration was not repeated by the commercial sector. The commercial sector had a very specifically developed team of individuals intimately aware of the needs and requirements for which they were writing contracts, bids, and requests.

Using a Phased Approach

Using a phased approach was a common suggestion from literature and ideally relies upon the end users' abilities to partially complete portions. The user could then determine remaining value and decide whether it was fruitful to continue their investment and modernization efforts. This is the way that commercial responders viewed project execution. They would have different gates or phases and assess at the end of each whether it was worth the investment to continue. Some deemed that gaining 80% of the benefits was sufficient and would stop the project. The phases of their design were independent when possible. Certain aspects could only be built or completed if another portion was also built. The interdependent portions were considered as one phase.

The government responders however viewed a phased approach differently. In their eyes phasing the project constituted the phases that the contract would go through to reach completion. Breaking the installment of the new technology and buildings into phases was necessary unless the project was a green field operation. The current operations must continue and thus a "phased approach" is their solution. They did not consider stopping the project after only completing a portion. The government sector considered the different gates or stages of an overarching project as phasing their approach.

The government and commercial sector have two different understandings of phased approaches. The similarities lie in the agreement that phases should be kept with the same contractor. If an installment of a warehouse management system is the current phase, it should be handled by one contract to ensure proper installment and coordination. Breaking the phases of one modernization project across different contracts was unanimously thought to be unwise.

Benchmarking

Benchmarking was the largest consideration from the commercial sector responders in Theme One. Both commercial and government responses aligned with utilizing technologies and methods already in place within the industry. The differentiating factor came in the commercial sector's ability to prototype their own facility and repeat rapidly across the nation. The commercial sector prototyped a method of modernization and execution based upon industry methods and lessons learned off their own processes. They then repeated this prototype and adjusted based upon location factors and product type.

Automation Integration

The final component of physical design requiring attention is automation integration. The respondent percentages do not necessarily highlight this as imperative, but it is important to DLA as a consideration. Responses focused on finding the right balance of automation against investment cost. Not every problem can be solved with automation. Additionally, respondents wanted the investment to provide advantages that they could not find on the market. Bouncing back to the competitive advantage code, one commercial respondent said, "I don't want to put a bunch of money into a process that all kinds of people are putting money into if I can competitively acquire that process from the market." They were concerned that investing in a new technology not unique to their goal would prove unnecessary. The commercial industry would rather focus investments on unique, core competency requirements over easily sourced services or processes.

Physical Design Summary

The first theme uncovered similarities and differences between the commercial and government sectors pertaining to physical design factors. The main focal points were physically designing flexibility, phasing the projects appropriately, benchmarking from industry, and the balance of automation integration. The commercial respondents relied upon knowledgeable expert contractors and teams to develop a design envisioning growth. The commercial respondents built their contracts and phases to be broken into portions that could be stopped upon a certain level of utility gained. That utility determination came from executive decision makers responsible for project execution and the firm's future state. The commercial sector relied upon a benchmarking and prototype method of modernization. Upon determining a successful design, it was repeated and adjusted dependent upon location specific requirements. Commercial respondents considered the integration of automation to meet their needs. Finding the balance of automation to labor was a critical consideration, which was determined largely by the investment required versus the gain from the technology.

The government respondents discussed their frustrations with lengthy, unclear and poorly designed projects. They felt the contracting office and decentralized nature of procurement led to poorly articulated bids and designs. There was a consensus of proper team formulation as a requirement of success. The government viewed phased approaches completely differently than their commercial counterparts. The government did not consider stopping a project from full completion. They fully committed to a project from the beginning and counted the different phases of construction or implementation as a phased approach. The government respondents also relied upon benchmarked practices from industry but did not consider the prototype

methodology of modernization. Each project developed individually. The design elements or technological benchmark considerations were sourced from the industry for consideration in their design. A similarity between the government and commercial sectors was the integration of automation. Neither agency wants to overcommit to an automation process and overly invest in a technology. Both agree that the decision makers must determine the correct balance and implementation of automation. The next theme will address the organization’s structure as it pertains to flexibly modernizing.

Environment of the Organization

The second theme revolved around the organizations’ views or goals and their operating mentality when approaching new modernization projects. Responses in this theme were heavily focused on procurement of goods and services, end goal alignment, and the labor force. The theme centered around the attributes that describe and are inherent to the organization itself. The attribute describes whether it is a positive feature or a negative one, describing the overall organization’s ability to support a flexible project. This theme was not as strongly mentioned as theme one, with 34.38% of total comments. The commercial responders brought in 32.58% of their total comments while the government responders sat at 36.71% of their comments in this theme.

Table 5: Environment of the Organization Percentages

Environment of the Organization								
Weighted Average	Purchasing Power	Purchasing Agility	Preferred Vendors	Single Source	Regulations	End Goal	Labor	Payment Method
Commercial	13.1%	14.8%	8.2%	10.7%	13.1%	21.3%	9.8%	9.0%
Government	12.7%	8.9%	2.5%	11.4%	8.9%	31.7%	12.7%	11.4%

There are four main areas within this theme: purchasing power, agility, preferred vendors, and end goal alignment. These will be discussed but with an additional note on workforce/labor.

Purchasing Power

The lack of purchasing power of an organization was stressed by government respondents but not by the commercial side. The commercial agencies delegate purchasing power and approval from the executive level down to the operational and executional levels. The government personnel continually reiterate their lack of purchasing decision abilities. They have no purchasing power at their level to make decisions but have requirements for those decisions. The commercial sector easily purchases based off need and a proven value. As long as the return on the investment was proven out to the executives, they provide the funding. This is the largest disparity between the government and commercial industries. The awarding of capital investments in the government relies upon national organization and national priorities. Contrarily, the commercial sector can turn on and off project funding based upon market fluctuations and expected workflow. In one instance the commercial responders spoke of a \$100M+ project being turned off and on again in the course of 2.5 years. They were responsive to the market and flexible enough to fully-sanction the project in a matter of months and begin awarding contracts within the same quarter of the decision to proceed with the modernization.

Purchasing Agility

The ability to rapidly make purchasing decisions blends into the second category of purchasing agility. This consisted of being able to utilize a team of personnel with the knowledge and experience to rapidly adapt to changing conditions. Secondly, the commercial sector focused

on quick adaptation using change requests, options built into the contract, and “add-ons” to extract the most value out of options.

The commercial respondents were able to provide the team with an option and upon approval from the well-rounded committee (safety, operations, engineers, environmental, project managers, etc.) execute that option. For example, one commercial respondent described their project’s agility this way, “We basically told them if you want S then you have to have additional ‘this’ to hit that capacity. So, we then partner with the executives, if you want this level you’ve got to give us this.” The executive decision makers requested a certain service level that was unanticipated, and the respondent was able to clearly communicate the cost of reaching that level. Upon explaining this, the executives agreed to that level, authorized the spending, and the project continued with higher performance capability.

Whereas the government employees were in a corner waiting upon bureaucratic competition within the agency. One respondent went so far as to say, “We lack the agility to modernize, by the time we get through the process, the stuff we're putting in the building is already out of date.” There is no rapidly adjusting design alterations within the government agencies. On top of that, the competition within the agency pits IT systems against warehouse modernizations solely based upon organizational structure and approval processes. The organization of the government agency requires funding requests for modernizations to all compete. The problem that respondents felt occurred is that there is no direct comparison between software upgrades and physical distribution center modifications. The agency is comparing two drastically different investment opportunities without some common criteria for comparison. This misalignment of commonalities hinders the ability to judge similar items

against one another. It forces the agency to “win money” for a hard-infrastructure update over a soft network update.

Preferred Vendors

Preferred vendors for the modernization efforts are viewed differently between the two sectors. The commercial agencies relied heavily upon strengthened relationships and continuous supply chain enhancement from those relationships. The strength between buyers and suppliers allows rapid changes to be supported. With a strengthened relationship the commercial sector leveraged their history to support new projects and quickly adapt to changing requirements. One commercial respondent described the relationship as, “I have my guys that I go to and are ready to move quickly and efficiently. We use a 3PL as well which is essentially the most preferred vendor.”

Another commercial respondent responsible for distribution centers built across the nation stated, “I rely on my vendors. When you get in a partnership with them, if you screw up they screw up and if they screw up you screw up and if it gets screwed up they don’t get paid.” The respondent recognized the importance of the relationship and long-term vision of supply chain management. They were closely connected with their vendors to extract as much value as possible from each other. Out of the nine commercial responders, five positively indicated their reliance upon preferred vendors.

Conversely, the government sector was practically silent on the issue because it does not exist. The two responses that the government agents gave were wishes for the ability to have a preferred vendor and capitalize on the long-term relationships; the other six did not mention them at all. One of the government responders stated their frustration, “So the best person may

not bid, and we don't get quality options.” The response came from a line of questioning about bidding out and asking if they had a preferred vendor or even vendor list. The bidding process eliminates the long-term value of relationships between buyers and suppliers.

End Goal Alignment

The largest code by percentage across all codes was end goal alignment. Out of the entire field of responders it garnered 9.46% of all comments. This doubling of the expected percentage demands attention. It is one of two codes that every single responder gave comments for, the other being breaking into phases. Both agreed that all members up and down the chain of command should be on the same page for the end goal. One respondent said, “You got to start first with the end in mind.” Others echoed, “What is the purpose or what are we trying to do here?”

From this though, the sectors break apart. The commercial responders discussed metrics that they believed would deliver “logistics as a competitive advantage.” The metrics or considerations commonly discussed across the commercial sector were: safety, efficiency, cost, quality, procurement, inventory, people, productivity, and forecasting. Each category played a role in a successful end state according to stakeholders and executives, profit.

The government agents relied upon, “support the warfighter” as their mantra. The government agent however cannot quantify supportability to the warfighter. The responders certainly track similar metrics as cost, inventory, efficiencies, etc., but they feel these do not translate into service potential to a combatant commander or on a greater scale, the Department of Defense. The attempt across agencies is to align with strategic goals in order to justify spending. A respondent stated, “I look at the entire center and not only how do we use it today

but also what do we need to do for the future and the next twenty, thirty years into the future. So, it is trying to look at where the agency's strategic plan is and where we think we're going." The difficulty lies in that prediction.

There is a second component in the end goal alignment discussion. The commercial sector presents current states of projects and modernizations to their executives. Executives can decide rapidly to continue or divert based upon the ever-changing value of expected returns. Many spoke of only completing 80% of the total project to capture the most value and diverting the remaining capital investments to other ventures. This power of options allows their end goal of profit maximization to be the forefront of their motivation.

A final note on goal alignment, the commercial sector assessed products and services on individual value streams. They determined which products required which investments based upon the demands for that product or service. Doing this allowed the commercial personnel an ability to cut modernization efforts in some areas while increasing in others; resulting in the greatest value for the investment. There is no real similar comparison in the government sector. The government plans for facilities to last 30+ years but without knowing the realistic outlook of volume or mission requirements it proves difficult to maintain an individualized value return. There are certain investments that must be made to ensure the surge capacity required by the DoD can be met. The individualized approach is complicated for the government agent. The shifting arenas of involvement and volume require shifting support measures. Basing the investment off projections can seem intimidating but is in line with their goal to meet the surge capacity and required agility of a top tier supply.

Labor Constraints

The workforce of any organization requires consideration when undergoing modernization efforts. There will be new processes and systems. The entrenched personnel will have a culture shift as noted by several responders. Furthermore, respondents agreed that a dynamic workforce allows for peak surges, and the easier the training or spin-up then the easier it is to adapt to seasonality or unpredictable swings. However, there is an element of constraining factors within the government sector. The labor union, bargaining units, and military personnel drive manning levels.

Headcount reduction is responsible for the majority of cost savings from modernizations. A respondent stated, “right away most people jump straight to ROI or headcount reduction,” when asked about calculating value from investments. But, if there are legally binding headcounts and salaries to be paid then those savings will not occur regardless of the efficiency of the system. The government responders believed they could get to those numbers needed without massive layoffs. The commercial responders focused their comments on training and culture changes over actual cost of labor. The next focus will begin addressing these cost savings and predictions on executability based upon criteria developed by decision makers.

Environment of the Organization Summary

Across the discussion of the organization’s environment several key characteristics stood out. The strategic goal alignment of that organization drives the purchasing power and agility. Rapid changes are required for flexible decision making. The environment that is aligned strategically to consider these changes and make determinations throughout the project will remain the most flexible. An aspect of that organization is the relationship throughout the supply

chain. Organizations that support long term strong relationships with suppliers and contractors are able to adjust more rapidly on projects than those continually using new sources. Throughout the project each phase and decision should relate to an overarching goal of the agency. Goals then drive and justify continuing or ceasing project phases.

Executability of the Project

The third theme dealt largely with the assessment of a project’s ability to be executed. These codes came from questions about criteria for choosing a design plan. This theme gained the fewest comments of the three themes (27.3%), but as can be seen in the next section the codes in this theme cross into the other themes easily.

Table 6: Executability Percentages

Executability							
Weighted Average	Pilot Study	Contingency/ Overages	ROI / Payback	Cost Cutting	Timeline	Risk Mitigation	Option Comparisons
Commercial	10.7%	14.3%	23.8%	19.1%	11.9%	3.6%	16.7%
Government	11.4%	15.2%	26.6%	10.1%	11.4%	8.9%	16.5%

Table seven shows the codes broken out by percentages in the same manner as the previous two themes. Several of these codes seem insignificant but while receiving fewer total comments, their importance cannot be negated. For instance, responders overwhelmingly understood that it is impossible to pilot study an entire warehouse modernization. But they also utilized technology to assess the possibilities through computer modeling and projections of improvements. Only one responder truly piloted processes and that was due to a spare warehouse of 400,000 sq. feet. A total agreement between both sectors and similar practices indicate a strong level of support for pilot studies. If the pilot or modeling study seemed to functionally

work the sectors both move to different considerations for developing criteria. The largest and most obvious is analyzing the amount of investment based on the expected return.

Return on Investment / Payback

The discussion of return on investment fell into conversation constantly and across many categories. There seemed to be several different versions of the concept. If the modernization sprouted from the need for growth, then an ROI analysis appeared unnecessary since the growth in volume demanded higher capacity and commercial responders were not required to stringently justify the investment. However, if the investment was to increase profits on an already profitable system, they were required to provide the justification with an ROI appealing to executives. The commercial sector wanted an ROI in the time that a project took place. For example, if the project was going to take eight months to complete then the executives wanted the ROI to match that timeline. Rarely, did anyone, government or commercial, mention an ROI greater five years as acceptable. The only instance where this was the case was in new builds for government sectors in which the ROI had to be under the life of the building, usually 30 years. The largest disparity in quantifying payback is in the definition of the word. The commercial sector increases profits to payback the investment, whereas the government sector relies on decreasing costs alone to justify investments. These are two completely different views of paying back investments that must be taken into consideration.

Option Comparison

The responses coded as option comparison dealt with criteria development and alignment with the end goal mentioned in the previous theme. This code shows, not the actual criteria, but the importance of developing said criteria. It reveals that the criteria must be quantifiable and

translatable to the decision makers assessing the designs. They must be able to see how the investment ties into their end goal and how to delineate a difference between options. These are things that must be considered upfront and defined upon beginning a design. Otherwise, a project will proceed for months when the time comes for comparison no one will be able to show why one plan is superior to the other. Many responders highlighted using modelling and simulations of options to test the operational status of the designs and then assigning quantifiable numbers against values gained. The next section discusses how these comparisons spread across themes and highlights the specific codes that played a role within other themes.

Timeline

The timeline of a project and organization define many different factors. It is a critical characteristic of modernization projects when comparing different designs. Each responder at one point highlighted getting the project done on time. There is little value in a distribution center built to handle the holiday rush that cannot function until after Christmas. The timeline of building, testing, and opening the modernized sections was a critical element of the criteria developed in judging plans. Interestingly, timeline was used in different capacities. One expert highlighted their use of slowing down a timeline from one year to two in order to gain financial benefits. The project then “changed from a timeline driven project, to a cost driven project.” Altering the timeline became a tool for cost cutting actions.

More frequently however, the timeline is truncated and must meet a critical deadline. In these instances, responders from the commercial experience signified the importance with the ability to rapidly change purchasing decisions and in one instance a respondent recalled, “I got approval for an entire project from a parking lot of a little league game in order to meet a

deadline.” The power to rapidly and expertly adjust within a project gave freedom and success to those organizations able to do so.

Summary of Executability

Every option was tied to a certain ROI. The ROI was developed by the engineers designing the plan, but the executives also considered the value added and new capabilities the said modernization would offer. This is one of the option comparison criteria required by successful decision makers prior to bid. Without an end score card to hold up against other designs it will prove fruitless to try and assess one against another. A commercial respondent stated, “There was a lot of scrutiny of the vendors and the team developed a scorecard.” Aligning end goals with criteria of value helps quantify the decision. When comparing designs commercial experts relied upon a score card developed internally. One organization gave the researcher a copy of their scorecard and the top priorities are: confidence in design, references/comparable projects successes, IT capability, schedule, confidence in approach, and total cost. These highlight their top concerns, but the total scorecard was made up of 39 considerations. This criteria for analysis helps their executives quantify differences between somewhat subjective areas.

The scorecard method relates ROI and timeline to one another and is a direct result of developing option comparison criteria. The scoring of projects in this method is an attempt to judge their executability and directly pulls from several attributes within the topic of executability. The timeline and ROI commonly rank at the top of an option comparison list and judging whether the organization can truly execute the proposed project.

Cross Theme Analysis

The research conducted was driven by several investigative questions. Through the process of interviews and coding responses lessons can be learned to answer investigative questions. There were two overarching categories of respondents: government and commercial. The three primary themes focused on: flexible physical design, the organizational structure supporting flexible decision making, and the judgement of executability of said design.

The investigative questions can be answered in the following summary table. It depicts the question and the answer for each sector. The answers are based upon the previous chapter's analysis and understanding gained from the research.

Table 7: Investigative Question One Answer

IQ1	What options were present at the onset of the modernization project?
Government	Received one overall idea with plug and play options
Commercial	Sought and received several completely different bids/approaches

The purpose of this question was to determine the amount of options that each sector considered. The literature suggested that a range of options should be considered to entertain options that would provide maneuverability amongst uncertainty. The government agencies placed a request and the cheapest option would win the bid as long as those requirements listed in the request were met. Conversely the private sector would consider many different options from different vendors or suppliers. The end goal of the government would be to receive a project meeting required capabilities with an approved ROI. The commercial sector sought a competitive advantage that would improve profits. The timeline for the government would be set

by the proposed bid whereas the commercial sector could exploit a short or long timeline to their advantage.

The different project approaches the commercial sector received would be graded against each other and chosen based off the executive stakeholders’ interests. At any point during the projects the commercial sector can alter course based upon the changing needs or environment of their organization. The government felt tied to completion of the project. The different phases of the project allow an opportunity to gain value and then stop the project for the commercial sector. The ability to stop or divert is the true ability to phase investments. The next investigative question sought to understand constraints across the sectors.

Table 8: Investigative Question Two Answered

IQ2	What critical constraints limit flexibility when designing the project?
Government	Timeline of approval process, financial power, rapidly changing business environment, difficulty quantifying successful execution of vision
Commercial	Square footage, location, money

The constraining factors viewed by each sector provide insight on the environment in which the projects took place. For the government respondents, limitations were in the physical design, organizational environment, and executability. The government agencies felt restricted by their timeline, inability to make purchasing decisions rapidly, lack of normalized comparison between projects, and the powerless nature to influence their budget. The commercial sector felt limited by physical limitations more than anything. The commercial sector recognized budgetary constraints but only as a guidance because with the correct justification and effect the executives

can support the project. The physical limitations were far more concerning than purchasing ability or timeline. The commercial planners cannot alter the location or literal acreage to their benefit as easily as other potential limitations.

Table 9: Investigative Question Three Answered

IQ3	What risk mitigation steps did you conduct or consider?
Government	Modeling and simulation, modernizing is the largest risk mitigation to avoid obsolescence
Commercial	Contingency funds of 10% minimum, well rounded team assessment

The commercial sector saw risk as a factor of their option comparison. Risk was assessed by a strong team approaching the project from many different angles. The team would present areas of risk and executives would decide based upon their end goals. The most common response to risk was, “There’s always an allowance built in so 5-10% allowance should always be built in to cover little things along the way.” Many respondents stuck to the 10% coverage as the risk mitigation. The government viewed their modernization as a risk mitigating factor. One of their largest fears is obsolescence and replacement by 3rd Party Logistics. The view held by the government shows their end goal and competitive advantage playing into option comparison and criteria development. The government want options that benchmark from industry and maintain functionality for their end goal, mission support.

Table 10: Investigative Question Four Answered

IQ4	What design elements provide flexibility?
Government	Change orders and submittals
Commercial	Overdesigning (extras built in for decisions later), change orders and rapid approval, quick approval and taking advantage of technology, ability to switch/adjust based upon product specific and gain most value for that product line

The fourth question aimed at the respondents' views of their own flexibility. An interesting characteristic that the government respondents highlighted was the reactive nature of their flexibility. The government relies upon decisions made after an event to realign with their goal, physical requirements, or integration of technology. The government places change orders or submittals that have the ability to alter contract portions but at a price premium, which in turn changes their timeline and ROI.

A proactive method of flexibility relies upon options built into contracts that can be acted upon later or disregarded. Additionally, phasing the approach allows executive decision makers to align goals and projects at the end of each portion. The commercial sector seizes these opportunities to adjust during the project. They do concede that decisions like these will cost money but justify the investment by eventually cost savings or potential cost savings from second or third order effects. For instance, deciding to stop the project at 75% completion may require an exit fee but saving the cost of the last 25% would outweigh that and still achieve the value required by their organization. Acting in this way relies upon rapid purchasing decisions, phased approaches, aligning goals, and making value-based decisions.

Table 11: Investigative Questions Five Answered

IQ5	What criteria is used in judging flexibility and feasibility of a project?
Government	pilot study/simulation, consulting firms, approval of funding
Commercial	ROI, value added, competitive advantage, meeting new need, assessing incrementally along implementation, basing off market, budget, validation using simulation

The final investigative question sought the top considerations that commercial and government agents considered critical criteria when comparing options. The government respondents relied upon the propositions from vendors, suppliers, benchmarked processes, and simulations to pilot study. The government then compared the options and sought funding based upon those results. The commercial sector judged several proposals using a similar process. Both sectors relied upon pilot studies conducted in simulation software. The simulation of projects allowed decision makers a range of options possible for different investment levels. These options could then be compared and provide different paths for decision makers to take. Through this analysis the researcher discussed characteristics supporting flexible design options for large warehouse or similar infrastructural modernizations. The themes were broken into three categories and each category was supported by a host of attributes coded across seventeen interviews. The following chapter will discuss the implications of this analysis and where further research could expand upon the knowledge gained.

Chapter V: Conclusion

The purpose of this research was to develop considerations for decision makers approaching large scale modernization projects; specifically, those of warehouse and distribution facilities. The following chapter will discuss: a flexibility framework, characteristics that provide flexibility, how those attributes can be used to judge options, and where further research is needed. The research did not judge whether or not the modernization is necessary but rather the method of modernizing to maintain flexible options and a competitive advantage while meeting the end goal. The previous chapter outlined the similarities and differences between government and commercial agencies. Table 7 directly displays the answers to the investigative questions. The overall research question, how can flexibility be designed into warehouse modernization efforts across the Air Force and DoD? Is best answered in the following section on flexibility scorecards.

Key Findings

Agility

There are several guiding principles that interviewees relied upon when discussing their issues and their successes. Lacking the agility to act, commonly came from the government respondents. They felt particularly boxed into long-term single method options. They felt forced to process their design procedures and requests the exact same way it has been done in the past. The organization limits the ability to adapt to constantly changing environments. The organization in this instance is not the EDC but rather the DoD regulations and limitations. The stakeholders are limited to the money budgeted from the government and competing across lower organizations and within the lower organizations (DLA) for modernization money. A

subsequent issue is the approval authority and process of this money. All these projects fall under the IT portion of DLA's approval process. The cross-functional area demands its own consideration for funding.

Timeline and End Goal Alignment

Another insight common amongst peers was end goal alignment. Both the government and commercial responders consistently drove this theme as imperative throughout design, approval, execution, and testing. The difficulty arises when judging this alignment. The commercial sector easily points to profits and gained competitive advantage as driving motivations. However, the government struggles to clearly define its goal. It is a service provider not a producer. How then can they clearly tie projects to an end goal? It was commonly relayed that their goal is mission or warfighter support. The alignment then would seem to be clear, but it further confuses when trying to reveal the absence of goal achievement. What happens when they do not tie their projects to their goal, will the warfighter no longer be supported? How much money does it take to adequately provide the service? The mission of supporting the warfighter has quantifiable metrics: lead time, on time delivery, successful delivery, delays, cost per item moved, etc. Each metric kept should directly contribute to warfighter support. If this is true, then improving those metrics will improve their end goal. Therefore, tying investments to metrics directly links the investment to warfighter support. DLA decision makers must decide how much of a limited resource they will provide to meet this goal across several arenas. Maximizing the agility of a modernization effort will then allow them to better utilize these resources over a longer period of time.

The timeline phase is the biggest indicator/difference between the commercial and government worlds. Instead of using the timeline as an advantage the government actors remain stagnant on projects until finally receiving approval to proceed. The initial concepts and investigations revealed plans and possibilities but then those plans remain locked until funded. Upon funding there seems to be little to no alterations from the original design. The timeline for this occurrence is multi-year. Profits are not the government's goal but cutting costs are and if early procurement over a longer time period resulted in discounted pricing then the government should seriously consider those options.

On the commercial side, the timeline is determined directly by those interested in the modernization. They purposefully expedite or extend timelines to better suit their projects. They focus on continual alterations to design until fully sanctioned projects break ground. This ensures that they are adapting to new technologies and new improvements within and across industries. The commercial sector then leverages the slower timelines for better procurement and larger end profits or cost savings.

However, at this time, the government projects are only approved in whole. The commercial sector can decide to act rapidly and adapt to new volumes or products in order to meet their end goal. The government actors understand that there are options that would be beneficial but without the legal ability and capital flexibility to act upon those options. The bureaucratic processing will not be removed; it proves necessary then to develop an adequate method to approach modernizations to maximize returning benefits on investments.

“Flexibility Framework”

The idea of developing a flexibility scorecard arose several times in the literature and interviews. As mentioned in the literature review a simple additive model of key components can provide a quantitative value, however, the ranking of those attributes proves vastly more difficult when considering the different options. Decision makers at DLA are attempting to compare software enterprise wide programs to a distribution center modernization. Both revolve around technology and both provide economic and non-economic benefits to the organization. Assessing these on the same model would undoubtedly dilute into departments arguing which is more important. It would appear that breaking the individual projects down to their portions and assessing within the projects which portions are flexible and beneficial would be more appropriate. In order to accomplish this, a flexibility framework has been created from this research. The model assesses flexible attributes for the decision maker to consider.

The model relies heavily upon the input from decision makers. They will need to develop an internal condition of each element. This model merely represents key themes and attributes based upon the interviews conducted with commercial and government personnel familiar with large scale modernization projects. With any research there are complications that hinder research. The limitations of this case study will be discussed in the following section.

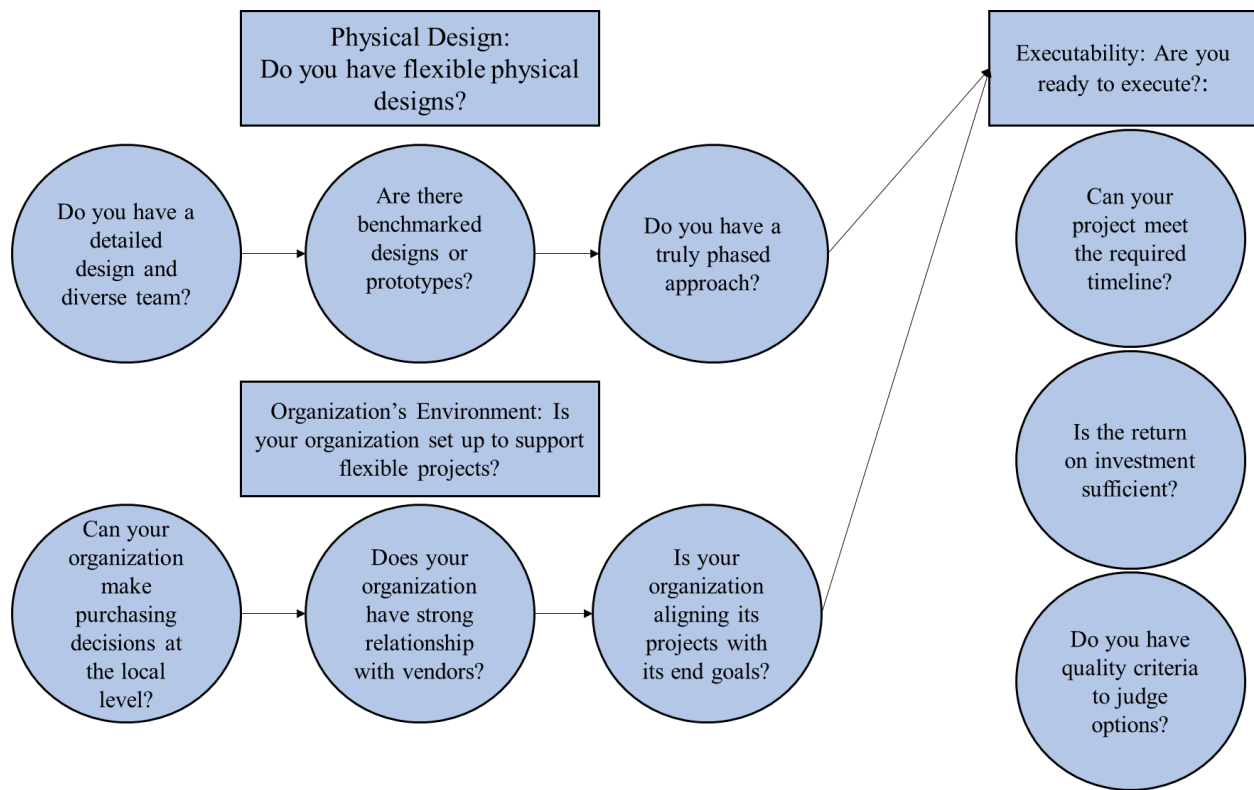


Figure 1: Flexibility Framework

The model framework builds off the three themes. Each question can be answered yes or no and provide guidance for areas to consider improving flexibility. There are not specific values assigned to rank projects because doing so is subjective to the decision makers. Rather this model provides a framework of considerations for decision makers to assess if flexibility can be designed into warehouse modernization efforts across the Air Force and DoD. There are feedback loops, but it is shown as a straight linear process for simplicity. The physical design and organization structure questions can and will most likely occur congruently. Neither one is more prioritized over the other and dependent upon the organization utilizing the framework. Finally, the third column helps decision makers determine their ability to carry out the proposed project.

Design Features and Team

The design of the modernization can be judged on its ability to adapt to further technological predictions and surge or growth requirements. Additional open space, redundancy in potential bottlenecks, and “knock-down walls” are a few of the characteristics described by responders that provided flexibility to their designs. The more characteristics present in the design, the higher the score in this category. Finally, there must be an expert team to assess these designs. The team must be able to articulate needs well enough for contract and bid communication. The commercial sector relies on a launch team mentality, the same personnel repeating processes to execute similar functions. They not only prototype design features but also team aspects.

Prototype

The idea of prototyping modernization efforts allows for decision makers to start with a past success. Starting at this point then allows them to adjust based on the specific criteria for that specific project. Responders overwhelmingly rely upon industry leaders to develop and smooth technologies and processes. Judging whether a project has been completed within the industry will reveal its ability to provide the required benefits with a lower risk. The more proven out a technology or improvement is, the more flexible responders judged it. Many respondents in the commercial sector attested to their own company’s ability to benchmark and prototype methods for modernizing within its own organization. The prototype or benchmark gave decision makers a platform to begin with and adjust depending upon specific location requirements. Having a model to work from provides shorter design requirements and more agile decision-making abilities. A commercial responder stated of his company, “We put together a prototype

because we didn't know exactly what we would need but we had an idea so that each one would be somewhat interchangeable at least. Going forward that became the prototype for the whole company." If the modernization project is well benchmarked or prototyped, then its overall assessment of flexibility would be more favorable.

Phased Approach

A common theme amongst the commercial sector and literature from de Neufville (2011) was a phased approach. The government responders believed in a phased approach but only insomuch as there were several phases of the overall project execution. The commercial sector relied upon the ability to continue or cease the overall project at the completion of each phase for flexibility. With this knowledge a prudent decision maker can gain benefits from considering these top attributes to provide flexibility: timeline, phases, design, net present value or discounted cash flow, and benchmarked success.

Local Purchasing Power

Throughout the research many responders commented on the level of purchasing power within an organization. The lower the level of purchasing power, the more rapidly an organization could respond to developing technologies, benefits, or avoidance of overages. The larger the chain of command between purchasing power and execution, the larger the timeline for decisions and often larger cost for mistakes or missed opportunities. Delegating portions of purchasing ability to the lower levels allows for more flexibly designed executions of projects. In turn this allows for the lower level expert team the power to maximize the return on investment.

Vendor Relationships

Maintaining a small pool of vendors or suppliers consistently allows for relationships between the buyer and supplier. The chain becomes a symbiotic relationship where each is working to benefit the other because it will eventually benefit them. Strong, repeated relationships pass information quickly. They adapt to arising situations with the other organizations benefit as a core driving factor. If the organization has strong relationships with its supply chain, then it will flexibly alter its course more efficiently and successfully.

End Goal Alignment

The modernization project for each organization must directly improve or strengthen the end goal of that organization. Aligning decisions to goals can maximize value and allows decision makers to directly evaluate investments. As decision makers evaluate options they can consider different phases and options for their project. Each option should improve their end goal metrics as defined by the organization. Furthermore, the end goal alignment will provide criteria for option comparison not only from the onset of the project but throughout its development and execution.

Timeline

The timeline can be viewed as a strength. An elongated timeline allows for further design development and goal alignment while letting the technology develop within the industry. The assessment would be whether or not the agency can reap benefits during the timeline of the project. If the timeline is short, then the flexibility will most likely be lower and thus a lower score should be given. A longer timeline, if cost-free adjustments can be made during it, should

give a higher score allowing more decisions and changes prior to execution. The phased approach relies on the ability to break decisively between stages of the overarching project. The modernization of an entire distribution center could be segmented in order to invest smaller individual amounts and potentially reach the 80% benefit sufficient to stop the project.

Return on Investment

An evaluation of investment consistently touts the largest consideration by decision makers. It must be included to weight the score. A short and long-term view of investment should be considered. The money invested or set aside early on for one project but not “costed” until later in the project could potentially earn benefits elsewhere. Understanding the value of money long term will help when considering a truly phased approach. If the project is broken into smaller projects, albeit costlier individually, then the investments can be spread across more platforms or a longer timeline. The division of investment allows decision makers a more diverse and flexible option for project continuance or secession.

Criteria for Evaluation

The organization and decision makers specifically, needs to have an upfront understanding of their evaluation criteria. The quantitative comparison categories that will be judging the project’s phases must be laid out to properly assess. Without an understanding of critical components and values there will be no determining factors to flexibly plan a course of action. Using valued components from the overall goal and strategy should provide a starting point for decisions to be evaluated.

Limiting Factors

Finding commercial equivalents to DLA EDC members proved more difficult than anticipated. Several contacts were too busy with the holiday season to take interviews and the researcher merely did not know enough people within the industry to cast a wider net. This was overcome by utilizing the individuals that were interviewed based off the similarities between large modernizations or warehouses, distribution centers, and large-scale construction projects renovating products from research laboratories to air craft carriers.

Furthermore, it would have been beneficial to study the process of modernizing the distribution center over a longer time period. As Yin highlights, cause and effect studies are beneficial in case studies (Yin, 2014). The given timeline and structure of this particular case study was not well suited for a lengthy observation of this method. If the research was conducted in residence over the life of the project and assurance that the modernization would take place there could be even more benefits gained from development and early design phases. This obstacle was avoided by attempting to gain knowledge from personnel involved throughout the process and the most up to date respondents interviewed.

Lastly, the opinions of the respondents will always be biased in a qualitative study. This unavoidable limitation certainly seems limiting but assuming the biases up front allows the interviewer to frame their questions to eliminate as much bias as possible. There were few speculative or opinion only questions asked. The questioning focused on experiences and attributes of projects in the past.

Further Research

There are three areas for future study: change management, a green-field study, and contract construction. How change and innovative processes affect organizations is critical to understand. The ability to purchase and plan a new method of doing business may make sense to executives but studying how it will work at the operational level can provide benefits to decision makers as well. There is a significant amount of contract law specialization necessary to research the possibilities with creative and flexible contracts. There was a small focus in this research on the options to add or modify contracts, but a further study may offer great benefit to the DoD. Finally, research on a green-field analysis can provide knowledge from the ground up. The DLA Distribution Center in California is considering a green-field project that could reveal benefits or costs differently than a renovation of an antiquated structure.

Closing Remarks

The EDC requires modernization to maintain the warfighter support that DLA demands. The facility and project can be used as a beginning template for the DoD to model further modernization prototypes. The decision makers can plan for flexible options within this project that allow them to capture the most value for the least cost. It will require investments, expertise, and time. Through proper evaluation of design, organizational factors, and executability, DLA can flexibly adapt to certain uncertainties. DLA and the DoD can further improve upon their initial modernization as they move forward. Keeping their end goal in sight at all times, they can support the warfighter while flexibly designing modernization efforts across the enterprise.

Appendix A: Interview Questions

Pilot Interview Guide for Exploratory Interviews: DLA EDC Project

Introduction (~3 mins)

Hi, _____, my name is Steven Lane, and I am a Masters Student in Logistics and Supply Chain Management at the Air Force Institute of Technology. How are you doing today?

🕒 Thanks for agreeing to talk with me, and thanks for your time. The purpose of this interview is to ask you some questions about the work your organization does with planning and designing large modernization projects. I would like you to think of it as an open conversation, rather free flowing, about the framework of decisions that you all think about when developing project designs. *It won't take more than 1 hour but less time is of course ok.*

Now, since it is an academic interview, you have some special rights as a respondent:

- All the information you give me today will be treated confidentially.
 - Your name and your organization's name will not be linked to any answer.
 - I am having similar discussions with multiple stakeholders in this area, including individuals from government and inter-government organizations such as DLA, NASA, Husky Energy, P&G, Newport News Shipbuilding, and other for-profit companies. Any insights or take-aways from our conversation will be reported as originating from the stakeholder group and not a specific person or company, unless you give me permission to do so.
- The interview is voluntary, which means:
 - You have the right to decline to answer any particular question,
 - And you can stop the interview at any time.
- I now request your permission to record the interview, if that's OK with you. 🕒
 - You have the right to stop the recording at any time.

- The recording will be kept in an encrypted digital file, guarded by me personally.
- All copies will be destroyed once our research project is complete.

Do you have any questions? 🔄 (Answer the questions, if any). Let's proceed.

Positioning questions (~10-15 minutes):

1) Can you describe your current duties and role?

1a) What does your work primarily entail?

1b) How long have you worked in the organization? In the development or supply chain realm?

2) Can you tell me a bit about (your company)'s background?

2a) Where do you operate – regional or country specific?

2b) What about the overall budget and size of your operations?

2c) What modernization projects have you recently seen or been a part of?

3) Can you talk a bit about your warehousing process?

3a) How much inventory do you hold?

3b) What technologies do you currently have?

3c) What technologies did you improve on/wish to improve?

4) Can you talk a bit about your Distribution processes?

3a) How much processing do you experience daily/weekly?

3b) What technologies do you currently have?

3c) What technologies did you improve on/wish to improve?

Closed section on SC financing topics (~30-45 minutes):

1. Can you tell me about _____'s business and operations currently?
 - a. What gap in ability existed or exists that required modernization?

- b. Who do you compare yourself to?
 - c. What do you wish you knew a year ago?
- 2. What projects have you all worked on recently?
- 3. Are there any modernizations you are currently working on?
 - a. Do you see any in the near future?
- 4. Did you commit money for recent projects upfront?
 - a. Why or why not?
 - b. Was it a consideration?
- 5. What modernization efforts or projects have you all undertaken?
- 6. Did you set up a pilot study?
 - a. Was this a consideration?
 - b. How did it help?
- 7. What are the challenges and issues around modernizing?
- 8. Did you consider any flexible options?
 - a. What did they look like?
 - b. Did you delay decision points/commitments?
 - c. What options did you have upfront?
- 9. What unexpected costs or events arose during your project?
 - a. What would have been helpful to know ahead to prevent?
 - b. What barriers did you face before and during?
- 10. What about risk and risk mitigation?
 - a. How do you identify risks?
 - b. What did you do to prevent?
 - c. What kind of uncertainties did you anticipate? Supply/funding/technology?
- 11. What critical constraints did you face?
 - a. When designing a project what constraints were limiting?
 - b. What constraints did you use in any modelling that you conducted?
- 12. Did you consider alternative options/designs?
 - a. What made you choose the one you did?

13. What kind of return on investment do you all consider?

14. What additional options would you have liked to have?

During the course of this conversation, try to move the conversation from the individuals to the organization's overall strategy and how it has positioned itself in modernization/design of projects. Try to keep it anchored on how decisions are made.

- *For interesting things, ask: "Tell me more about X".*
- *When the respondent is getting vague, ask: "Can you give me an example of X?"*
(Especially important for successful or unsuccessful programs or operations. Make sure their definition of success is outlined).
- *If the conversation is getting lost in operational details, ask: "What is the purpose of this?", or "What is the philosophy/idea behind this?"*
- *If the conversation is getting too strategic, ask: "How do you implement this?", or "How do you ensure this happens", or "How do you enable this?", depending on the subject.*

Strategic / Open section (~5-15 minutes)

(Note: All these questions are optional. Ask only those that seem relevant to the position and that have not been answered before during the course of the conversation.)

1. What do you wish you knew, or, what would you do differently?
2. Can you talk about any truly effective, or ineffective strategies that you have seen deployed in your organization or others?

Thank you very much for your time and that's pretty much what I had to ask you. The formal portion of our discussion is over, and I'm turning off the recorder.

- Are there any points you would like to add or do you have any feedback for me? I really appreciate your answers and your time. Would you happen to have any contacts that you think would be interesting in having a similar conversation?

I hope I can contact you with follow up questions after I have analyzed our conversation. I'll send a copy of the interview transcript if you would like to review our conversation. Thanks again!

Appendix B: Codes and Definitions

Nomenclature	Definition
Purchasing Power	The level at which purchasing decision can be made
Purchasing Agility	The flexibility to change purchasing decisions rapidly *Development or discussion amongst a breadth of people looking at the project from each person's professional expertise
Detailed Design's Elements	Correctly filled out and articulate RFP's, requiring little to no alterations, specific design elements *Considerations like: Specific actions/policies for specific goods
Preferred Vendors / sources	Relationship between supplier/vendor and purchasing agent
Agile Support System	Creating a system to rapidly respond to the market/demand, by decreasing on hand inventory
Green Field vs. Reno	Debating between the benefits/feasibility of a retrofit or green field
Breaking into Parts/Phases	Pros/Cons of phased approaches or investing portions for partial modernizations instead of the entire thing at once *Independent vs. dependent phases of the project, independent can be done simultaneously or separately but dependent portions must be accomplished in specific order *Building in the options to grow over time / increase capacity (final phase is growth option for future)
Pilot Study	Conducting simulations or practice runs of modernization or piece to test functionality
Benchmarking	Comparing to other industry leaders and past projects and not re-inventing the wheel
Single Source Contracting	Using one contract/bid to conduct all of a project *Hiring contractors to perform analysis or 3PL functions
Regulations	Limiting factor of regulatory guidance *Auditability and having eyes on items
Cost of overages/contingency money	How much something tends to go over or how much they assume they will need to cover unknowns
End Goal Alignment	Purpose development of facility modernizations aligned with funders purpose for facility (i.e. winning the request for money) *Using key performance metrics to pass along end goal
Competitive Advantage	Investments should provide competitive advantage when weighing investment decisions / do the job better or do new things others aren't *Adding Value and a focus on defined value
Automation Integration	The importance /non-importance to a firm of incorporating automation
Payback Requirements (ROI)	The terms or demands of paying back the investment *Lessons learned, tracking the true cost/resource utilization *Putting together True cost estimates

Cost Cutting	Cost cutting measures to provide flexible cash flow
Timeline	The weight of importance of timeline/schedule of a project
Risk Mitigation	Specific actions identified to avoid or kill risk
Work Force / Labor	Flexibility in surge capacity and funding through labor hiring/firing *Training required/not due to modernization
Option Comparisons	Comparing options presented to one another, using either simulation or theoretical data; criteria developed to compare options
Payment Method	The manner in which firm's pay for the service/projects they require

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14. ABSTRACT The Department of Defense relies upon a vast network logistics facilities and capabilities across the planet. Assets are largely sourced from the Defense Logistics Agency, which is considering a modernization project for their Eastern Distribution Center (EDC). It handles 25% of all materials that DLA supplies, and the facility is antiquated. In order to maximize their investment, flexible options for the modernization should be considered. This research was conducted as a case study of the EDC in order to develop a framework of flexibility for DoD decision makers going forward. This case study gathers subject matter expert knowledge from government and commercial decision makers to develop a framework for DoD managers moving forward into the future.					
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