

**THE EFFECT OF MILITARY CONSTRUCTION
TRANSFORMATION ON PROJECT COST AND SCHEDULE
WITHIN THE UNITED STATES ARMY CORPS OF ENGINEERS
SOUTH ATLANTIC DIVISION**

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by

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TABLE OF CONTENTS

ACKNOWLEDGEMENTS	iv
LIST OF TABLES	viii
LIST OF FIGURES	ix
LIST OF SYMBOLS AND ABBREVIATIONS	x
SUMMARY	xiii
CHAPTER 1. Introduction	1
1.1 The United States Corps of Engineers	2
1.1.1 Overview	2
1.1.2 South Atlantic Division	4
1.2 Base Realignment and Closure	6
1.3 USACE Project Delivery Models	7
1.3.1 Design-Bid-Build	7
1.3.2 Design-Build	8
1.3.3 Adapt-Build	9
1.3.4 Conters of Standardization	9
1.4 MILCON Transformation	Error! Bookmark not defined.0
CHAPTER 2. Literature Review	14
2.1 History of Public Sector Procurement	14
2.1.1 Pre-WWII Procurement	14
2.1.2 Post-WWII Procurement	15
2.2 Legislation	115
2.2.1 The Federal Acquisition Regulation (FAR)	1Error! Bookmark not defined.
2.2.2 The 1972 Brooks Architect and Engineer Act	17
2.2.3 The Competition in Contracting Act	18
2.3 MILCON and the USACE Project Management Business Practice	19
2.3.1 Military Construction	19
2.3.2 Project Management Business Process (PMBP)	20
2.4 Current Studies in Public Sector Design-Build Procurement	22
2.4.1 MILCON Cost Premiums	22
2.4.2 The Penn State Study (Konchar, 1997)	25
2.4.3 Public Sector Design-Build Evolution and Performance	27
2.4.4 Public Sector Design-Build Procurement Techniques	30
2.4.5 Model for Public Sector Design-Build Project Selection	32
2.4.6 NAVFAC Design-Build Performance	33
2.4.7 Design-Build Performance in the United States	34
2.4.8 MILCON Transformation Engineer Inspector General Report	35
2.5 Metrics for Evaluating Construction Projects	36

2.6	Problem Statement and Research Questions	37
CHAPTER 3.	Methodology	39
3.1	Research Framework	39
3.2	Data Collection Protocol	40
3.2.1	Electronic Database Warehouse (EDW)	40
3.2.2	Data Filtering Criteria	41
3.2.3	Time-Value of Money Adjustment	45
3.3	Data Demographics	46
3.4	Analysis	49
3.4.1	Metrics	49
3.4.2	Welch's T-test	51
3.4.3	Qualitative Evaluation	52
CHAPTER 4.	Data Analysis	54
4.1	Analysis of All South Atlantic Division Projects	54
4.1.1	Cost	54
4.1.2	Time	56
4.1.3	Commanders Rollup of Overall South Atlantic Division Performance	57
4.2	Analysis by Building Type	59
4.2.1	Administrative Building Type	Error! Bookmark not defined.1
4.2.2	Barracks Building Type	62
4.2.3	Community/Food Service Building Type	Error! Bookmark not defined.4
4.3	Analysis by District	155
4.3.1	Savannah District	Error! Bookmark not defined.7
4.3.2	Mobile District	68
4.3.3	Charleston District	70
4.3.4	Wilmington District	71
CHAPTER 5.	Conclusions	73
5.1	Conclusions to Research Questions	74
5.1.1	Cost Savings	74
5.1.2	Schedule Reduction	75
5.2	External Validation of Results	77
5.2.1	Question 1 Responses	77
5.2.2	Question 2 Responses	77
5.2.3	Question 3 Responses	78
5.2.4	Question 4 Responses	80
5.3	Limitations	82
5.4	Future Research	83
5.4.1	Cops-wide Study	83
5.4.2	Quality Measurements	83
5.4.3	Qualitative Analysis	83
5.5	Conclusions	84
5.6	Recommendations	85
APPENDIX A.	MILCON Funding Codes Used	87

APPENDIX B. Data Elements	88
REFERENCES	97

LIST OF TABLES

Table 1	Center of Standardization Responsibilities within the South Atlantic Division	11
Table 2	Median Scores for 351 Projects by Project Delivery System (Konchar, 1997)	28
Table 3	Difference between Project Delivery Systems by Metric (Konchar, 1997)	29
Table 4	Advantages and Disadvantages of Design/Build Methods (Molenaar 1999)	33
Table 5	Type I and II error explanation (Miller, 1977)	54
Table 6	Cost T-test Summary of All SAD Projects from 2002-2014	58
Table 7	Time T-test Summary of All SAD Projects from 2002-2014	60
Table 8	Commanders Roll-up of All SAD Projects from 2002-2014	64
Table 9	Commanders Roll-up of Administrative SAD Projects	67
Table 10	Commanders Roll-up of Barracks SAD Projects	69
Table 11	Commanders Roll-up of Community/Food Service SAD Projects	70
Table 12	Commanders Roll-up of Savannah District Projects	73
Table 13	Commanders Roll-up of Mobile District Projects	75
Table 14	Commanders Roll-up of Charleston District Projects	76
Table 15	Commanders Roll-up of Wilmington District Projects	77
Table 16	MILCON Fund Codes	95

LIST OF FIGURES

Figure 2	The MILCON Business Process (Project, 2010)	22
Figure 3	The USACE Project Delivery Process (PMBP, 2009)	24
Figure 4	Design/Build Project Performance (Molenaar, 1999)	30
Figure 5	Type of Specifications (Molenaar, 1999)	31
Figure 6	Applied Research Process (Sekaran, 1992)	42
Figure 7	Yearly Project Dispersion for Collected Data	44
Figure 8	Impact of Data Filtering	47
Figure 9	Project Breakdown by Cost Category	48
Figure 10	Project Breakdown by Year and Project Delivery Method	49
Figure 11	Impact of BRAC by Year	50
Figure 12	Project Dispersion by Building Type	66
Figure 13	Amount of Projects by District	71

LIST OF SYMBOLS AND ABBREVIATIONS

A&E	Architect and Engineer
AFB	Air Force base
BEQ	Bachelor Enlisted Quarters
BRAC	Base Realignment and Closure
BIM	Building Information Modeling
BOD	Beneficial Occupancy Date
BOT	Build-Operate-Transfer
CEFMS	Corps of Engineers Financial Management System
CICA	Competition in Contracting Act
CMAA	Construction Management Association of America
CMAR	Construction Management at Risk
COS	Center of Standardization
CPI	Consumer Price Index
DA	Department of the Army
DB	Design-Build
DBB	Design-Bid-Build
DBO	Design-Build-Operate
DPW	Directorate of Public Works
DOD	Department of Defense
EDW	Electronic Database Warehouse
EFARS	Engineer Federal Acquisition Regulation Supplement
EIG	Engineer Inspector General

FAR Federal Acquisition Regulation

FARA Federal Acquisition Reform Act

GS General Schedule

GSA General Services Agency

GWOT Global War on Terror

IDIQ Indefinite Delivery Indefinite Quantity

IRB Internal Review Board

LEED Leadership in Energy and Environmental Design

MATOC Multiple Award Task Order Contract

MILCON Military Construction

NASA National Aeronautical Space Administration

NAVFAC Naval Facility Command

P2 Program and Project Management Business Process

PDT Project Design Team

PMBP Project Management Business Practice

PMP Project Management Plan

QBS Qualifications Based Selection

RFI Request for Information

RFP Request for Proposal

RMS Resident Management System

SAD South Atlantic Division

SAC Charleston District

SAM Mobile District

SAS Savannah District

SATOC Single Award Task Order Contract

SAW Wilmington District

SOF Special Operations Forces

SOW Scope of Work

USACE United States Corps of Engineers

UAI USACE Acquisition Instruction

USG United States Government

SUMMARY

The United States Corps of Engineers (USACE) has been the primary Construction Agent of the United States Army and Air Force. Its members are considered the experts in project delivery for the Department of Defense (DoD). In 2006, the Base Realignment and Closure Program (BRAC) and the Global War on Terrorism (GWOT) led to increased workload which caused the USACE to adopt the Design-Build project delivery process as a primary means of project delivery in an effort to leverage the method's ability to deliver projects at a lower cost and faster delivery time as compared to conventional methods. The focused use of the Design-Build process was to become the primary business practice of USACE after the BRAC/GWOT period, replacing the traditional Design-Bid-Build process that had dominated the USACE landscape for 50 years. The USACE Commander's intent behind the Design-Build incorporation was to realize a 15% cost savings and a 30% reduction in delivery time over the traditional method. This measure of success would serve as a guide to the USACE for future business practices.

Military Construction Transformation, or MILCON Transformation, was the name designated to the Design-Build process when it was approved as the primary form of project delivery in the USACE in 2006. Since then, the four-year spike in project workload brought about during the BRAC and initial GWOT period has been diminished, and the business practice has taken some time to incorporate refinements based on lessons learned during the BRAC/GWOT period. In 2009 the Engineer Inspector General (EIG) was commissioned to measure the performance standards given by the USACE Commander, but after conducting only interviews of district chiefs across the USACE, the EIG was

unable to quantify any project data that was relatable to the Commander's metric (EIG, 2009). Independent studies evaluating the performance of Design-Build in various domains of the public sector have been conducted in the past, however a measurement of this specificity has yet to be conducted.

The scope of this thesis is to evaluate the MILCON Transformation performance of the of the South Atlantic Division during 2002-2014. Project data was gathered from the USACE-internal automated information system, Enterprise Data Warehouse (EDW). Only MILCON, vertical construction project data was collected from EDW, and four hypothesis based off cost and time were developed for testing. Five project milestones for 304 projects that qualified for evaluation were evaluated using 180 separate Welch's T-tests to test for a statistically significant difference between Design-Bid-Build and Design-Build. Of the 180 T-tests conducted, 37 were in support of the alternate hypothesis, which stated that there was a statistically significant difference with 95% confidence between the two project delivery models.

Projects were analyzed in three different ways. First, projects were distributed between the two project delivery populations and all performance metrics regarding cost and time were analyzed from the Division level. Next, projects were analyzed by building type, to find out if there were any specific types of buildings where Design-Build performed better than Design-Bid-Build. Finally, projects were analyzed by District, where projects from each of the 5 Districts within the South Atlantic Division were analyzed to determine if any one District executed Design-Build more successfully than another District. From this analysis, it was found that the 15% reduction of cost by use of Design-

Build was realized from a Division level. However, in no circumstance was the target 30% reduction in time realized for the Division, any District, or any specific building type.

Results were then presented to a focus group of leaders within the USACE South Atlantic Division to gather insight on why the USACE Commanders goals were not completely met. Since literature pointed to Design-Build as being a source of lower cost and time in the public sector, data results warranted further insight as to why the USACE struggled to gain full value from the Design-Build delivery model. The focus group validated the data and findings while attributing discovered performance metrics to operational tempo, manpower, and conservative management. From these results, the researcher submits recommendations on how the USACE can realize greater value from the use of Design-Build.

CHAPTER 1. INTRODUCTION

Military Construction (MILCON) projects have fluctuated in amount over the past 15 years due to the Congressionally mandated Base Realignment and Closure, the reduction of the Global War on Terror (GWOT), and the completion of the United States Army's Force Re-alignment. However, at more than six billion dollars of congressional funding, it tends to show that the amount of demand is growing (Bloomberg, 2014). The United States Corps of Engineers (USACE) is tasked to provide professional construction procurement services to the United States Army, Air Force, and any other Federal Agency that requests design and construction services. USACE enacted a program called Military Transformation in the beginning of 2006, a program that was intended to refocus the USACE business model to becoming more Design-Build oriented. Part of this transformation was to develop Model Requests for Proposals (RFP) in Centers of Standardization throughout various USACE Districts. These RFP's communicated baseline USACE standards that were meant to be performance-oriented in their specifications. The purpose for turning towards this business model was to explore the different options the private commercial market could give the USACE through allowing design-builders the flexibility to define value (Tyler, 2006). Prior to MILCON Transformation, the USACE South Atlantic Division (SAD) experienced a project cost of \$52 Million and an average contract growth of 3%. With the GWOT and the BRAC mandate, a change was necessary to give Districts the flexibility to keep project efficiency to at an optimal level. MILCON Transformation was expected to reduce project cost by fifteen percent and reduce project delivery time by thirty percent while meeting additional

Federal design requirements (Temple, 2006). The examination of MILCON projects within the South Atlantic Division of USACE will be able to provide insight into whether or not the intent of MILCON Transformation was met.

1.1 The United States Corps of Engineers

1.1.1 Overview

The Department of Defense (DoD) employs the USACE as the primary construction agent to be responsible for the development of military infrastructure. The USACE primarily finds their customers in the United States Army and Air Force however can be requested by outside governmental agencies such as NASA and the National Parks Service. While the USACE has the responsibility of providing services for major Civil Works such as maintaining waterways and basins within the United States, it has roots in Military Construction. The USACE is divided into 9 divisions and 45 districts, each responsible for their own geographic area and the Civil Works and MILCON projects within those areas.

The districts are organized in a military fashion, with each district having a commander and a chain of command that flows to the lowest levels. Each district is commanded by either a Lieutenant Colonel or full Colonel, who is responsible for everything that occurs within the district. From there the district is broken down to a civilian and military chain of command which helps manage the professional civilian augmentation to the district. The Deputy Commander is the military portion of that split which controls the administrative functions of the district such as logistics and personnel.

The civilian is a General Schedule Fifteen (GS-15) Deputy District Engineer who is responsible for the operations, or projects of the district.

Each district at the USACE has different specified missions, but generally their scope falls in Civil Works (water ways, infrastructure), Emergency Relief, Military Construction and Regulation. Civil Works has been the primary function of the USACE since its development, but MILCON remains a constant focus. The districts are staffed based off the type of work they conduct and the workload.

Each district is broken up into several functional divisions on the operational side that help delineate tasks and responsibilities within the district. These areas include engineering and construction, program management, contracting, real estate management, resource management and information management. Each division has a “Chief” which is a GS-15. Each division is kept separate from the other, with closely correlating entities such as Engineering and Construction kept separate.

The engineering division incorporates all disciplines of engineers with all professional service personnel licensed through the states in which the district operates. Architects are assigned to the Engineering section in order to facilitate internal design of projects and to conduct design reviews of contracted work. Every type of engineer and architect can be inserted into a PDT as needed to work under the direction of a project manager, however they answer to the Chief of Engineering. This format of personnel accountability holds true for every division within a district.

No district is staffed the same, with personnel hired in accordance with their mission need. For example, within the South Atlantic Division, the Jacksonville District is set up

to accommodate their focus on Civil Works projects. This is in stark contrast to the Savannah District who has a large MILCON effort to complement their Civil Works campaign focused on the Savannah River.

USACE is set up to be a “one-stop shop” for all potential customers. Each district is already responsible for their geographical area, but many districts are also the Center of Standardization (CoS) for the USACE as a whole. For example, if the Los Angeles District accepts responsibility to work on a hospital at Ft. Irwin, they will incorporate a member from the Medical Expertise CoS in Huntsville, Alabama into their Project Delivery Team in order to bring the specialized expertise necessary and the standardized structure design to the project. Another example would be that if any district wants to construct a new base family housing complex, the Savannah District CoS would be consulted to provide design specifications for that project. Each CoS has specific model RFP’s for their respective building type which can be sent to a District, and together with the CoS expert, the project-owning district can deliver the building in a more streamlined fashion.

1.1.2 The South Atlantic Division

The South Atlantic Division is headquartered in Atlanta, Georgia and supervises the operations of its five assigned districts; located in Savannah, Mobile, Jacksonville, Charleston, and Wilmington. Each district has their own area of geographic responsibility that includes both Civil Works and MILCON projects. No one district is structured and staffed the same, with each tailoring their personnel to meet the challenges specific to their region. For purposes of this study, the Jacksonville District was omitted due to their lack

of a sustained MILCON program. The four other Districts contributed to the Division MILCON program in varying, but sustained degrees.

The Savannah District is the largest district and has the widest mission set within the South Atlantic Division. Civil Works missions include the oversight and maintenance of three major dams and lakes, the Savannah Harbor, multiple levee's and wetlands. Their MILCON program is equally as robust, facilitating construction operations of 10 bases, including Fort Benning, Fort Bragg, Fort Stewart, and Dobbins Air Force Base (AFB). With this region of responsibility that incorporates a large military need, the Savannah District represents one of the largest MILCON project loads in the USACE. The Savannah District is also the Center of Standardization (CoS) for family housing, headquarters, and support infrastructure for brigades, battalions, and companies. This standardization can be found throughout all Army units that have had both new construction and renovation over the past 15 years.

The Mobile District is equally as diverse as their sister Savannah, but have a smaller concentration of a MILCON program. Focused on providing hydroelectric power at eight different locations and managing five main river systems and basins, Mobile's MILCON program pales in comparison to their Civil Works effort. However, the MILCON program is substantially diverse, manning remote project offices on 15 different military bases.

Charleston is focused on Civil Works, with numerous efforts focused on the Charleston Harbor as well as flood and hurricane mitigation. However, the Charleston District does provide MILCON project support primarily to Fort Jackson, a large training base located outside Columbia, South Carolina. They also provide MILCON support to

four other locations, enabling the construction of necessary infrastructure from barracks to headquarters for tenant units.

The Wilmington District can be closely associated with its sister Charleston when focusing its Civil Works efforts on flood and hurricane management as well as the numerous ports along the coastline of its geographic responsibility. Wilmington's MILCON program has grown since 2007 when the South Atlantic Commander focused Wilmington on providing MILCON services to the Special Operations Command at Fort Bragg, North Carolina. The district has overseen the growth of Special Operations infrastructure throughout the course of the past ten years and continues to maintain the Military Ocean Terminal Sunny Point, which is the United States Army's primary deep water port along the east coast.

1.2 Base Realignment and Closure

Since 1988 the United States Government has directed 5 separate BRAC analysis from the Department of Defense (DoD). Until the 2001 directive, the previous four had been responsible for the closing of 97 major domestic bases and 235 minor installation closures or realignments with 55 major base realignments (Ewing, 2006). The United States Army began to conduct an internal analysis of capacity based off the 2001 directive and prepared recommendations for the BRAC 2005 Congressional Commission. 95% of the Army's recommendations were received by the commission and by November of 2005 the recommendations were signed into law with a completion date of October 2011. The Army's piece of BRAC was expected to see of \$1.5 billion of reoccurring savings and began to reshuffle brigades across the continental United States (Ewing, 2006). The

USACE, being the construction agent for the Army and Air Force was placed in charge of overseeing the various renovations and closures of military bases and camps across the United States. This task ran concurrently with the outbreak of the GWOT as their construction task included not just the BRAC mission, but enabling the United States Army for war. Staffing for USACE remained generally the same, and as a means to cope with the increased workload, MILCON Transformation was put into place. Until BRAC's completion in 2011, USACE was executing projects at speeds that had previously been unrecognizable due to the shifted primary focus on schedule and mission completion that MILCON Transformation brought.

1.3 USACE Project Delivery Models

1.3.1 Design-Bid-Build

The Design-Bid-Build (DBB) method is considered to be one of the oldest forms of project delivery. DBB is the most commonly used delivery method for construction in both the public and private sectors. Commonly, the owner will contract with an architect or an Architect and Engineer (A&E) firm in order to develop the project through the design process. Generally, the A&E firm will walk the owner through several critical design phases including programming, schematic design, design development, and construction documents with owners approval after each step required in order for the firm to continue design. Once the construction documents are completed and approved, they are assimilated into a bid package and presented to contractors who are interested in completing the work. General contractors will come back to the owner with pricing bids based on the design package and one will be selected, generally through the lowest responsive and responsible

bid. Contractors, just like the A&E firm will enter into a separate contract with the owner in an agreement to complete a project for a specific period of time, cost, and quality. Generally the architect will assist the owner throughout construction in order to answer any Requests For Information (RFI) that the contractor might have. In order to keep the project on time and on budget, an owner may also hire a Construction Manager in order to represent him throughout matters in the design and construction phase, and to vet decision points that need the owners input or guidance (CMAA, 2010).

There are numerous ways to procure services during a DBB administered project, however, in the public sector, particularly with the USACE, a firm-fixed price is generally the more common approach. There are however other procurement possibilities as outlined in Part 32 of the FAR which lists choices from incentive-based contracting to lump-sum bidding. The USACE generally sticks to firm-fixed price due to its extensive understanding throughout all public sector agencies, however in some Design-Build contracts they will assume an incentive contract.

1.3.2 Design-Build

Design-Build (DB) became regulated for public sector construction in 1996 with the Clinger-Cohen Act. The project delivery method attempts to bridge the communication and knowledge gap between architect and contractor by bidding them as one firm. The firm is under a single contract with the owner that facilitates a simplified work flow and gives a single touch-point for the owner to communicate with during project delivery. This delivery system harkens back to the Master-Builder concept of old, where a single individual was skilled enough to create, build, and manage construction of a structure.

However, with facilities much more advanced than previous years, it takes a specialized team that the DB firm brings to the competition table in order to reduce cost and time to a minimum. This reduction of cost and time, which has been well researched to support the reduction claim (Molenaar, 1998; Webster, 1997; Roth, 1995; Konchar, 1998) has only recently been approved by the federal government as an alternate project delivery method. While being conceptualized as early as the 1970's, design-build was not approved by the federal government until 1996 after heavily scrutinized testing and specific authorizations from Congress, and it was not until later when the military began to incorporate it into service-regulation in effort to curtail rising cost and scheduling issues.

1.3.3 Adapt-Build

Adapt-Build is a USACE variation of Design-Build. Adapt-Build is taken from the private sector's Design-Build variation of Bridging (Project, 2010). The process is driven by the model RFP which is developed for each type of building type the USACE has to deliver. These model RFP's are primarily designed to schematics and are written with predominately performance specifications. These are developed in-house by the engineering division within a Center of Standardization (CoS). They are refined as requirements change and post-project recommendations are made. Adapt-Build is performance specification oriented for site development work while having prescriptive specifications for the actual facilities (Project, 2010). Adapt-Build is used for applicable buildings which need to be produced in larger amounts, such as barracks, dining facilities and family housing.

As part of the “One door to the Corps” approach, each District has the ability to reach out to the applicable CoS that is in charge of maintaining a model RFP for the building type needed to be procured. The CoS generally provides the model RFP and necessary technical support. This allows for the PDT to be adequately staffed with the appropriate personnel, thus allowing the programming process to be streamlined.

Once a model RFP is amended to support the installation design plan, a request for qualifications are sent out to prospective contractors. From the respondents, a shortlist is made, following the two-step procurement process that is outlined in the FAR. From there, an RFP is sent to the contractors on the shortlist.

1.3.4 Centers of Standardization

Part of the MILCON Transformation effort was to create Centers of Standardization (CoS) into already existing Districts. These CoS would develop and maintain model RFP’s for specific building types. In the South Atlantic Division, only two Districts acted as CoS. Table 1 below outlines the responsibilities of the Savannah and Mobile District CoS.

Districts/CoS are charged to develop and maintain model RFP’s, Building Information Modelling (BIM) and other drawings in effort to continue to refine and develop the RFP’s. The intent is to find an appropriate balance between the performance and prescriptive specifications. The designs are intended to accommodate the owners standard of façade that is outlined in the base design plan.

Table 1: Center of Standardization Responsibilities within the South Atlantic Division

Savannah CoS	Mobile CoS
Company Operations Facility	Aviation – Vertical Construction
Tactical Equipment Maintenance	Four-Star HQ Facilities
Brigade Operations Complex	
Brigade/Battalion HQ Administrative	
Command/Control Corps HQ	
Deployment Facility	

1.4 MILCON Transformation

USACE business practices adapted in 2006 as they moved from the Traditional DBB to a DB primary project delivery model in effort to save time and money. BRAC 2005 and Army restructuring were a major influencer for this change, however the introduction of the DB centric MILCON Transformation was intended to endure past the BRAC and GWOT mission period. MILCON had up until that point had heavy reliance on the DBB project delivery method, and the USACE was not experiencing much cost and budgeting success with using it (Tyler, 2006). As a result, the concept of MILCON Transformation was introduced, in which the USACE commander at the time had stipulated some criteria for success. According to the USACE, MILCON Transformation would be considered successful if costs were reduced by 15% and there would be an average of 30% time

savings realized (Tyler, 2006). There were to be no compromises on procurement or construction requirements, such as Small Business involvement, LEED requirements, or Anti-Terrorism/Base Security requirements because these were unavoidable standards that are a part of most Federal projects (Temple 2006, Blomberg 2014).

Precedent for the use of Design-Build as a more efficient project delivery model had been established within the USACE since 1994 and the building of the Sparkman Center in Huntsville, Alabama (Setzer, 1993). However, despite the USACE's success in delivering an efficient project, multiple protests from losing-bid contractors influenced the USACE to shelve any ideas for DB being a primary project delivery model. DB would then be used only under careful planning and scrutiny. When MILCON Transformation was being tested, five different projects were completed during the fiscal year 2006 that indicated that DB was a project delivery method to endorse as a primary business model (Tyler, 2006). Successes across the nation, on bases such as Forts Campbell, Knox, Riley, Carson, and Bliss indicated that DB would bring 15% cost savings within 100% scope (Tyler, 2006). These projects included a diverse range of building types, from barracks to headquarters and dining facilities. Lessons learned from this study of projects were then used to define the expected success of MILCON Transformation.

To assist in achieving the cost and time goals, USACE created several administrative and system controls. Systematically, USACE introduced their CoS and model RFP for standardized building types. This changed the format in which project scope was communicated to the bidder. Administratively, USACE published ER 1180-1-9, which provided a standardized set of evaluation criteria to PDT leaders in order to help them navigate DB contractor selection. The criteria laid out in ER 1180-1-9 serves not just as

selection justification, but also helps the PDT leader navigate the complex environment of completely defined customer requirements, project size and complexity, quality requirements and time constraints. The regulation dictates a mandatory market analysis that takes into account the capabilities and experience of the potential contractors to ensure there are qualified bidders available to handle the DB work. Finally, the PDT leader is guided through FAR 36.301 which lists out the DB contractor procurement criteria (ER1180, 2012).

With the advent of the CoS and Model RFP, USACE began a divergence away from prescriptive specifications to performance specifications. This process hinged on the Adapt-Build project delivery method, where the in-house design team of USACE defines the initial scope with a design ranging from 10-70% completion which is communicated through the model RFP. This was meant to allow contractors more flexibility to conduct value engineering during their design collaboration. USACE, not just the South Atlantic Division also incorporated the use of the International Building Code (IBC) and several other commercial standards, to encourage the performance specification intent that the USACE is trying to achieve through MILCON Transformation.

Since implementation of MILCON Transformation, the USACE has gone through the BRAC, which was a holistic approach at altering military infrastructure to meet the demands of the Army going through an organizational change during a time of war. The use of MILCON Transformation and its Adapt-Build project delivery process made it possible to keep up with the demand of new infrastructure development and renovations. The purpose of this study is to quantify USACE project data to confirm that the USACE

Commanders intent of MILCON Transformation has been met, with a 15% reduction of project cost and a 30% reduction in project delivery time.

CHAPTER 2. LITERATURE REVIEW

2.1 History of Public Sector Procurement

2.1.1 Pre-World War II

From the beginning of the United States until 1933 the Federal Government was largely dependent on private funding to finance governmental infrastructure. The United States Government (USG) developed a Dual Track Strategy towards project procurement to accomplish both military and civilian infrastructure requirements between USG and private sector construction assets.

The USG was financially strained due to routine wars in its fledgling history and the lack of ability to procure outside financial help from friendly governments forced the USG to exercise extreme financial responsibility. Infrastructure that was deemed routine was placed on Track 1 largely due to their being generally well understood, which made for certain successful project delivery. New industrial and transportation capabilities that were necessary for the westward development of the nation was largely financed through partnerships with private entrepreneurs who had interest in the westward growth. Project delivery models such as Build-Operate-Transfer (BOT) and Design-Build-Operate (DBO) were the vehicles for the USG to develop the construction and transportation infrastructure that was necessary for the country to deal with its rapid expansion. Steel bridges, canals, and ferry services that were constructed under the franchises of BOT and DBO laid the foundation of the telegraph and transcontinental railroad success (Dobbin, 1994).

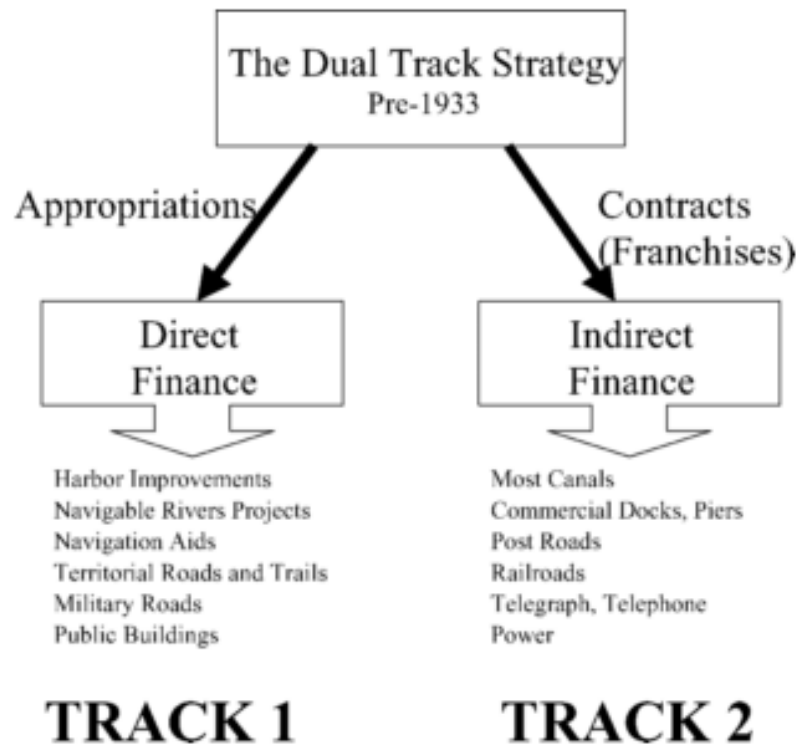


Figure 1: US Dual Track Strategy (Pietroforte, 2002)

As the success of these delivery models was proven, the private franchises were given more latitude to expand as newer technology developed, thus ushering in a rapidly developing infrastructure with the emergence of water power dams. Since USACE was positioned at the time as the USG primary construction agent, they provided the government oversight of all waterway improvements and dam operations.

Professionalism of the separate construction entities at the time was also beginning to take hold, with architecture and engineering services forming their own separate organizations to set trade standards and the builders unionizing. Rapid construction and governmental backing of private franchises had set the tone for specialized professions to develop standards of practice within their community and hold each other accountable. Furthermore, the government began validating these standards by issuing licenses that were

based off standards set by the professionals. This was largely due to issues seen in and around 1875 where there were over 20 cases a year of bridges and dams failing due to faulty design occurring (Pietroforte, 2002). Unions became a mainstay in American culture pre-World War II due to the proliferation of construction related safety and man-hour issues. Men who had grown up in the builder section of the construction system began to focus on their own quality of life and safety standards.

2.1.2 Post-World War II

The economic situation in America post-World War II was ripe for American veterans returning home. President Franklin Roosevelt had set the conditions through his New Deal concept to establish federal procurement regulations for the governmental agencies such as the General Services Administration he had set up. Federal control over government construction started becoming a reality with the 1947 Armed Services Procurement Act and the 1949 Federal Property and Administration Act. The latter provided federal construction agents such as USACE and GSA to use methods such as DBB over the then traditional BOT or DBO. This act only encouraged architects and engineers to establish themselves in their niche and begin competing for the federal dollars which had begun to flow through municipal governments due to the Federalization that had taken place in the United States during the 1950's (Pietroforte, 2002).

2.2 Legislation

2.2.1 The Federal Acquisition Regulation (FAR)

The Federal Acquisition Regulation (FAR) was developed by the Federal Procurement Policy Act of 1974 and serves as the regulation for all Federal entities that

required contractual services from the private sector. The FAR was developed and is maintained by the Secretary of Defense, the Administrator of the General Services Administration and the Administrator of the National Aeronautics and Space Administration. The FAR derives its authority from Public Law 93-400 and outlines in six subchapters and 53 parts how to procure contracted services from the private sector. The FAR can have additional regulation added to it that is specific to the Federal organization doing the contractual procurement. For example, USACE has their own USACE Acquisition Instruction (UAI) and Engineering Federal Acquisition Regulation Supplement (EFARS) that supplements the FAR and provides additional contractual guidance to USACE employees. Generally, these policies cannot be circumvented except by going under an extreme request for exemption process. For construction agents, the original version of the FAR only allowed for the DBB method to be used for all construction projects. This was attributed to the project delivery method's perceived ability to set conditions for a competitive and transparent bidding process.

A major change was authorized to the FAR through the Clinger-Cohen Act of 1996. Before the Clinger-Cohen Act, Congress allowed both the United States Army and Navy to select three projects each out of their MILCON project list per year with the intent to use the DB method in 1985 (Roth, 1995). This set conditions for Congress authorizing less than 10 projects annually for the DB method in the Department of Defense for the next 10 years leading up to the Clinger-Cohen Act (Loulakis, 2003).

This reform included significant additions to the FAR to include Part 36 of the FAR which added in the DB method as an authorized project delivery model for construction agents to utilize and redacted the limited use of DB. This method was authorized under two

procurement methods, a one-phase and a two-phase method. The one-phase method allows for a construction agent to receive bids from Design-Build contractors without price as a competitive factor. From there, a construction agent makes a determination of which proposal to accept based off qualifications and design. The two-phase method allows a construction agent to send out a Request for Proposal (RFP) to all potential contractors. From the responses, a construction agent can make a shortlist of desired contractors and send back out a request for bid. Bids are then sent in by the contractors to the government construction agent, an DB contractor is selected, and a project moves into execution.

2.2.2 The 1972 Brooks Architect and Engineer Act

As the architecture and engineering professions became more formalized, and work became more available, it started becoming apparent that a low-bid process of procurement was not always conducive to finding the best design. Since the beginning of public sector procurement, selection of architect services had been largely based on good faith with the understanding that a franchises or architects reputation was behind the price, and that an architect's experience was reflected in that reputation. While markets developed and opportunities for employment increased, it became more apparent to the USG that more refinements were needed to the public sector procurement process. Safety concerns derived from catastrophic collapses in other countries highlighted the importance of government standards getting ahead of the potential problems with low bid and formalizing a Qualifications Based Selection (QBS) for public construction agents (Stone, 2012). The Brooks Act would set conditions for the use of Design-Build in federal regulation 20 years later.

2.2.3 The Competition in Contracting Act

From 1975 to 1984 Litton Industries executed over 45 contracts for the US Military in which they were found to defraud the USG out of \$6.3 Million (Smith, 1986). Instances such as Litton Industries and the “Pentagon Catalog” which advertised diagrams of military hardware such as hammers being sold at \$435 dollars. Screws, bolts, any item that could go into a greater material that was procured through contract was grossly overpriced and justifications of price were that such materials were exclusive and specialized. The authors of the Pentagon Catalog, Christopher Cerf and Henry Beard stated that the success of Litton Industries was attributed to the lack of competitive bidding, lack of fiscal accountability by the government (Smith, 1986).

The scandals resulted in a refinement to the QBS that the Brooks Act defined. Passed into law in 1984, it served as the basis for the soon to come FAR, enacted by the GSA and DoD entities in April of the same year. The intent of the Competition in Contracting Act (CICA) was to ensure that competitive bidding took place with all federal procurement in effort to reduce costs and open opportunities for small businesses to win government contracts. Competition advocates are personnel in each federal construction agency tasked with reviewing and challenging any anti-competition methods. Single Award Task Order Contracts (SATOC), which do not govern MILCON projects are excluded from the CICA, while the Multiple Award Task Order Contract (MATOC) which MILCON projects are defined under the FAR (GSA, 2012).

2.3 Military Construction and the USACE Project Management Business Process

2.3.1 Military Construction (MILCON)

MILCON is a type of public sector construction where military units construct new facilities at a value of \$750,000 or more. The MILCON business process is depicted in Figure 2 below. Generally taking around eight years, it is a lengthy process focused around ensuring congressional appropriations and completing the design/construction process. The process of acquiring the funds through congressional appropriation can sometimes take up to two years after the initial planning charrette and initial DA Form 1391 which initiates a project. Once the funds are procured, the USACE is notified via a Directorate of Public Works (DPW), which acts as the base commanders representative and represents the users of the facility to be built. Throughout the design and construction process, USACE acts as the construction agent for the garrison commander and his DPW representative. The process and interaction is supposed to promote collaboration and teamwork, both with the Owner/User (Garrison Commander), the Design Team, Contractors, and the USACE PDT (Project, 2010).

MILCON Business Process

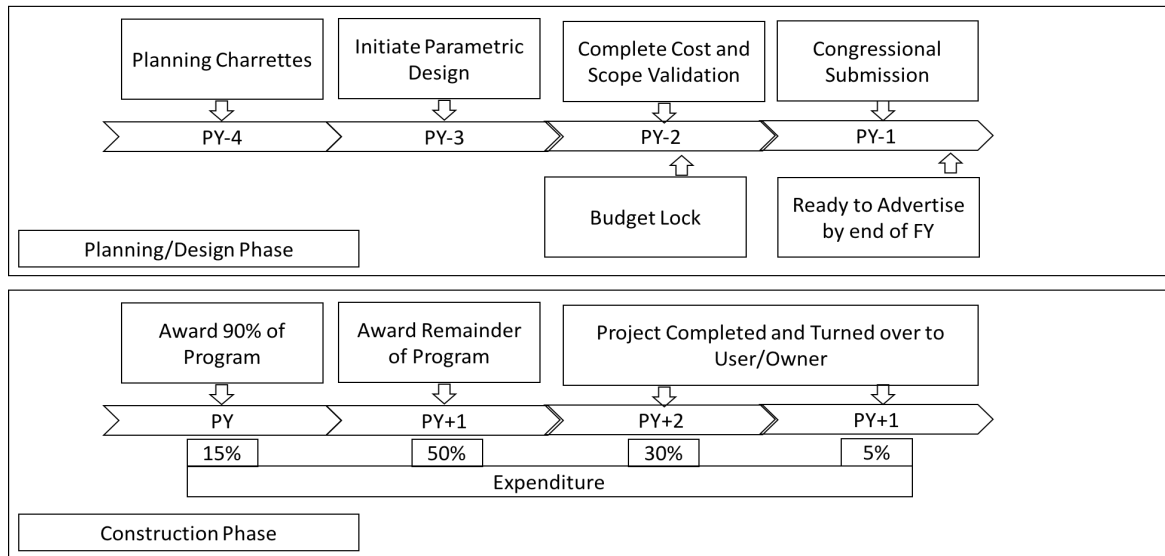


Figure 2: The MILCON Business Process (Project, 2010)

2.3.2 Project Management Business Process (PMBP)

The USACE PMBP is the outline by which MILCON projects are executed. Arranged by a series of flowcharts, each hub in the flowchart is defined as a process which has it's own series of steps in order to complete the process step. Applying to "the planning, development and management of programs as well as projects" it is used at all program levels within USACE (Project, 2010). The PMBP as it stands today began to take shape as early as 1939 with Congress authorizing the USACE to contract for A/E services. Over the next 60 years, the USACE business practice was largely shaped by Federal Law, however in 1992 the USACE began to codify its practices through internal regulation. ER 5-7-1 was the initial Program and Project Management regulation designed to guide the USACE employees through the project delivery process. This was not revamped until 2001 when ER 5-1-11 became available as well as the implementation of Project Management Plans

(PMP's). Finally, ER 5-1-11 was updated in November of 2006 to reflect the implementation of MILCON Transformation. The subsequent PMBP that followed was to align the USACE business practices with the Project Management Body of Knowledge (PMBOK) issued by the Project Management Institute (Project, 2010).

The PMBP goals are to maintain open communication between the customer (owner/user) and contractors while keeping the user in mind. The PDT is completely tailorable to fit the specific project by custom fitting an assortment of specialists, consultants and other governmental liaisons to ensure project success. Led by a Project Manager, the USACE's vision of PDT's and the PMBP is to "never forget that the finished product of our efforts is the delivery of a complete and usable facility to our military family on time and within budget" (Project, 2010).

Figure 3 below is an adapted outline of the Project Delivery Process, as outlined by the PMBP. It's primary purpose is to streamline the project delivery process and bring consistency to USACE's business practices. There are process procedures for every milestone within the delivery process which warrants specific actions by the Project Manager and the PDT. This ensures that due diligence is performed among all levels of managers within USACE no matter what level of ability in the project manager.

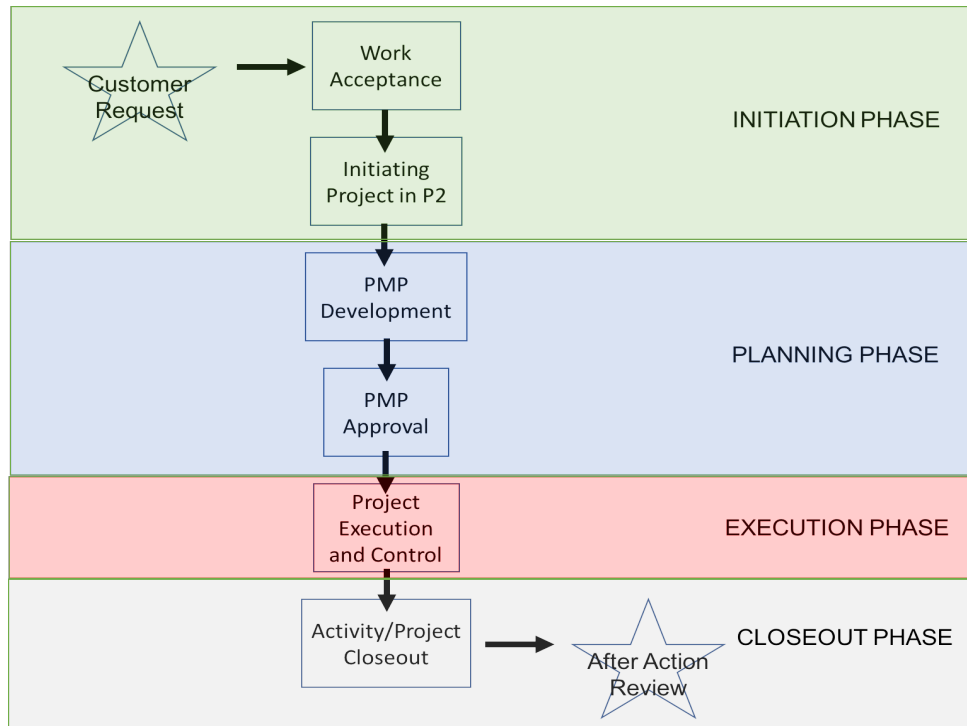


Figure 3: The USACE Project Delivery Process (PMBP, 2009)

2.4 Current Studies in Public Sector Design-Build Procurement

2.4.1 MILCON Cost Premiums

2012 and the advent of a new Congress led the members of the Congressional body to investigate the assumption that construction costs were still rising for MILCON programs. In 2011 it was assumed that out of the \$30 billion spent on federal construction, 40% of it was spent on MILCON programs (Blomberg, 2014). Following the Congressional lead, a study was launched, which was directed at Air Force procurement processes. While the Air Force accounts for a smaller percentage of all MILCON programs, it's primary construction agent, USACE is one of four mandated agents that the military can use according to DoD Directive 4270.5.

Previous to the study into MILCON premiums in the Air Force, there had been several other analyses done by both the House Armed Services Committee and private entities (Pope, 1990). The 112th Congress found that there was a 25% to 40% cost difference between MILCON cost when comparing like-facility construction with the private sector (112th Congress, 2011). The reasons between the differences between the sectors generally vary greatly, with attention being focused on regulations imposed by the Federal Acquisition Regulation or internal, self-imposed regulation that military construction agents adhere to such as the EFARS or UAI. The added regulation, while necessary to ensure that USACE and other construction agents maintain fair competition amongst potential bidders, can force the construction agent into a form of linear thinking. This has been reflected through the study in Air Force projects where the USACE PMBP would push Design-Build Contractors to agree to a schedule and cost within two months, while it is generally understood for that agreement to take anywhere between eight months to a year (Blomberg, 2014).

The case-study examined the impact of different construction agent regulation by conducting an analysis of two identical hangars built in Alaska by different construction agents. The goal was to identify, if cost was higher for either construction agent and the reasons for the difference in final cost. One hangar utilized USACE as an Construction agent, and the other utilized U.S. General Services Administration (GSA) schedule and procurement techniques. The structure that the utilized the GSA scheduling and DB techniques ended up costing 27% less than the one that USACE procured (Blomberg, 2014). Both structures were programmed with the same amount of money, scope and timeline. Differences between the two can be demonstrated in two examples. First was an

issue with quality requirements for flooring. The GSA scope building allowed for expert opinion to allow for a cheaper alternative that met the performance specifications for the flooring. However, USACE scope building prescribed specific standards for the floors, driving up cost and labor hours. Secondly, the differences between the RFP's, Scopes of Work, and contractor administrative requirements was shown through the 161 total pages for the GSA building while USACE had over 1,000 total pages (Blomberg, 2014). Further investigation through surveys of contractors indicated that USACE was more stringent through their requirements, an opinion which ranked number one out of six possible rankings of contract requirement differences between the GSA and the USACE (Blomberg, 2014).

Final conclusions from the study indicated that a federal construction agent will generally partner with a private contractor through a contract only, and not actively participate in problem solving (Blomberg, 2014). The shift in business practices between DBB and DB only shifts risk completely from the construction agent to the contractor, instead of finding a middle ground to share the risk. Issues with committing to a fixed price too early, such as with the Alaska District of USACE, resulted in a higher cost and turned a longer schedule than originally intended. Therefore, the issue of true collaboration may be a characteristic of an individual district, rather than a consideration of USACE as a complete entity.

2.4.2 The Penn State Study (Konchar, 1997)

Konchar's study of project delivery methods were limited to the three most widely used methods in the United States at the time of study. Project performance data was

gathered from 351 United States building projects in both the public and private sector that would evaluate factors of cost, time, and quality in a univariate and multivariate comparison. The study collected, checked, and validated industry data, and was one of the first to use multivariate linear regression models to predict average project performance. Konchar conducted significance testing using almost 100 variables to explain the relationship between cost, schedule and quality performance. Furthermore, comparisons between delivery systems and different facility type were investigated (Konchar, 1997).

Research was sponsored by the Construction Industry Institute and was divided into four phases. Phase one consisted of developing performance metrics and data collection instruments. Konchar's key metrics have become the standard used in studies today, such as Unit Cost, Cost Growth, Intensity, Construction Speed and Schedule Growth. Quality was measured using a qualitative analysis, by sending surveys out to Owners who would rate their satisfaction of their building's performance. Phase two was the collection of data where 7,600 surveys were sent with a response rate of 5.1% (Konchar, 1997). This made for 301 usable projects once the responses were vetted for projects that fit the scope of the study. Phase three and four were the data scrubbing and analysis portions of the study with sample t-tests for means and Mood's median test being used to combine data samples. The results of these tests confirmed that the data was statistically similar, indicating that comparisons were valid.

Distribution of the three project delivery models were unbiased towards any specific delivery system with 23% of projects being CMAR, 33% traditional, and 44% design-build. Initial Univariate cost and schedule results can be seen in the table below.

Table 2: Median Scores for 351 Projects by Project Delivery System (Konchar, 1997)

Metric (1)	Unit (2)	Construc- tion man- agement at risk (3)	Design/ build (4)	Design/ bid/build (5)	Maximum standard error (6)
Unit cost	Dollars/m ²	1,140	861	1,291	197
Cost growth	%	3.37	2.17	4.83	2.2
Schedule growth	%	0	0	4.44	1.7
Construction speed	m ² /month	761	845	477	220
Delivery speed	m ² /month	438	636	302	191
Intensity	(dollars/m ²)/ month	50	62	40	13

From Table 2, Design-Build and CMAR has surpassed the Traditional method by all metrics. This suggests that by having a Contractor involved early, as the DB and CMAR methods do, the probability for lower cost and scheduling growth rise. To confirm this hypothesis, Konchar conducted multivariate regression analysis to develop three models that would explain cost, construction speed, and delivery speed.

Table 3 below outlines the results of the multivariate linear regression that evaluated the project delivery systems. By considering data from every variables data points in this research, regression adjusted direct project delivery comparisons. Konchar extrapolated five models, three representing primary results based on unit cost, construction speed, and delivery speed. The remaining two were cost and schedule growth which represented areas of less certainty. The first three columns summarize the results of the models, while the fourth column displays the percentage of variation explained in the model.

Table 3: Difference between Project Delivery Systems by Metric (Konchar, 1997)

Multivariate model (1)	U.S.			R ² (%) (5)
	DB versus CMR (%) (2)	CMR versus DBB (%) (3)	DB versus DBB (%) (4)	
Unit cost	4.5 less	1.5 less	6 less	99
Construction speed	7 faster	6 faster	12 faster	89
Delivery speed	23 faster	13 faster	33 faster	87
Cost growth	12.6 less	7.8 more	5.2 less	24
Schedule growth	2.2 less	9.2 less	11.4 less	24
Note: DB = design/build; DBB = design/bid/build; CMR = construction management at risk; NA = not ap				

Konchar's research is beneficial to Owners by displaying a project delivery models strength in successfully delivering a project under budget and scheduled completion time. Project attributes as well as cost, time and quality considerations for project delivery models for specific faculties can act as guidelines for Owners to follow when developing their project management plan.

2.4.3 Public Sector Design-Build Evolution and Performance

The private sector has a greater amount of latitude for project procurement than the public sector. The FAR allocates strict rules in place for federal entities to conduct project delivery. After the Federal Acquisition Reform Act of 1996, only the Traditional and DB project delivery methods are authorized for use at the Federal level of government (FAR, 1996). This limits Federal agencies for project delivery options, and places responsibility on those agencies to be good stewards of governmental funds while maintaining a climate for open competition.

The validation of DB as being a more effective project delivery method than DBB for the Public Sector was the topic of several studies in the 1990's (Webster, 1999, Roth, 1995, Gordon, 1994, Konchar, 1998). Quantifying the markets reception towards a new

way of conducting governmental project delivery was crucial to ensure that there were enough private firms available who understood the DB process and could make a bidding process competitive. A study from the University of Colorado-Boulder measured the advantages and disadvantages of the One-Step, Two-Step and Qualifications Based DB Methods which highlighted the changes that the 1996 Federal Acquisition Reform Act put into place with the authorization of federal construction agents to utilize the DB method (Molenaar, 1999).

The study of the different selection methods was based on 104 public sector projects that used the DB method. Projects, as well as participating governmental agencies ranged from the federal, state to local level (Molenaar, 1999). Figure 4 below displays the project performance data for the DB method in the public sector. Based on those projects, 59% were within 2% of the budget that was established when the DB firm was hired while 77% of the projects were within 2% of the established schedule. These metrics are given that 73% of the DB firms that were hired were at 25% or less of the completed design (Molenaar 1999).

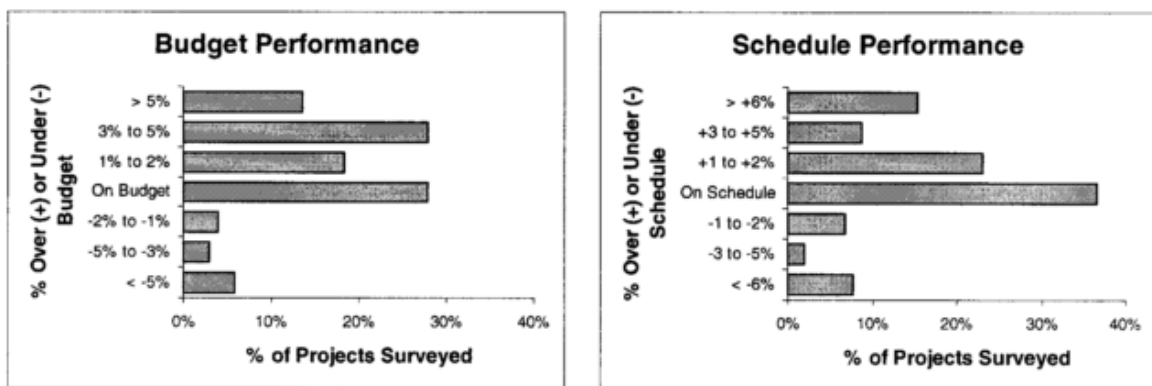


Figure 4: Design/Build Project Performance (Molenaar, 1999)

While the DB method has shown that it can be beneficial to adopt, it has resistance within the public sector. Aside from the project delivery method being shown to be more efficient than the traditional method, several public owners, who were experienced in DB, indicated in interviews that the early pre-design and design phases are more difficult than the traditional method (Molenaar, 1995). This could be an indicator with the public sectors familiarity with prescriptive specifications rather than being comfortable with performance specifications. DB generally forces an Owner to lean more towards the use of Performance Specifications, which allow the Contractor to give more input on saving cost by finding cost-effective quality substitutions. This fundamental change from the Traditional method, which uses almost all Prescriptive Specifications, that has defined the public sector's business method for the past few decades (Molenaar, 1999). Figure 5 below outlines the type of specifications that were noted throughout the study.

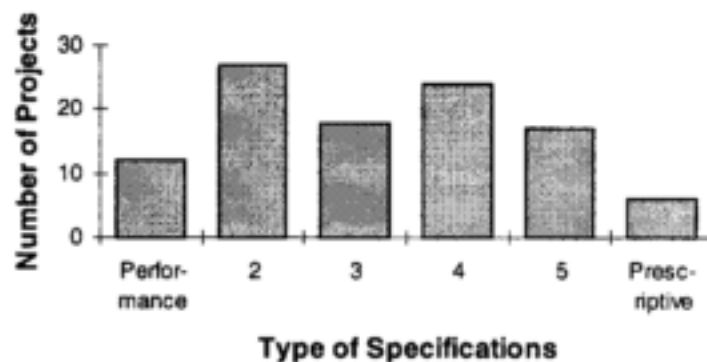


Figure 5: Type of Specifications (Molenaar, 1999)

DB has grown in popularity so much to where certain federal public entities such as USACE and NAVFAC, have recently began developing their own procedures to supplement the DB procurement procedures outlined in the FAR. However, even with this popularity growth, a public owners lack of sophistication with the DB method can limit the

delivery methods effectiveness with a unrelenting focus prescriptive specifications. This study acted as a benchmark for public owners to refer to when developing a procurement strategy. The 1996 FARA outlined a 2-step DB method that has been adopted by most public entities today. The public sector, despite the additional regulations that govern their procedures such as the FAR, can still gain the cost and schedule advantages of DB by relying more on performance specifications, contractor expertise, and team collaboration.

2.4.4 Public Sector Design-Build Procurement Techniques

The validation of DB as being a more effective project delivery method than DBB for the Public Sector was the topic of several studies in the 1990's. Quantifying the market's reception towards a new way of conducting governmental project delivery was crucial to ensure that there were enough private firms available who understood the DB process and could make a bidding process competitive. Table 4 below illustrates results from a study from the University of Colorado-Boulder measured advantages and disadvantages of the One-Step, Two-Step and Qualifications Based DB procurement Methods which highlighted the changes that the 1996 Federal Acquisition Reform Act put into place with the authorization of federal construction agents to utilize the DB method (Molenaar, 1999).

Qualifications Based Selection was omitted of the table because it is not used by USACE. The study of the different selection methods was based on 104 public sector completed design build projects with participating agencies ranging from the federal, state and local levels (Molenaar, 1999). Based on those projects, 59% were within 2% of the budget that was established when the design/build firm was hired while 77% of the projects

were within 2% of the established schedule. 73% of the design/build firms in the study were hired when the design was at 25% or less of the completed design (Molenaar, 1999).

Table 4: Advantages and Disadvantages of Design/Build Methods (Molenaar 1999)

Form of Design/Build	Advantages	Disadvantages
One-Step Procurement	<ul style="list-style-type: none"> • Allows for award on overall value (price and technical) • Designs that exceed minimum specifications can be realized • Delivers a product that most closely conforms to the user expectations 	<ul style="list-style-type: none"> • Burdensome to evaluate multiple proposals • Greatest chance of delays due to protests from inadequate offerors • Costly preparation for offerors • May require the most detail in the RFP, placing a burden on the owner
Two-Step Procurement	<ul style="list-style-type: none"> • Allows for award on overall value (price and technical) • Allows for short-listing, saving owner and offeror time and money • Offers a wider range of design solutions • Delivers the best budget and schedule performance 	<ul style="list-style-type: none"> • Technical and design review process can become lengthy • Chance of delays due to protests from inadequate offerors during technical evaluations • If low bid award is chosen, all classic low-bid problems exist

2.4.5 Model for Public Sector Design-Build Project Selection

The University of Colorado sponsored a study in 1998 focused on developing a predictive model for Design-Build use. This study, based off 122 projects in the public

sector, relied heavily on the Federal level for its models with over 75% of its data coming from that entity. Using questionnaires as a source of data collection, inputs were compiled based off Owners, Designers, and Contractors responses when they were asked to rate building construction performance criteria based on a variety of factors. Utilizing regression, the study was able to develop a model that could predict the potential for success for projects using the DB method.

Key results from the study indicate that DB saw high levels of success when first used by a construction agent, but did not sustain that success as the entity became more familiar with the process (Molenaar, 1998). This confirms Blomberg's suspicion, based upon contractors assertions that the construction agent was pushing too much risk onto the Design-Builder by not fully immersing themselves into the design process (Blomberg, 2014).

2.4.6 NAVFAC Design-Build Performance

The United States Navy's Facility Command (NAVFAC) is the DoD sister of USACE that primarily serves the Navy and Marine Corps construction needs much like USACE serves the Army and Air Force. NAVFAC operates under the same conditions as USACE and conducted an analysis of both DBB and DB within its business structure. Hale (2009), realized early in the data collection process that it was necessary to narrow down the analysis by only taking samples from each project delivery method as they were applied to a specific building type. For NAVFAC, the Bachelor Enlisted Quarters (BEQ) was chosen as the building type to be studied. BEQ's are similar to U.S. Army barracks in that the facilities are designed essentially the same across branches. Designs are kept

generally the same, with only façades being changed based on which base the structure is located on. Therefore, the conditions in which the two sample sizes of 39 DBB projects and 38 DB projects were generally the same and suitable for an accurate comparison.

Results of the NAVFAC study were clearly supported by statistical significance for performance metrics related to time, but only suggestive when related to cost. Hale (2009) acknowledges that the homogeneity of the samples can only characterize the performance in BEQ's. He continues to say that careful analysis should be made before extending these results to other facility types (Hale, 2009). However, due to the close homogeneity of design standards between BEQ's and Army barracks, it is assumed for this study that Hale's study could indicate a savings in time for the USACE efforts in procuring barracks for Army bases.

2.4.7 Design-Build Performance in the United States Air Force

The United States Air Force's primary construction agent is USACE, which makes Rosner (2009) research into Air Force MILCON projects closely related to this study. For his study, a data set of 835 Air Force MILCON projects were analysed to determine the best project delivery system. DBB and DB were compared using six different performance metrics via one-tail T-Tests. Additionally, a facility type analysis was conducted for nine facility types to identify which facility types were best suited for the DB delivery method.

While the project data was skewed heavily in the favor of DBB with 557 projects, DB demonstrated a statistically significant reduction of cost growth and controllable change in the 278 projects built under the DB method. It is interesting to note that the DBB method outperformed DB for performance metrics related to time. However when Rosner

compares his study to historical data, DB is shown to be closing the performance gap that DBB currently held (Rosner, 2009). This was shown in cost growth, where DB reduce it's margin from 8.21% in FY 96 to 2.79% in FY 04 (Rosner, 2009). Additional reductions in Modifications Amount and Project length in years were realized during the same time frames with DB reducing itself by \$1.78 Million and 0.84 years (Rosner, 2009).

Examination of the project performance trends showed that certain facility types could set the conditions for a more successful use of either DBB or DB. Using the same performance metrics that were used for the overall comparison, Rosner compared the two delivery methods for nine different facility types. Of those nine, six facility types were found to result in better performance when DB was used as a delivery method. Out of these six identified, Operations, Administration, Fitness Centers, and Child Development Centers were applicable to the current study. Roser concluded that Maintenance, Storage and Dormitory did not seem to favour either method. Air Force Dormitories are closely aligned with Army Barracks in terms of design and therefore was also focused on as well as the DB preferred four building types for the current study.

2.4.8 MILCON Transformation Engineer Inspector General Report

In 2009 the USACE Commander ordered the Engineer Inspector General (EIG) to conduct an investigation into MILCON Transformation to see if the original intent had been met. The EIG assembled a team of three personnel to conduct interviews and have discussions at all levels of USACE command. Four Division Commands, all eight CoS Districts and three additional Districts that had MILCON missions but no CoS

responsibility were sampled. The purpose of the inspection was to evaluate MILCON Transformation from the following objectives:

- Command-wide understanding and support of MILCON Transformation principles
- Whether MILCON Transformation goals and objectives had been attained
- Whether Customers have adjusted to the MILCON Transformation process (EIG, 2009)

The EIG team conducted interviews with USACE personnel for nine months and at the conclusion the team found no quantifiable evidence that supported the objectives. The final report stated that the team could not quantify any cost savings because USACE commands had not developed a system to identify and segregate cost that would identify successful implementation of the MILCON Transformation process. MILCON Transformation schedule completion, which was aimed to overall reduce time by 30% rate as compared to the traditional process, also had no system to measure data to support that metric. Since then, various automated information systems such as the Electronic Database Warehouse have become available making project data more accessible, however a study of MILCON Transformation has yet to be completed.

2.5 Metrics for Evaluating Construction Projects

The importance of standardizing a project's performance metrics is important so that evaluations can be conducted across the construction market, and not just an individual firm or entity. While numerically articulating the perceived success of a project through figures relating to cost and time is important, this data is not completely indicative

of the reasons for why a project was successful or unsuccessful. Projects that have a negative trend in numbers that are less than the original contracted amount are generally referred to as successful, while those with inflated metrics are considered unsuccessful. However, there are a multitude of reasons why cost and time inflate, and having quantifiable data points for each reason is important in developing a standardized perception across the professional landscape.

Project metric types can be classified as relative, static and dynamic (Gransberg, 2002). Relative metrics allow financiers to evaluate small projects alongside larger projects and identify trends in a project management. Static metrics are a product of a project's size in relation to time and cost, and when used for a study need to be compared with projects of similar scope. Finally, dynamic metrics are a product of cost versus time which numerically articulates a project's efficiency (Gransberg, 2002). Each metric has its own limitations which can be mitigated through the proper application of filters to ensure that equal conditions exist between the types of projects being compared. The USACE has long used these types of metrics to evaluate project performance which is therefore is justification to use them throughout this study (Gransberg, 1999).

2.6 Problem Statement and Research Questions

Research into the comparison between DB and DBB is extensive and supports the hypothesis that true savings can be achieved in the current market using DB over DBB. MILCON Transformation was the business model change that the USACE Commander believed was necessary to bring USACE up to current private sector standards and achieve new savings. The implementation of MILCON Transformation during the beginning of

BRAC was crucial to USACE achieving mission success, while at the same time maintaining control of financial resources and time. MILCON Transformation was enacted during a time of high operational tempo and was theorized to be able to be tailored to the high demands of an army modernizing at a rapid rate. Thus, the focus on a reduction of cost and time was important to the USACE Commander so that he could deliver much needed buildings to base commanders at a lesser cost and time than DBB was currently delivering. To address this problem the following research questions are proposed:

2.6.1 Cost Savings

Was the USACE Commander's intent of 15% reduction in cost by implementing MILCON Transformation as an alternative to the traditional DBB project delivery method achieved?

H₀: There is no difference in Cost between DB projects and DBB projects.

H₁: There is a lower cost for DB projects than DBB projects.

2.6.2 Schedule Reduction

Was the USACE Commander's intent of generating a 30% time savings by implementing MILCON Transformation as an alternative to the traditional DBB project delivery method achieved?

H₀: There is no difference in project delivery duration for DB projects in comparison to DBB projects.

H₂: There is a shorter project delivery duration for DB Projects in comparison to DBB projects.

CHAPTER 3. METHODOLOGY

The purpose of this study was to answer the questions that were proposed in Chapter Two and to quantify the assumptions made in the Engineer Inspector General's report. To help establish and vet performance metrics, a pilot-study was conducted on Barracks-classified building type projects within the Savannah District. That study established the standards and parameters for harvesting, cleaning and analyzing data throughout this thesis. From that study, the basis for the investigation into the South Atlantic Division took shape. All project data was collected and analyzed at the South Atlantic Division Headquarters in Atlanta, Georgia.

3.1 Research Framework

This study was developed using the Applied Research Process outlined in Figure 6 below. Block one was achieved by researching the issues surrounding public sector cost and schedule inflation in comparison to the private sector. This led into preliminary data gathering where a literature review was conducted on the analysis of the two authorized types of project delivery methods in the Federal government.

Through this review, a gap in knowledge was discovered in USACE's metrics where the measurement of MILCON Transformation had not been quantified and compared against project data from the Traditional Method. The investigation into this project data as well as past and present USACE business practices helped identify the framework of the study. Further reading of the USACE Project Management Business Processes (PMBP) shows that the intent of both the DBB and DB Project Delivery Methods is to maximize the efficiency of the taxpayer dollar. This indicated that developing hypotheses that were

focused on the differences between the two methods are best suited to suggest reasons for reductions in cost and time for MILCON projects. Block 6, the Scientific Research and Design will be discussed in this Methodology Chapter while the Data Analysis and Deduction portions of the Research Process will be discussed in Chapter's 4 and 5 respectively.

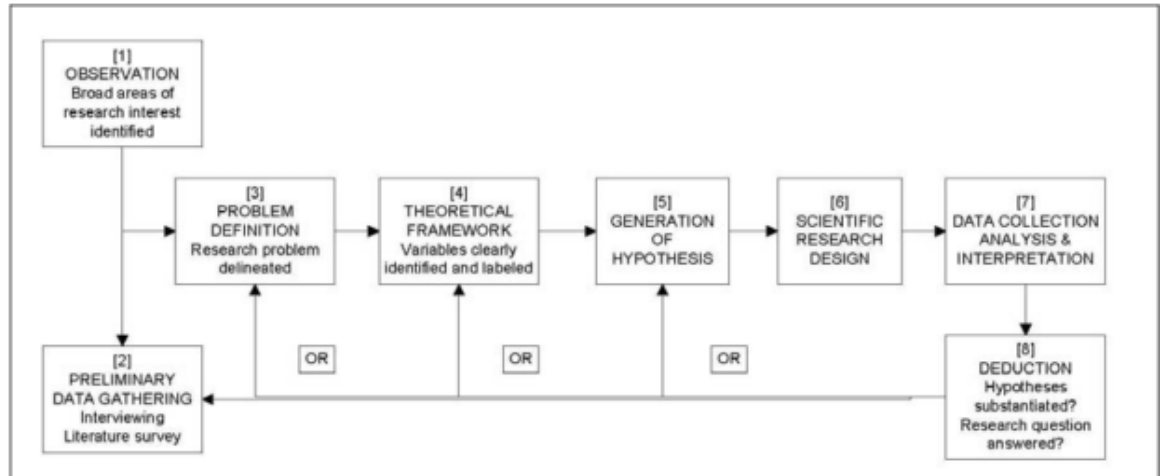


Figure 6 Applied Research Process (Sekaran, 1992)

3.2 Data Collection Protocol

3.2.1 Enterprise Data Warehouse (EDW)

The primary data gathering tool of this study was the USACE's Enterprise Data Warehouse (EDW). EDW is an automated information system that allows the USACE Project Data Managers to gather and quantify project data that meets the Commanders reporting needs. EDW pulls its information from several other USACE databases which are:

1. Resident Management System (RMS)- Construction-related information. RMS is, "a quality management and contract administration tool that provides an

efficient method to plan, manage, and control construction projects” (Project, 2010).

2. Program and Project Management Business Process (P2)- project-definition and basic financial information. P2 is, “an automated information system (AIS) to effectively manage all programs and projects in USACE” (Project, 2010).
3. Corps of Engineers Financial Management System (CEFMS)- project financial data. CEFMS is, “the primary source of financial statements and upward reporting requirements necessary to comply with the CFO Act” (Project, 2010). It supplies labor data necessary to pay the USACE employees for work completed.

Project information gathered from EDW is tailorable to the request using project milestones which are outlined in the Military Programs Data Dictionary, a USACE-internal publication that aids employees in understanding the types of Project Reports, their associated Milestones and the associated Codes that communicate project development. The project data from EDW can be filtered by every Milestone for every project conducted by all Divisions and Districts inside USACE.

3.2.2 Data Filtering Criteria

The initial data pull of all MILCON projects resulted in 902 projects meeting the initial search criteria within EDW. Initial search criteria was done by MILCON funding codes listed in Appendix A. There were no filters for the initial query other than finding all projects that were listed as funded under MILCON fund code. This ensured that every MILCON project executed in the South Atlantic Division within the 2002-2014 time period was found. Filters listed in the forthcoming sections were then applied, leaving 304 MILCON projects within following filtering parameters for the time period of data collection between March and April 2017. The final data field of 304 MILCON projects

were solely from the South Atlantic Division between 2002-2014. Only projects that had completed data sets for the milestones identified for report selection were used. Completed projects were only measured, with completion being considered as construction complete with final payments to the contractor made. The histogram in Figure 7 displays the number of projects by programmed year during the surveyed period.

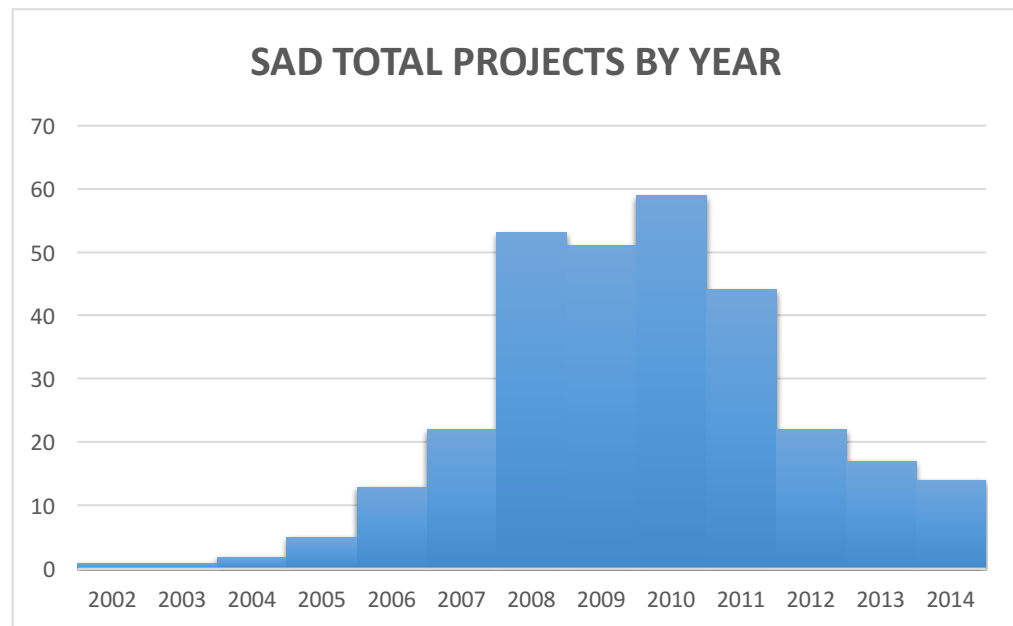


Figure 7 Yearly Project Dispersion for Collected Data

3.2.2.1 Filter by Fund Type

There are 223 different types of fund codes which correlate to the specific type of federal funds that are allocated for types of military programs. They are broken down by three business lines, which are categorized as Installation Support, Environmental Renovations, and MILCON. There are 115 fund codes associated with the MILCON business line. Of these 115, only 22 pertained to projects within the South Atlantic Division from 2002-2014. The list of fund types can be found in Appendix A.

3.2.2.2 Filter by “Design By” Data

There are seven metrics for “Design-By” data which signify how the design was developed. The “Design-By” field can have the following data entry points via the EDW query:

- Design-Construct (Design-Build)
- A&E (Design-Bid-Build)
- Hired Labor – In House (Design-Bid-Build)
- DB RFP by In House (Design-Build)
- DB RFP by A&E (Design-Build)
- DB RFP by Hired Labor (Design-Build)
- Adapt-Build (Design-Build)

Based off of these seven metrics, projects can be have their project delivery method categorized as either, “Design-Bid-Build” or “Design-Build”. In order to validate the Design-By data, projects were looked at individually in their RMS notes file to see Project Manager’s description of the project delivery method. After this validation, 26 Projects had no Design-By data and were purged from the overall data set.

3.2.2.3 Filter for Incomplete Data

There were some projects that did not have complete data for every project milestone. Projects that had incomplete milestone data were removed from the data set, resulting in 487 projects being purged.

3.2.2.4 Filter for Vertical Construction

MILCON can include both horizontal and vertical construction. Horizontal construction includes various types of ranges for weapons and vehicles, road construction, fencing, airfield paving, environmental retrofits and water treatment systems. Vertical construction is any project which primary focus is the construction of a building or group of buildings. In order to focus on a more specific type of MILCON that would be amenable to a more accurate statistical analysis of facility type, the data pool was filtered for only vertical construction. This resulted in 31 projects purged from the data pool.

3.2.2.5 Filter for Incremental Funding

Projects were labeled by the designation of a P2 number, which is assigned once a project becomes funded. During the GWOT, several bases such as Fort Benning, Fort Bragg and Fort Stewart were going under rapid facility expansion in order to house the arrival of thousands more Soldiers. Changes in a Tenant units force requirements would turn projects that were just for a single barracks expansion into an entire barracks complex. To meet this need and to handle the rapidly expanding cost, projects were incrementally funded due to requests of funds to Congress being sent whenever the need for an expanded project was communicated. Therefore, there were 22 projects with P2 numbers that were listed separately in the EDW report, however upon validation of data within RMS, it was found that these 22 projects were actually sub-projects of already existing projects in the data set. In order to confirm the financial and time data, the researcher totaled the data from the sub-projects to ensure the parent project was accurately reflected as a summation

of its sub-projects. Once confirmed, the sub-projects were removed from the data set as their inclusion would have been redundant due to it's reflection in it's parents project data.

3.2.2.6 Final Impact of Data Filtering

The result of all above filtering was a total of 599 projects removed from the original data set. This filtering allowed for a more reliable data set than what was originally obtained from the EDW query. The final project set is comprised of 304 projects over the span of 2002-2014 in the South Atlantic Division. This final set resulted in 60% of projects being DBB, and 40% being DB.

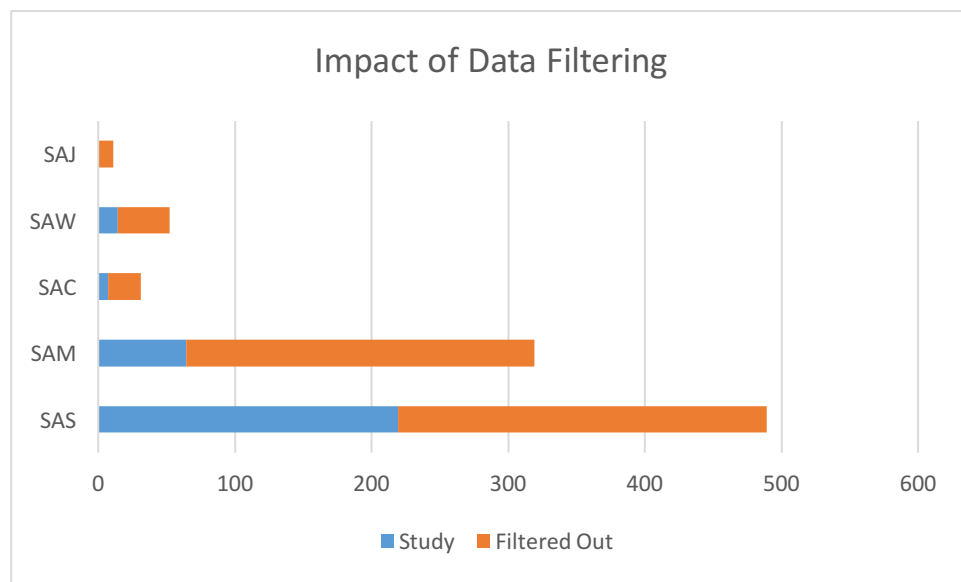


Figure 8: Impact of Data Filtering

3.2.3 *Time-Value of Money Adjustment*

Since the projects in the data set span over the course of 12 years, it is necessary to account for the time-value of money using the Consumer Price Index (CPI) provided by the United States Department of Labor. This is used to convert dollar amounts listed for

projects into constant dollars in another year. For this study, all projects were converted to the 2006 CPI, which was when MILCON Transformation was enacted. All cost data was adjusted for inflation to prevent a distorted cost analysis that failed to account for the changing purchasing power of the dollar (Inflation, 2002). The result of the adjustment is shown in the Figure 9 below with projects classified in cost categories to help show the scale of projects in the study. Five cost categories are generally accepted across the construction industry. The categories are as follows:

- Micro projects are less than \$2 Million
- Small Projects are between \$2-\$10 Million
- Medium Projects are between \$10-\$50 Million
- Large Projects are between \$50-\$100 Million
- Mega Projects are above \$100 Million

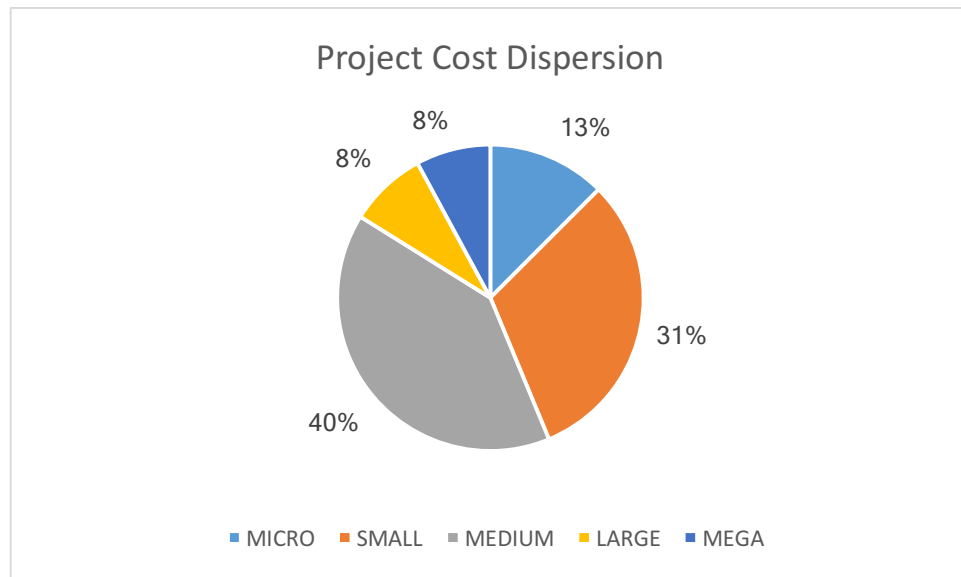


Figure 9: Project Breakdown by Cost Category

3.3 Data Demographics

The importance of uniformity of data was key in order to produce an accurate display of MILCON Transformation effectiveness. Through prejudicial filtering and additional validation of data through other USACE internal data systems, the data used is an accurate representation of the entire South Atlantic Division MILCON project field. Projects were segregated based off their initiated year, size, scope, and delivery method in order to help identify any divergent characteristics with any of the segregated criterion.

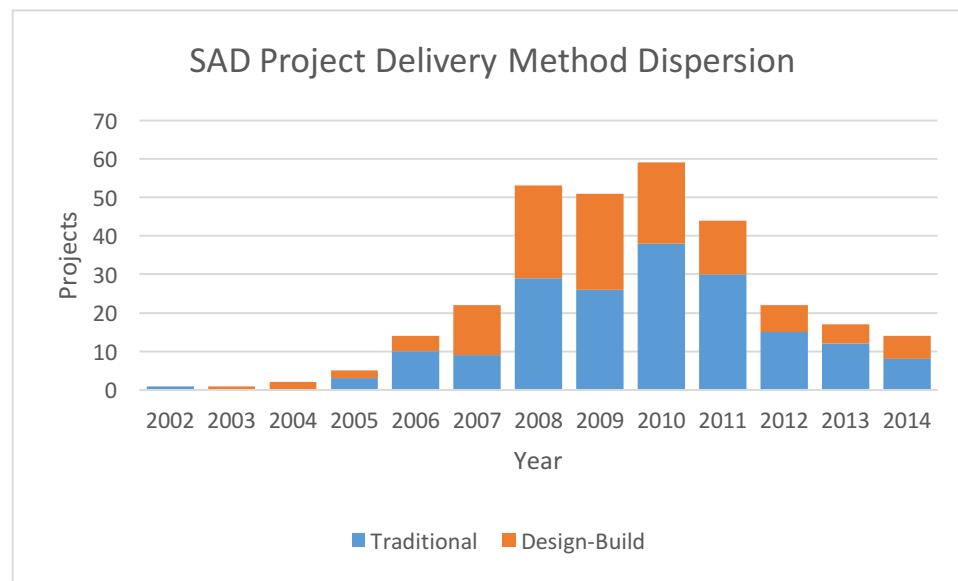


Figure 10: Project Breakdown by Year and Project Delivery Method

Before the study was conducted, the expectation of the researcher was that all MILCON projects post-2006 would be conducted DB, either by way of an Adapt-Build CoS process or a pure 2-Step DB process. Demographic Analysis shown in Figure 10 shows this is not the case with 53% of projects being conducted as DBB and 46% of projects being conducted as DB. The conclusion is that while MT was endorsed and pushed

by the USACE Command, it did not fully supplant the DBB process due to the flexibility Project Managers in the districts have to execute project management practices.

BRAC was expected to have a huge impact on project load. To be able to show the added project impact on the South Atlantic Division, projects were given an additional classification of being a BRAC-directed project. The impact of BRAC is indicated in the Figure 11 below. The added BRAC projects shown by the figure are only indicative of the projects that passed through all the filters listed above. The figure shows only the amount of BRAC projects within the data set and are not an accurate representation of the entire BRAC impact.

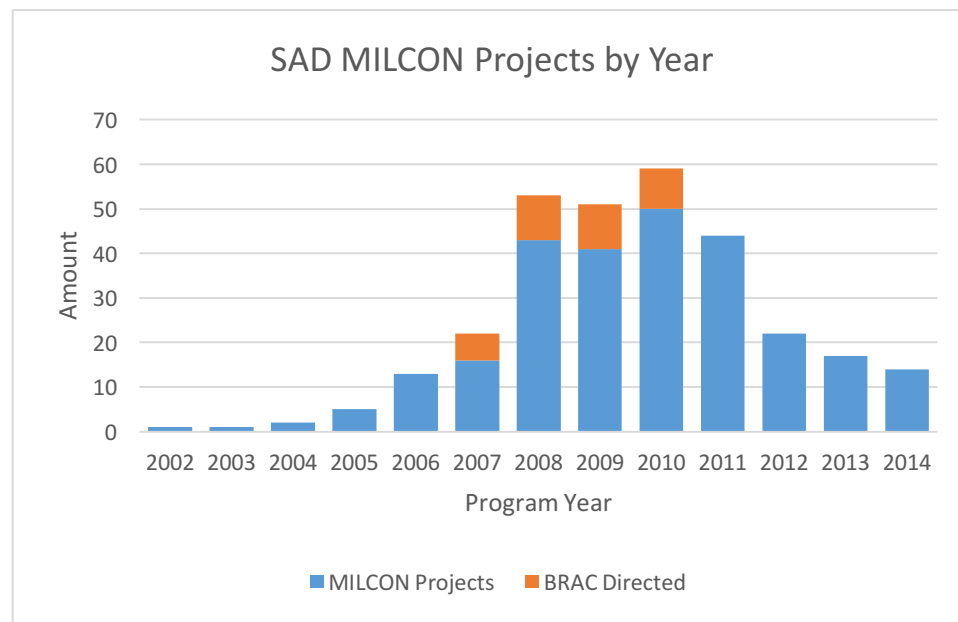


Figure 11: Impact of BRAC by Year

Projects were categorized by building type after looking at their project description. Using the same terminology observed in literature, projects were considered “Administrative” if they were a headquarters building for a company, battalion, brigade, or division. Maintenance facilities and other like-headquarters offices were considered Administrative. Projects that were considered “Barracks” were buildings meant to house

Soldiers in some capacity. Barracks serve one purpose, to house Soldiers, and there is a standard of living within the army that ensures barracks amenities are standardized for everyone. Community and Food Service buildings were grouped together due to their likeness in size and scope complexity. Buildings identified as Community were Fitness Centers, Chapels, Child Development Centers, and Schools. Food Service buildings were simply troop dining facilities. Projects that remained were labeled “Infrastructure/Warehouse/Training Area”, which was a catch all for projects that did not fit the parameters of the first three molds. Training Area projects were projects specifically related to vertical construction, such as shoot-houses and urban assault areas, not training areas such as rifle and grenade ranges.

Projects were finally arranged and evaluated by District. Simply put, projects executed by a specific district were categorized as such. The four Districts tested contributed to the results of the South Atlantic Division. However, certain Districts showed a greater ability to implement DB than others. Therefore, a comparative analysis was conducted within each district to investigate specific performance metrics as related to a district.

3.4 Analysis

3.4.1 Metrics

Project performance is generally depicted as an analysis of a project’s Cost, Time and Quality. Changes in either three fields are what generally govern the measurement of each project performance metric, however literature suggests that this kind of legacy measurement does not accurately reflect a project’s performance. Performance can be broken down by relative, static, and dynamic metrics (Gransberg, 2002). For purposes of this study, only relative and dynamic metrics are used. Relative metrics are performance

based metrics that allow for various sizes of projects to be compared. They can be applied to cost and schedule growth, which will be seen in this study. A complete list of all data points pulled in the EDW query can be found in Appendix B.

3.4.1.1 Contract Growth (Gransberg, 2002)

Contract growth is not a new metric, and has been seen throughout studies which measure project performance (Gransberg, 2002, Konchar, 1998). The calculation is expressed as a percentage and uses a contract's dollar amount for the equations value. This study used the following calculation to express cost growth:

$$Cost\ Growth = \left[\frac{(Final\ Contract\ Cost - Original\ Contract\ Cost)}{Original\ Contract\ Cost} \right] * 100$$

3.4.1.2 Contract Time Growth (Gransberg, 2002)

Contract Time Growth, much like its contract growth counterpart is also seen throughout many studies in project performance. This calculation is measured in days, and uses days to express value. The following calculation was used throughout the study to calculate contract time growth and is expressed as a percentage.

Contract Time Growth

$$= \left[\frac{(Final\ Contract\ Time - Estimated\ Contract\ Time)}{Estimated\ Contract\ Time} \right] * 100$$

3.4.1.3 Beneficial Occupancy Date (BoD) Time Growth

Since USACE projects rely on several different governmental payment mechanisms, a project cannot be completely closed out until final payments are made and

litigation, if there is any, is completed. However, for the purpose of this study, the Beneficial Occupancy Date (BoD) time growth will be calculated to be used as a metric for project completion. This BoD is reflective of when military personnel are allowed to enter a structure and begin operations, which is the actual intent of the build structure. For this calculation this study will calculate the difference between BoD Scheduled and BoD Actual in days. The following calculation was used throughout the study to calculate BoD Time Growth and is expressed as a percentage.

$$BoD\ Time\ Growth = \left[\frac{(BoD\ Actual - BoD\ Scheduled)}{BoD\ Scheduled} \right] * 100$$

3.4.2 *Welch's T-Test*

A Welch's T-test is a hypothesis test which determines if two data groups came from the same population. The Welch's T-test, also known as the unequal variance T-test, is used when working with small sample sizes or when a researcher wants to err on the side of caution when drawing conclusions (Boslaugh, 2012). For this study, the Welch's T-test was assumed appropriate for use due to the small sample sizes tested such as the districts of Charleston and Wilmington, and researcher conservatism. If the T-value is greater than the probability listed on the t-table for a 95% confidence rating, the null hypothesis was rejected. The 95% confidence rating was chosen due to the focused scope of this study and to reduce the amount of Type I errors that would be the incorrect rejection of a true null hypothesis. The use of the confidence rating is also prevalent in literature (Rosner, 2009) and is therefore generally accepted amongst professionals. Errors were mitigated through the use of the high confidence rating and the unequal variance T-test. Table 5 below outlines the types of statistical errors faced throughout this study. Literature tells us to be concerned with a Type I error more than Type II (Miller, 1997).

P-Values are used in data analysis to communicate statistical significance in this research. The alpha level that served as the cut off point was 0.05, and for P-Values that fell below the alpha level, it was interpreted that the null hypothesis was to be rejected. P-Values that were greater than 0.05 failed to reject the null hypothesis.

Table 5: Type I and II error explanation (Miller, 1977)

Reality	Decision	
	Reject H_0	Accept H_0
H_0 true	Type I error	Correct
H_0 false	Correct	Type II error
Type I error: Reject a true H_0 Type II error: Accept a false H_0		

3.4.3 Qualitative Evaluation

Validation of findings by a panel of experts is vital to any comparative research. A focus group was therefore brought together to whom the researcher presented the purpose, methodology and results of the research. A 30 minute background was given on all results and background to allow for an hour and a half of discussion. Results of the focus group's input was recorded by hand, as regulation did not allow the use of tape recorders. The researcher had an assistant on hand to help take notes and moderate the discussion.

3.4.3.1 Focus Group Recruitment

The focus group consisted of three employees within USACE that either had at least five years of project management experience, currently was in a project management position, or was in a leadership position within the South Atlantic Division. Inclusion

criteria was limited to their specific work experience and position within the South Atlantic Division. No exclusion criteria was given as all personnel who met the inclusion requirements were present at the time of the focus group. Recruitment of the personnel was done formally over email and followed up personally. The focus group was conducted at the Sam Nunn Federal Building on the ninth floor and lasted for approximately 2 hours.

3.4.3.2 Discussion Questions

Discussion questions were developed to guide the focus group members. After a short 30 minute presentation on research background, methodology and results, members were then posed a single question and given a chance to respond individually and to each other. Responses were recorded manually with certain parts omitted due to member request. All presented qualitative data was given consent to be used. The questions that follow were posed one by one in the order of which they are written:

- Are the Project Performance results reasonable? Do they make sense?
- Is there anything specific that's surprising about the research results?
- What are the reasons for the performance differences amongst the four districts that have MILCON projects sampled?
- How does the PMBP enable (or vice-versa) the project delivery process? How do you think this has affected the performance results?

Answers are captured in Chapter 5 and are used to foster discussion and gain insight for MILCON Transformation performance displayed in the Data Analysis portion in Chapter 4.

CHAPTER 4. DATA ANALYSIS

Data Analysis for the project data was primarily conducted through the use of the Welch's T-test. For this study, the two groups were initially formed based off similar project scope and data size of both Pre-MILCON Transformation and Post-MILCON Transformation periods. Rationale was based off the thought that all projects executed prior to 2006 were conducted solely with the DBB delivery method and projects executed after were conducted using DB. This segregation left only 22 projects that were DBB in the Pre-MILCON Transformation period against the 282 projects that were in the Post-MILCON Transformation period. Having such an unequal population size would skew any sort of statistical test and cause either a Type I or Type II error. Furthermore, less than 30 samples in either of the populations would jeopardize the central limit theorem, which would indicate that the data would not follow a normal distribution. A confidence interval of 95% was chosen due to the focused scope of this study and its use throughout literature. When a higher confidence interval is applied, no performance metric is shown to reject the null hypothesis.

Based off data demographics it is shown that DBB continued to be used even after the implementation of MILCON Transformation in 2006. This disposed of the first notion that projects had to be analyzed from a standpoint of Pre MILCON Transformation and Post MILCON Transformation. Therefore, considering that MILCON Transformation was designed to bring in the DB method into the USACE business practice, it was then therefore acceptable to readjust the populations by comparing a pure DBB population to a DB population. This resulted in a DBB population of 190 vertical construction projects and a DB population of 128 vertical construction projects. The study can test for the USACE Commander's performance metrics with assurance that conditions have been set for the USACE staff to meet the projected goals.

4.1 Analysis of All South Atlantic Division Projects

4.1.1 Cost

Project data was organized and divided by either being confirmed as DBB or DB. Initial tests considered all projects, of all cost and building type. The results of the tests intended on validating the Commanders metric of 15% cost reduction by using DB through the MILCON Transformation initiative. The T-test analysis tested the following hypothesis:

$$H_0: \mu_{\text{DBB}} = \mu_{\text{DB}}$$

$$H_1: \mu_{\text{DBB}} \neq \mu_{\text{DB}}$$

Table 6: Cost T-test Summary of All SAD Projects from 2002-2014

Metric	Traditional (Mean) n=180	DB (Mean) n=124	P- Value	Reject Null
Adjusted Original Contract Cost (Constant 2006 dollars)	\$18,539,548.89	\$48,858,423.64	0.000	Y
Adjusted Final Contract Cost (Constant 2006 dollars)	\$19,271,624.64	\$49,957,091.62	0.000	Y
Contract Cost Growth (%)	0.06	0.04	0.027	Y
Controllable Change (Dollars)	\$629,085.32	\$1,063,372.70	0.293	N
Final Change (Dollars)	\$911,314.13	\$989,672.99	0.926	N

Based off Table 6, there was significant change seen amongst Contract Cost Growth. In this analysis, the DB delivery method realized lower cost growth than DBB by 34.4%. Furthermore, the Welch's T-test indicated that this difference between the delivery model was statistically significant which verifies that the change in cost growth can be attributed to the use of DB. For this analysis, the differences in Contract Cost are not important due to the wide range of projects for the overall test.

Change Orders did not yield any significant results, however Controllable Changes were much higher on average for DB rather than DBB. This could indicate the improvement process the USACE undergoes every time they review their model RFP for specific building types. Lessons learned by the USACE during a project is driven by the dissatisfaction by the Design-Build Contractors interpretation of performance specifications, which causes the USACE to 'refine' their model RFP post-project and become more prescriptive with the specification they were dissatisfied with. The controllable changes can also be attributed to Owner's changing demands as Post-Commanders (Users) attempt to shape the building to the constant changing demand of a military undergoing modernization.

4.1.2 Time

As with the analysis for Cost, time data was organized and divided by either being confirmed as DBB or DB. Initial tests considered all projects, of all cost and building type. The results of the tests intended on validating the Commanders metric of 30% time reduction by using DB through the MILCON Transformation initiative. The T-test analysis tested the following hypothesis:

$$H_0: \mu_{DBB} = \mu_{DB}$$

$$H_1: \mu_{DBB} \neq \mu_{DB}$$

Table 7: Time T-test Summary of All SAD Projects from 2002-2014

Metric	Traditional (Mean) n=180	DB (Mean) n=124	P-Value	Reject Null
Contract Time Overage Days	157.46	139.49	0.380	N
Contract Time Growth (%)	32.34	25.97	0.125	N
All BoD Growth (Days)	74.99	77.50	0.895	N
All BoD Growth (%)	12.78	12.99	0.945	N
Controllable Change (Days)	65.52	69.91	0.699	N
Final Change (Days)	160.03	150.60	0.626	N

Table 7 shows overall time test results for USACE South Atlantic Division. None of the tests indicated any statistically significant differences between DBB or DB. However, there was a noticeable decrease in contract time growth with DB producing on average an 11.4% reduction on contract time. Interestingly, BoD growth stayed consistent for both project delivery models. BoD, however, can be changed based off USACE and Owners decision to occupy a building before a project is complete.

Change Orders had less of an impact on time than the cost implications of the change orders. Controllable change, staying consistent, indicates that project delivery methods have little impact on the time it takes to implement a change order. The difference

in days added to a project's time caused by controllable change between project delivery methods are within 5 days. This accounts for around 25% of the average schedule decrease that DB projects realized for contract time overage.

4.1.3 Commanders Rollup of Overall South Atlantic Division Performance

The vision for MILCON Transformation was to achieve the 15% and 30% reduction of cost and time, respectively. While those factors can be evaluated through simple math, it was necessary to conduct an in-depth statistical analysis in order to attribute the fluctuation of differences between populations to either project delivery model. The table below is to be treated as a sort of “Commanders Rollup”, designed to combine the simple reduction comparison with the statistical analysis.

The Commanders Cost/Schedule Analysis table focuses on the performance metrics that directly relate to the 15% and 30% reduction of cost and time. Considering Table 8 as a reference, performance metrics evaluated are listed vertically in the column furthest to the left. The following performance metrics were selected because of their direct correlation to the cost and time goals of MILCON Transformation:

- Cost Growth
- Controllable Change
- Contract Time Growth (Day)
- Contract Time Growth (Percentage)
- BoD Day Growth

The top of the chart lists all the data points for the performance metrics. They articulate the direct comparison of project delivery models. The column next to the list of performance metrics is the column for the DBB averages. The third column are the averages for DB. The column labelled “% Change” is the difference between the two averages of DBB and DB. To determine the difference, the following equation was applied to the mean values for the project delivery methods being compared:

$$\% \text{ Change} = \left[\frac{DB \text{ Average} - \text{Traditional Average}}{\text{Traditional Average}} \right] * 100$$

A negative percentage indicates a reduction in performance metrics favouring the DB delivery method. A positive percentage indicates an increase in performance metric indicating that the DBB delivery method performed better than DB.

The column labelled, “P-Value Validation” refers to the P-Value given from the T-test performed with the project delivery method averages. Any P-value below 0.05 was considered statistically significant and was given a “Y” beside the P-Value listed in the column. If the P-Value was above 0.05, an “N” was listed beside the P-Value, indicating that there was no statistical significance between the two project delivery method populations. Finally, the column labelled, “Meets True Commanders Intent” was inserted. Values for this column are listed as the following:

- “Y” – Yes, Meets the MILCON Transformation goal of either 15% reduction in cost or 30% reduction in schedule growth.
- “N” –No, does not meet the MILCON Transformation goal. There can be three reasons for a “N” value, either DBB performed better than DB, the P-

Value did not validate the difference of averages, or the MILCON goal was not met outright.

To further explain how the table reads, consider the performance metrics in Table 8. For cost growth, there is a -34.40 % change between the averages for DBB and DB. This negative percentage means the difference is in favour of the DB delivery method. This value is also below the 15% cost savings goal of MILCON Transformation. To validate this difference of averages, the P-Value was considered. The P-Value, being less than 0.05, therefore validates the differences in averages therefore attributing the reduction in cost growth to the DB project delivery method. Therefore, in the column “Meets True Commanders Intent”, this performance metric is given a, “Y” for Yes, the 15% reduction in cost goal of MILCON Transformation was achieved. Conversely, if the MILCON Transformation goal was not met, or if the P-Value did not validate the differences in averages, or if the DBB project delivery method performed better, the value for “Meets True Commanders Intent” was given an “N”. In parenthesis next to the “N” is a note that lists why a performance metric did not meet the commanders intent of MILCON Transformation.

Table 8 below reflect inputs from the statistical analysis in tables in this subchapter. First, a simple comparison of means are used to develop a percentage of change. Second, that percentage of change is evaluated to see if the DB mean met the USACE Commanders metrics. Finally, if met, the statistic is validated through the P-Value, which if lower than .05, can attribute the differences in mean to the project delivery model.

Table 8: Commanders Roll-up of All SAD Projects from 2002-2014

Commanders Cost/Schedule Analysis					
SAD All Projects, All Cost					
Metric	Traditional (Mean) n=180	DB (Mean) n=124	% Change	P-Value Validation?	Meets True Commanders Intent
Cost Growth	0.06	0.04	-34.40	0.02 (Y)	Y
Controllable Change	\$629,085.32	\$1,063,372.70	69.03	0.29 (N)	N (DB, or MT has increased)
Contract Time Growth (Day)	157.46	139.49	-11.41	0.38 (N)	30% goal not met
Contract Time Growth (%)	32.34	25.97	-6.37	0.12 (N)	30% goal not met
BoD Day Growth	74.99	77.50	3.34	0.89 (N)	N (DB, or MT has increased)

Here we see where Cost Growth has exceeded the expectations of the USACE Commanders intent with a 34.4% change in Design-Build's favor, and with a P-Value of .027, it is assumed that this change can be attributed to the project delivery model. However, while success was realized with the reduction of Cost Growth, Time Growth did not meet intent nor was it validated by the Welch's T-test. Furthermore, the differences between Contract Time Growth and BoD Day Growth indicates how the BoD can be shifted based off the using Commanders need and prerogative.

4.2 Analysis by Building Type

Literature indicated that there were six building types that were best suited for the DB process. (Rosner, 2009) While the projects in literature were pulled from Air Force projects, the facility types were procured by USACE as the acting construction agent, which handles those projects much as the same as they do the Army projects. Rosner (2009), indicated 6 building types within his research that were conducive to DB success, however only Administrative, Fitness Centers, Child Development Centers, and Operations buildings relate to this study. Administrative and Operations Facilities relate to the Administrative building type category used in this study while Fitness and Child Development Centers relate to the Community/Food Service building type. Literature was inconclusive about the performance of the barracks building type, which prompted investigation in this study. (Rosner, 2009; Hale, 2009; McWhirt, 2007) The barracks type used in Hale's study was BEQ's delivered by NAVFAC, but are considered relatable by nature due to the public sector conditions of NAVFAC and the barracks-centered design and intent of the BEQ. Hale (2009) and McWhirt (2007) both indicated that barracks were indicators of successful DB performance while Rosner's investigation was inconclusive with neither the DBB or DB method being favored.

The projects were grouped based off a building type, which identified a single project as part of a single group. Projects were grouped by their project title in the P2 program. Out of the seven types of groups, only three had enough data to support adequate population sizes for the T-test. Figure 12 outlines the project demographic based off building type:

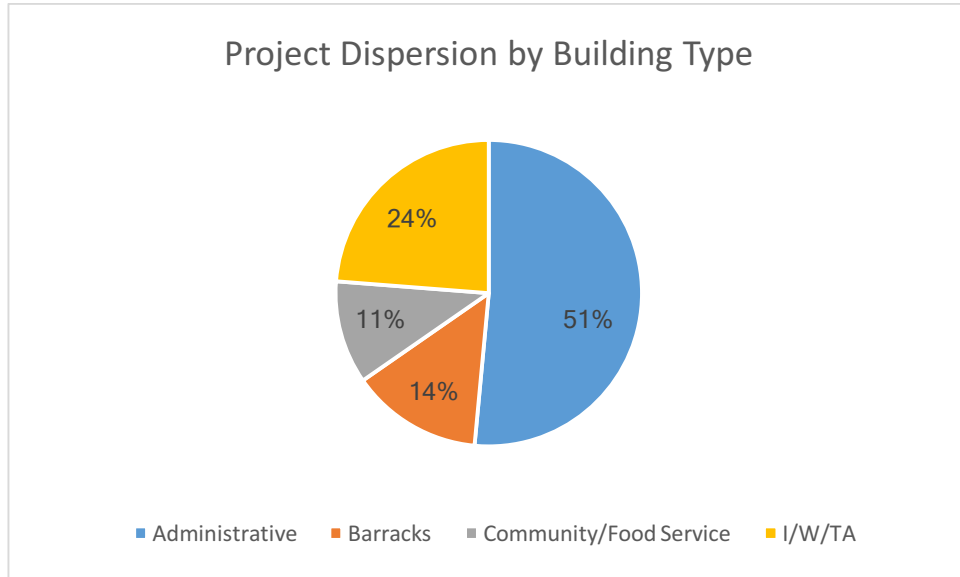


Figure 12: Project Dispersion by Building Type

The intent behind breaking down projects into building type groups is to identify where the use of DB made a type of project perform more efficiently than its counterparts that used DBB. Project data was organized into separate populations by their project delivery type of either DBB or DB Building type tests considered only projects of that specific building type, and of all cost-sizes. The results of the tests intended on validating the Commanders metric of 15% cost reduction and 30% time reduction by using DB through the MILCON Transformation initiative. The T-test analysis tested the following hypothesis:

$$H_0: \mu_{DBB} = \mu_{DB}$$

$$H_1: \mu_{DBB} \neq \mu_{DB}$$

4.2.1 Administrative Building Type

DB had the greatest impact on the Administrative building type in this study. Administrative types were classified as projects that were headquarters of Companies,

Battalions, Brigades, or higher echelons of units. Examples of the project labels in P2 were, “SOF (Special Operations Forces) BN & CO Operations Building” and “Unit Operations Facility”.

Table 9: Commanders Roll-up of Administrative SAD Projects

Commanders Cost/Schedule Analysis					
SAD Administrative Buildings, All Cost					
Metric	Traditional (Mean) n=92	DB (Mean) n=64	% Change	P-Value Validation?	Meets True Commanders Intent
Cost Growth	0.07	0.04	-43.23	0.03 (Y)	Y
Controllable Change	\$701,207.66	\$1,520,076.95	116.78	0.29 (N)	N (DB, or MT has increased)
Contract Time Growth (Day)	169.79	123.06	-27.52	0.11 (N)	30% goal not met
Contract Time Growth (%)	34.81	21.87	12.94	0.01 (Y)	30% goal not met
BoD Day Growth	72.86	78.22	7.36	0.83 (N)	N (DB, or MT has increased)

Table 9 above indicates a 43% reduction in cost when using the DB Method over the DBB method when applied to Administrative buildings. However, there is a large increase in controllable change. This could indicate owner or USACE dissatisfaction with design standards that the contractor used when building a facility. Since controllable changes are owner or USACE initiated, it suggests that the changes are attributed to changing owner needs or design dissatisfaction. For administrative building types, there are building specifications that support rapidly developing technology requirements. This

increase in controllable change could indicate that dynamic where USACE initiated a change in order to keep up with the technological developments. Cost savings is still realized, but the drastic reduction in cost growth with DB is tempered with a large increase in controllable change. However, despite the tempered results of cost performance, the time growth almost achieved the USACE Commanders intent with an almost 13% reduction in Contract Time Growth Percentage that was validated with a P-Value that was less than .05. While this does not meet the 30% expectation, this was the only time performance metric within specific building types that was validated with a P-Value less than .05.

4.2.2 Barracks Building Type

Barracks have been constructed using DB for longer than any other USACE project. Additionally, literature has shown that Barracks generally perform well under DB as opposed to any other building type (McWhirt, 2007). However, for the barracks data in the South Atlantic Division, this was not found to be the case. Table 10 below indicates that DBB performed just as well if not better then DB. While no metrics were validated by T-tests, means of project delivery populations point to this similarity in performance.

The difference between project delivery model performance for barracks in the South Atlantic Division was nominal. While there were differences in the performance metrics, P-Values given through T-test of sample populations were so high that performance would have been the same no matter which project delivery model was used. Contract Time in days was reduced drastically by almost 22%, however, with a P-Value of .35 there was no way that that reduction can be attributed to DB.

Table 10: Commanders Roll-up of Barracks SAD Projects

Commanders Cost/Schedule Analysis					
SAD Barracks Buildings, All Cost					
Metric	Traditional (Mean) n=19	DB (Mean) n=24	% Change	P-Value Validation?	Meets True Commanders Intent
Cost Growth	0.02	0.03	40.65	0.48 (N)	N (DB, or MT has increased)
Controllable Change	\$1,248,225.64	\$1,069,101.22	-14.35	0.77 (N)	N (Not Validated by T-test)
Contract Time Growth (Day)	198.26	155.29	-21.67	0.35 (N)	30% goal not met
Contract Time Growth (%)	29.51	26.47	3.03	0.71 (N)	30% goal not met
BoD Day Growth	60.84	92.25	51.62	0.55 (N)	N (DB, or MT has increased)

4.2.3 *Community and Food Service Building Type*

The last building type to be evaluated were the community and food service buildings. Just as seen with the barracks, community and food service buildings indicated that a pattern of equal performance between the two project delivery models. Table 11 below shows that the cost growth values for both delivery models were relatively the same while time performance differences were within 2% of each other. Controllable change is lowered for the community and food service building types, however no statistical significance was found to attribute that change to the delivery model.

Table 11: Commanders Roll-up of Community/Food Service SAD Projects

Commanders Cost/Schedule Analysis					
SAD Community/Food Service Buildings, All Cost					
Metric	Traditional (Mean) n=17	DB (Mean) n=16	% Change	P-Value Validation?	Meets True Commanders Intent
Cost Growth	0.05	0.05	9.28	0.95 (N)	N (DB, or MT has increased)
Controllable Change	\$295,619.01	\$204,252.27	-30.91	0.40 (N)	N (Not Validated by T-Test)
Contract Time Growth (Day)	106.53	123.75	16.17	0.44 (N)	N (DB, or MT has increased)
Contract Time Growth (%)	21.65	22.74	-1.10	0.80 (N)	N (DB, or MT has increased)
BoD Day Growth	45.71	54.06	18.28	0.68 (N)	N (DB, or MT has increased)

Both project delivery models perform near the same for the community and food service building type. Differences in cost growth are measured by thousandths of a decimal. BoD growth, while increased, further insinuates that its metric may not be reliable due to user-Commander influence on when a move-in date can be arranged.

4.3 Analysis by District

Each individual District had their own metrics, which can give a good indicator of performance by region. This can also indicate how each District contributes towards the overall performance of the South Atlantic Division's implementation of MILCON

Transformation. Projects were grouped by District, as assigned in the P2 program. Out of the South Atlantic Division's five Districts, only four were used. Jacksonville District was omitted due to none of its projects passing through the filters. Figure 13 shows the breakout of projects by District.

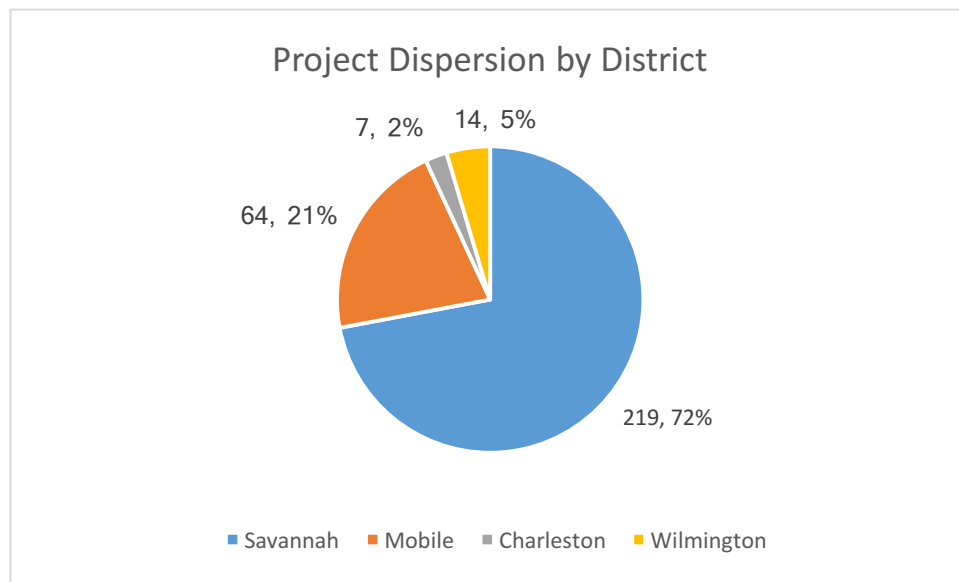


Figure 13: Amount of Projects by District

Savannah has a long history of providing construction services to some of the largest bases in the United States. Fort Benning, Fort Bragg, and Fort Stewart are the largest bases in the military, and all fall under the Savannah District's geographical responsibility. The Mobile District, which is second largest, serves predominately Air Force Bases with its MILCON program, however, it also provides construction assistance to several Alabama and Florida National Guard facilities. Wilmington, whose MILCON program became more robust in 2007, primarily services Special Operations Forces in Fort Bragg in order to help alleviate some responsibility from its sister Savannah. Finally, Charleston focuses

primarily on Fort Jackson, however like its sister Mobile, has several other Air Force and National Guard facilities to provide its expertise to.

The intent behind breaking down projects by District is to identify which District experienced the most success using DB. Project data was organized into separate populations by their project delivery type of either DBB or DB by District. District tests considered only projects of that specific District, and of all cost-sizes. The results of the tests intended on validating the Commanders metric of 15% cost reduction and 30% time reduction by using DB through the MILCON Transformation initiative. The T-test analysis tested the following hypothesis:

$$H_0: \mu_{DBB} = \mu_{DB}$$

$$H_1: \mu_{DBB} \neq \mu_{DB}$$

4.3.1 Savannah District

The Savannah District has one of the more robust MILCON programs in the South Atlantic Division, as well as USACE as a whole. The researcher conducted a pilot study focused on Savannah that shaped expectations prior to this study. This focused analysis on 22 DB and 15 DBB barracks projects within the Savannah District's determined that the two delivery models performed equally (Westcott, 2017). This study widened the aperture of the study to all Savannah projects conducted between 2002 and 2014. Table 12 below accounts for these projects. All projects represented fell into all cost categories. While DB did not achieve the USACE Commander's intent for any performance metric, this could be in part to the extreme workload the District had which in turn limits a District's staff to fully collaborate with the DB process and reap the recognized benefits of the delivery system.

Table 12: Commanders Roll-up of Savannah District Projects

Commanders Cost/Schedule Analysis					
SAS All Projects, All Cost					
Metric	Traditional (Mean) n=116	DB (Mean) n=103	% Change	P-Value Validation?	Meets True Commanders Intent
Cost Growth	0.05	0.04	-23.49	0.27 (N)	N (Not Validated by T- test)
Controllable Change	\$528,961.07	\$1,102,093.22	108.35	0.22 (N)	N (DB, or MT has increased)
Contract Time Growth (Day)	124.08	131.88	6.29	0.70 (N)	N (DB, or MT has increased)
Contract Time Growth (%)	22.53	24.00	-1.47	0.64 (N)	N (DB, or MT has increased)
BoD Day Growth	56.07	77.43	38.09	0.24 (N)	N (DB, or MT has increased)

Indicated from the table above, Savannah saw sufficient reduction in their cost growth, however with a P-Value above the Confidence Interval of .05, the reduction couldn't be attributed to the switch in delivery systems. However, the other performance metrics for time did not fall in favor of DB, as DBB performed as well if not better than DB. The District had a large majority of the project and workload, which would tend to reason that they had the greatest chance of gaining familiarity with the DB delivery model at a faster rate. Instead, DB seemed to perform worse as the years went on as displayed in Table 12.

4.3.2 Mobile District

The Mobile District had the second largest amount of projects and came the closest to achieving the USACE Commanders intent through their implementation of MILCON Transformation. Most of the Mobile Districts projects were categorized as the Administration building type, which in turn helped that building types overall performance. This could be an indicator that Mobile and its contractors understood the DB project delivery method and had enough time to maximize it's effectiveness through constant collaboration.

The Mobile District successfully achieved and surpassed the USACE Commander's intent of 15% cost reduction while maintaining a moderately close comparison of controllable change in relation to the rest of the districts. Performance metrics for time also suggest that DB helped achieve a drastic reduction in time, but this was not validated through the use of a T-test. The Mobile Districts success with DB could be a result of the sophistication and time available to the staff which is a dynamic not seen in it's sister, Savannah.

Table 13: Commanders Roll-up of Mobile District Projects

Commanders Cost/Schedule Analysis					
SAM All Projects, All Cost					
Metric	Traditional (Mean) n=52	DB (Mean) n=12	% Change	P-Value Validation?	Meets True Commanders Intent
Cost Growth	0.07	0.04	-44.61	0.08 (N)	N (Not Validated by T-test)
Controllable Change	\$944,503.01	\$1,118,519.54	18.42	0.86 (N)	N (DB, or MT has increased)
Contract Time Growth (Day)	230.81	173.00	-25.05	0.48 (N)	N (Not Validated by T-test)
Contract Time Growth (%)	53.36	35.29	18.07	0.41 (N)	N (Not Validated by T-test)
BoD Day Growth	100.77	83.17	-17.47	0.81 (N)	N (Not Validated by T-test)

4.3.3 Charleston District

The Charleston District has the smallest project portfolio of the four districts measured for MILCON Transformation. Generally staffed for their Civil Works mission, their MILCON program is small-staffed and isn't exercised often. Charleston Districts performance metrics are shown in Table 14.

Table 14: Commanders Roll-up of Charleston District Projects

Commanders Cost/Schedule Analysis					
SAC All Projects, All Cost					
Metric	Traditional (Mean) n=4	DB (Mean) n=3	% Change	P-Value Validation?	Meets True Commanders Intent
Cost Growth	0.07	0.09	35.35	0.67 (N)	N (DB, or MT has increased)
Controllable Change	\$524,624.94	\$1,370,838.27	161.30	0.49 (N)	N (DB, or MT has increased)
Contract Time Growth (Day)	122.75	374.00	204.68	0.09 (N)	N (DB, or MT has increased)
Contract Time Growth (%)	32.59	74.47	-41.88	0.22 (N)	N (DB, or MT has increased)
BoD Day Growth	127.50	88.33	-30.72	0.73 (N)	N (Not Validated by T-test)

Charleston's cost performance increased dramatically as DB was compared to DBB. The population sets between the two project delivery model were almost symmetrical, which suggests an accurate statistical analysis was done when the Welch's T-test was conducted. All of Charleston's performance metrics were heavily lopsided in favor of DBB. This could be an indicator of either the USACE or local contractors unfamiliarity and lessened use of the DB system.

4.3.4 *Wilmington District*

The Wilmington District was brought into a heavy MILCON role in 2007 when the then South Atlantic Division Commander had the District act as a construction agent for the Special Operations Forces (SOF) at Fort Bragg, North Carolina. Originally focused on their Civil Works mission, Wilmington was brought in to take on the SOF projects to help alleviate the project management burden of Savannah during the BRAC period.

Table 15: Commanders Roll-up of Wilmington District Projects

Commanders Cost/Schedule Analysis					
SAW All Projects, All Cost					
Metric	Traditional (Mean) n=8	DB (Mean) n=6	% Change	P-Value Validation?	Meets True Commanders Intent
Cost Growth	0.08	0.02	-75.70	0.20 (N)	N (Not Validated by T-test)
Controllable Change	\$82,902.01	\$134,643.98	62.41	0.57 (N)	N (DB, or MT has increased)
Contract Time Growth (Day)	182.13	85.83	-52.87	0.12 (N)	N (Not Validated by T-test)
Contract Time Growth (%)	37.99	16.98	21.01	0.03 (Y)	30% goal not met
BoD Day Growth	153.25	62.00	-59.54	0.44 (N)	N (Not Validated by T-test)

Wilmington displayed a strong preference to DB through their 14 projects. Six of the projects were DB and all 14 of the projects being in the Small-Medium price range and

categorized as either administrative or training area buildings. However, even with the DB means of both Cost Growth and Contract Time Growth being substantially lower than DBB, the p-values were not low enough to constitute being considered statistically significant at .20 and .12 for both cost and time respectively.

CHAPTER 5. CONCLUSIONS

The study regarding project delivery methodology in the South Atlantic Division was initiated by a pilot study in MILCON Transformation for the Savannah District earlier in the year. Project data indicated that there was still a preference to use the DBB method instead of the DB method even after the USACE Commanders decision to move to DB as the primary method of project delivery was made. The pool of data cannot be considered as an analysis of the entire range of delivery methods for MILCON projects due to the fact that the majority of projects were filtered out due to insufficient data. Therefore, this study only evaluates those projects that were completely entered into their respective automated information systems at the time of data collection between March 2017 to April 2017.

MILCON Transformation placed an emphasis on the use of DB, however its use was not mandatory. Initially, it was assumed that the overwhelming majority of projects Post MILCON Transformation would be conducted using the DB delivery method. However, project managers within USACE are given the authority to recommend the delivery method that best suits the project need at the time of a planning charrette being conducted.

District results are an indicator of how MILCON Transformation affected project performance metrics. MILCON Transformation was more than a change in project delivery methods, it sought to change a culture within USACE of being conservative and prescriptive. USACE is a highly complex organization, and it is impossible to attribute project performance metrics to a single project delivery method. Each district has a project management staff that varies in personality and culture from district to district. This has a direct impact on how well projects are managed within a district, not just how well a project

delivery method is executed. A Project Delivery Team's members are also members of other PDT's and performance performing multiple additional duties for the district. For the smaller Districts, this dynamic can be a huge factor for personnel acting in a MILCON project manager role that's more familiar dealing with Civil Works projects. Therefore, the results of this study indicate how well MILCON projects performed in a complex organization through the implementation of MILCON Transformation. Results suggest that a change to the Design-Build delivery method works better in certain districts rather than others. The study does not offer definitive reasons for both delivery methods project performance data. The quantitative portion of this study only states what the performance metrics were based off the data available in USACE's EDW at the time of collection. The focus group's comments are antidotal and suggest reasons for the differences in project performance metrics amongst the two delivery systems studied.

5.1 Conclusions to Research Questions

5.1.1 Cost Savings

MILCON Transformation was intended on enabling USACE to realize a cost savings of 15%. Therefore the question was asked, "Did the USACE Commander's intent of 15% reduction in cost by implementing MILCON Transformation as an alternative to the traditional DBB project delivery method achieved?" The data analysis for the South Atlantic Division showed that the 15% reduction of cost goal was achieved. This achievement is a result of the average of all the districts within the division. When each district is analysed separately, Mobile and Wilmington are found to have successfully attained the 15% reduction of cost as a result of MILCON Transformation implementation.

Savannah saw a decrease in cost growth as well, but the data analysis revealed that there was no statistical significance between the project delivery methods used, indicating that the results were by chance, not by MILCON Transformation implementation. Charleston had completely different results, with DBB greatly outperforming DB in cost performance metrics.

The cost growth project performance metric fluctuated depending on which building type was constructed. This suggests that a single project delivery method cannot be considered a ‘one-size-fits-all’ solution. The data for the administrative type suggests that the greatest potential for cost savings can be realized if the administrative building type is executed DB. The barracks building type seemed to be a good fit for the Design-Build delivery method because it has standardized performance metrics through its CoS. However, data indicates that the project delivery method had no impact on cost growth. This is surprising because barracks are built frequently and are less complex than other buildings that USACE generally has to deliver. Community and food service projects experienced the same results as barracks, which was also surprising because they share a similar dynamic with the barracks building type of being often repeated.

5.1.2 Schedule Reduction

MILCON Transformation was intended to bring a 30% reduction in project delivery time. Consequently, the question was asked, “Was the USACE Commander’s intent of generating a 30% schedule reduction by implementing MILCON Transformation as an alternative to the traditional DBB project delivery method achieved?” From the data collected and analysed, none of the statistical tests showed that the South Atlantic Division

achieved that goal. The districts showed the same results in their individual analyses on project schedule performance metrics. Mobile and Wilmington almost met the 30% schedule reduction goal. Their project time performance metrics were lowered by 15%-20%, with statistical tests indicating the reduction in time was a result of using the Design-Build delivery method. Savannah demonstrated that there was no savings in time when using either delivery method. Charleston demonstrated to have an uncomfortable relationship with DB as its project time performance metrics were strongly in favor of the DBB delivery method.

The time analysis conducted by building type failed to show any real preference to delivery system with no test yielding a statistically significant finding. While the administrative building type came close with realizing a 27% reduction in construction time and a low P-value, it could not be concluded that the 30% goal was positively met. While the tests for building types showed slightly lower BoD rates and contract growth rates, it could not be categorized as being statistically significant.

The Beneficial Occupancy Date (BoD) is a metric that can be adjusted based off several factors. BoD is the date that Soldiers occupy a building for use, regardless if a project is completed or not. This date can be adjusted based off a Commanders need, building importance, or a project completing early. For this study, BoD dates remained generally the same amongst project delivery methods. This dynamic allowed BoD to be shifted based off a buildings ability to meet the desired function, even though that might not mean completion. Therefore, the building was able to meet commanders even though a project was not completed.

5.2 External Validation of Results

An external examination of project data and results was conducted by a focus group of three USACE South Atlantic Division personnel. The intent of the focus group was to hypothesize reasons for MILCON Transformation results. Opinions expressed are antidotal comments from participants and are not complete explanations for the results of MILCON Transformation. USACE is a complex organization and a project's execution relies on a number of additional factors outside the use and execution of a project delivery method. The following four questions were used to spur discussion and to gain insight:

- (Question 1) Are the Project Performance results reasonable? Do they make sense?
- (Question 2) Is there anything specific that's surprising about the research results?
- (Question 3) What are the reasons for the performance differences amongst the four districts that have MILCON projects sampled?
- (Question 4) How does the PMBP enable (or vice-versa) the project delivery process? How do you think this has affected the performance results?

5.2.1 *Question 1 responses*

The project performance metrics were agreed upon to be acceptable for the study. There were no issues with the methodology or analysis done. The general consensus was that the results were not surprising and that they made sense.

5.2.2 Question 2 responses

Overall there were no surprises. The focus group acknowledged that the rate of projects drastically increased during the 2006-2010 time period due to BRAC and the increase in GWOT base infrastructure. Another reason was that while the rates of projects drastically increased, staff to help manage the projects did not increase. PDT's were having to handle double, sometimes triple the amount of work they were accustomed to seeing. Additionally, there was no real focus on two of the three "Time-Cost-Quality" triad. Initial guidance of MILCON Transformation was to focus on time (Project, 2010). Turning projects around within 18-24 months meant that USACE was keeping up with the needs of a growing military while meeting the GWOT and BRAC requirements. However, as contractor solution to performance specifications became known, USACE personnel developed quality concerns.

To highlight this point the focus group gave the example of the barracks building type, which was an area of surprise for most focus group personnel. According to literature, barracks executed under the DB model were expected to outperform DBB with statistical significance (Hale, 2009). However, the barracks studied here showed such results. To highlight this as a reason, the issue was that barracks were needing to be constructed efficiently and quickly. A model RFP was developed and used to solicit proposals. However, the Design-Build contractors' designs tended to be considered unsatisfactory due to lowered quality in Design-Build designs when compared to previous Design-Bid-Build projects. Simply put, project delivery teams were reluctant to approve Barracks demonstrating lower quality than what had been accomplished in the past. This triggered design changes, and amendments to the model RFP's, which translated into prescriptive

specifications, which are exactly what DB tries to steer away from. This could have compromised the MILCON Transformation process. Contractors generally would require higher cost premiums because an expectation was set that schedules would become extended due to the design change.

5.2.3 Question 3 responses

The focus group could only speculate as to why the districts performed differently. There was a wide range of issues from program managers' preference, to contractor sophistication to owner/user involvement. The focus group mirrored Brigadier General Merdith Temple's comments from 2009 he said that the number of projects increased while the amount of staff available either stayed the same or lessened (Project, 2010). Each district and the division headquarters were allowed to hire the personnel necessary to complete the spike of projects from 2006-2010. Some districts chose to do more with the capacity they had while other districts and headquarters staff chose to augment with contracted employees to address the increased workload.

Prior to the focus group, the expectation of the researcher was that each district stayed within their geographic area of responsibility and rarely shared workloads amongst each other. For the Mobile District, this is true because they service a specific niche and are geographically isolated from the rest of the South Atlantic Division. However, the focus group indicated that this dynamic was not always the case. For instance, Savannah provides much needed technical assistance and expertise to Wilmington, Charleston and Jacksonville. While Jacksonville does not execute many MILCON projects, they are without a MILCON-specific division within the district and therefore rely on Savannah for

project management and technical support. Charleston operates in the same way as Jacksonville but their requests to Savannah are more frequent and cumbersome, with Savannah technical personnel being requested to fill out Charleston PDT's in order to maximize internal knowledge and capacity.

Wilmington shares perhaps the most intricate and interesting relationship with Savannah, as they could be viewed as supporting Savannah, not vice versa. Since taking on Special Operations Forces projects from Savannah, Wilmington shares a resident office at Fort Bragg with Savannah. Wilmington, like Charleston, still needs technical assistance from Savannah in order to augment their PDT's, however it is easier for Wilmington to cross-pollinate talent from Savannah while sharing a resident office. Wilmington generally retains the PM and contracting authority while they receive engineering augmentation from Savannah. This relationship, while unorthodox, has proven to be a viable solution based upon the results of this study.

5.2.4 Question 4 responses

Unexpectedly, the focus group suggested that the PMBP did not have a considerable impact on the project delivery process the researcher had expected. Instead, the PMBP was suggested to give the procedural framework in which to work within the USACE and federal business system. How a project manager chose to operate within the architecture was up to the project manager alone. The PMBP is known as a type of checklist, full of procedures that are laid out for a project manager to execute in linear fashion. It also knits the right people and assets together to set conditions for a good PDT to become assembled.

One member put it another way, the PMBP codifies all the actions that a good project manager would do anyway.

The difference in performance of the DB delivery system between what was found in this study as opposed to what was seen in literature was first attributed to an organizational structure issue. A PDT's structure was covered in Chapter 1, however the dynamic of the structure was revealed in the focus group. The PMBP states that a project manager has overall responsibility for a project, and the members of the PDT can range across a host of architects, engineers, environmental experts and contracting agents. The project manager is in charge of the PDT in theory, but the organizational structure does not give the project manager the ability to officially task his team members with any responsibility.

As previously discussed in Chapter 1, the divisions within USACE districts were specifically divided based off function, such as construction, engineering, program management, etc. Each division within the District has a Chief who manages all employees assigned to the division. PDT members are pulled from a variety of these divisions, and the division chief, not the project manager, retains control of the team member's work. There are Chiefs of Construction, Engineering, and Project Managers. The Deputy Director of Project Management (DDPM) acts as the Chief of Project Managers and can also act for the District Commander if decision making authority is delegated to him via the District Commander. The DDPM is a GS-15, as well as all the other division chiefs. This means that there is an equal amount of authority amongst chiefs which makes for a gridlock of tasking authority amongst team members. To put it another way, a HVAC engineer on a PDT may get guidance from the PM to conduct a design review, however if the Chief of

Engineering wants him to prioritize that design review last, then the HVAC engineer will take the Chief's direction over the PM. This can cause for an adverse relationship within a District when things go wrong which can delay projects even longer as internal processes are sorted out. Each District Commander has the ultimate tasking authority, but the support structure that allows him to execute these multiple and minute tasks is not conducive for efficient results. This dynamic makes risk management for project managers difficult when they have no direct authority over team members to act on specific project tasks.

Most technical skilled personnel in USACE Districts are in short supply and are tasked to a multitude of projects. The focus group indicated that a single engineer on a PDT could also be on 6 other PDT's which could be a mixture of Civil Works or MILCON projects. This dynamic validates the division chief's roles in defining priorities for their personnel, but takes away the ability of project managers to act swiftly to RFI's or to integrate fully with contracted Design-Build firms.

Additionally, inefficiencies within the study were therefore attributed to the mindset of the project manager and the organizational dynamic within the PDT. Conservatism can often dominate the mindset of many project managers, which can make them act in a risk-adverse fashion. MILCON Transformation was meant to underwrite that aversion and give project managers the freedom to find innovative solutions to delivery projects at lower cost and time. However, if leadership is uncomfortable with the dynamic of underwriting measured risk, the project managers will not feel approval to innovate when a conservative attitude still exists. DB offered a great chance to meet the goals of MILCON Transformation, however individual lack of experience and confidence tended to make project managers shy of fully embracing Design-Build firms suggestions for USACE

performance specifications. In short, the unknown was a perceived risk, and in a conservative mindset, it is an unmitigated risk not worth taking.

5.3 Limitations

While the South Atlantic Division represents one of the largest Divisions in USACE, it is not necessarily representative of the entirety of USACE and its performance throughout the MILCON Transformation period. Every Division and District has their own dynamic of owners/users, A/E firms and building contractors, which can impact the type of project delivery method used as well as project cost and time metrics.

The breadth of the focus group was also a limitation in this study. While the input of three USACE employees input is extremely valuable, it is hardly indicative of USACE as a whole. USACE is a highly complex organization with different organizational cultures within each district's divisions. MILCON Transformation affected each district's project performance metrics differently, indicating that there are differences in project management as well as organizational teamwork.

Risk of discrepancies due to data misclassification is present due to the data input into the AIS being out of the researchers control. Despite careful efforts to filter projects through the necessary criteria, there is still a possibility that personnel responsible for data entry misclassified project data upon its entry into RMS or P2. Future studies should allow for time to conduct this verification through FedBizOps or District-level RMS databases to ensure that data pulled is an accurate representation of a districts project portfolio.

5.4 Future Research

5.4.1 Corps-wide Study

The limits of this study impacted the ability to completely evaluate the effect of MILCON Transformation on USACE. The South Atlantic Division, while one of the largest Divisions within USACE, cannot be considered as an accurate indicator of how well USACE executed MILCON Transformation across the entirety of USACE. The South Atlantic Divisions project performance data points to the need to conduct a wider, Corps-level evaluation of MILCON Transformation. For future research, a wider data set needs to be captured in order to measure a more thorough and accurate impact of MILCON Transformation throughout USACE. Through this research, patterns can begin to be established to see which type of building will be more conducive to MILCON Transformation effects.

5.4.2 Quality measurements

This study did not consider a projects quality standards. Quality can be measured a variety of ways, either through maintenance reports from INCOM, Operations and Maintenance expenditure for MILCON construction, or a deep-dive into specifications for individual projects. As pointed out by the focus group, there was much debate over the cheapening of materials due to the use of DB, which caused USACE to demand more prescriptive specifications for their projects after the DB performance specifications yielded unsatisfactory quality measures.

5.4.3 Qualitative Analysis

The use of a focus group was incredibly beneficial to gain insight into the inner-workings of USACE and offer explanations for data analysis results. However, with a group of 3, this is hardly indicative of the entire South Atlantic Division. Additionally, the focus group offered no direct comments about the time performance metrics. Therefore, future study must include survey questions directed at the specific issue to garner professional opinion and further insight. Surveys need to be focused on a diverse professional section of employees. This means input needs to be gathered from employees across the project management, construction, engineering and contracting divisions amongst all the districts. Feedback will offer insight into the culture and business dynamic of each district within the South Atlantic Division.

5.5 Conclusions

Literature showed that the key to successful DB delivery is heavy owner involvement during the design phase. Focus group comments as well as Brigadier General Merdith Temple comments about maintaining a staff capable of handling FY-2000 project amounts to deal with the sudden influx of projects that FY 2006-2010 saw seemed to inhibit the ability of USACE to completely maximize the potential of DB. Staffing limitations that occurred during increased workload could have limited the effectiveness of MILCON Transformation in some Districts. Furthermore, looking at the triad of cost, schedule and quality, it is common saying in the construction industry that you can only have two of the three elements of the triad. USACE believes that it can achieve all three through the use to specific and diligent processes, however this dedication to process-delivery ends up

becoming a double-edged sword. The time it takes to run through all the processes, obtain approvals for change and get final decisions made ends up increasing the schedule time that would have otherwise been saved.

Adapt-Build is a great adaption of the Design-Build authorization in the FAR, however it can turn into an issue for USACE when in the hands of risk-adverse project managers. Project Managers are told to “get it in the RFP before you advertise or pay for it in modifications later” (Project, 2010) which could warn managers to become more prescriptive in a performance-intended delivery method. This could shift more risk to the contractors than intended, therefore forcing costs to go up instead of truly finding value in innovation and pre-manufacturing.

This could explain the dynamic of cost and time throughout the study. The 15% goal of cost savings, while realized on the whole for the South Atlantic Division, was not evenly contributed to throughout the Districts. The 30% goal of schedule reduction, was not achieved, although some tests did validate certain nominal reductions in time for the DB delivery method. MILCON Transformation can be thought of as a partial success by USACE, although it can be argued that the intent was actually met. Given the conditions of the USACE working environment and it’s handling of BRAC, GWOT and Army restructuring, due diligence was given to the enduring goal of being fiscally responsible with taxpayer money by using DB as the primary business model for MILCON Transformation.

Literature indicated that USACE had the tendency to push too much risk onto the Design-Builder and did not fully immerse themselves into the design process (Blomberg,

2014). Focus group input further validated Blomberg's study by indicating that PDT members were stretched with numerous projects of many different types and sizes. The data analyzed quantified this dynamic and showed that it had an adverse impact on the project performance metrics. Prioritized by their Chiefs rather than the project managers they work for, it can be seen that in some cases, design reviews can be completed in a manner that is time inefficient.

5.6 Recommendations

Results of the study point to several successful trends of the use of Design-Build and the USACE's implementation of MILCON Transformation. To assist in the continuing effort of maximizing efficiency through process improvement, the following recommendations are given for consideration.

- Sustain the use of Centers of Standardization and the use of the Model RFP. Results given the use of model RFP's for the Administrative building type showed validated cost and time savings. The DB process is more efficient for the Administrative building type, and should be continued to promote further refinement to the model RFP.
- Initial guidance for the use of Adapt-Build was to focus on refining the model RFP until ideal prescriptive specifications were derived from contractor input over time and many projects. Continue to allow Design-Build contractors to innovate and update specifications by keeping the Model RFP oriented on performance specifications.

- Relax the use of prescriptive specifications within DB projects. Use the After-Action Reviews to identify quality measures that are most important with the owner/user and the USACE and detail those specifications only. This will translate to greater success with DB within building types that showed equal performance values between DB and DBB. Key to achieving this success is to modulate risk through Commanders underwriting certain oversights. Mistakes are commonly made even in processes that are repeated multiple times and have a high degree of comfort. Leaders still provide oversight to prevent gross-negligence but at the same time encourage project managers and PDT members to innovate and try methods that aren't commonly used in an effort to find more efficiency. Promoting a mindset of commitment to optimizing project efficiency instead of enforcing a "by the book" mentality will free employees up to continually improve.

APPENDIX A. MILCON FUNDING CODES USED

The following is a complete list of the funding codes that were used to identify MILCON projects. Projects are generally funded with either MILCON appropriations from Congress or from Operations and Maintenance funds. Construction that is over \$750,000 is considered to need MILCON funding.

Table 16: MILCON Fund Codes (Dictionary, 2010)

Military Programs Type Funds Codes			
Code Number	Abbreviation	Code Number	Abbreviation
2	BCA1	66	SAH
3	BCF1	67	MCDIA
4	BCD1	68	NGA
6	MMCR	69	NSA
7	BCA2	70	FMS
8	BCF2	83	RDTA
9	BCD2	84	RDAF
10	MCA	85	RDTD
10T	TMCA	98	DECA
11	MMCA	98T	TDECA
12	MCAR	0A	BCA3
12T	TMCAR	0B	BCF3
13	MAP	0C	BCA4
15	PBS	0D	BCF4
16	ANC	0F	BCA05
17	MCNG	0G	BCF05
20	MCAF	0H	BCD05
20T	TMCAF	0I	BCN05
21	MAFR	1A	ECIP
21T	TMAFR	1AT	TECIP
22	MAPF	1B	ECIF
23	MMAF	1BT	TECIP
25	MANG	1E	OECIP
26	FHAF	1ET	TOECIP
26T	TFHAF	1K	KWM
30	MCN	1N	NWM
32	NMCR	1P	PRP
34	MCARN	1S	SOCM

36	PRIP	1U	DERF
39	MDOD	2B	AFRM
40	FHNC	2L	AFLI
40T	TFHNC	2LT	TAFLI
41	DFAS	2S	AFSM
42	FHLI	3J	GOJC
42T	TFHLI	3K	ROKC
43	DODU	3Q	GOQC
44	FHEC	4A	MCDA
44T	TFHEC	4B	MDAM
46	DODM	4D	MDAMM
46T	TDODM	4F	MDAR
51	DODEA	4H	HAC
52	NATO	4S	SOF
53	CEETA	4T	CTR
54	DLA	5N	AFN
56	DMA	5S	S6S
57	N(DTRA)	6A	HN
58	DISA	6C	CDIP
61	DFIRA	6E	SACO
62	FRGA	EA	MCCA
63	PIKA	EB	MCCAF
64	AFES	EC	IGF
IR	IRRF	ED	CERP
Z1	MOSF	EF	TAEF
Z2	DODO		

APPENDIX B. DATA ELEMENTS

Appendix B outlines all the data points pulled directly from EDW. In some cases, certain data points were calculated using the formula's shown for the data point.

District

This data point labeled the District that was in charge of the project. The districts that had projects used in the study were SAS (Savannah), SAM (Mobile), SAC (Charleston) and SAW (Wilmington)

Project Number

This data point pulled directly from EDW is the P2 number associated with the project. In some cases, projects were incrementally funded and had several P2 numbers associated with the single project. In order to identify these circumstances, projects were verified within RMS. RMS identified all applicable P2 numbers for an individual project.

Program Year

This data point pulled directly from EDW indicated what year a project was initiated.

BRAC Identifier

This data point labeled the District that was in charge of the project. The Districts that had projects used in the study were SAS (Savannah), SAM (Mobile), SAC (Charleston) and SAW (Wilmington)

Type of Building

This data point pulled directly from EDW indicated what kind of building was being constructed.

Location

This data point indicated what military base the project was being constructed.

Design By

This data point is covered in Chapter 3.2.2.2.

Original Contract Cost

This data point pulled directly from EDW the contract cost when the project came back from bid. It is in the dollar amount of it's program year.

Original Adjusted Contract Cost

This data point was manually calculated in order to set all program year dollars to 2006 so that they can be accurately compared. The calculation for the Original Adjusted Contract Cost is as follows:

Original Adjusted Contract Cost

$$= \left[\frac{2006 \text{ CPI}}{\text{Program Year CPI}} \right] * \text{Original Contract Cost}$$

Options Exercised Amount

This data point pulled directly from EDW the options exercised at the time a contract is signed. Options are additional design and/or construction needs that the government will either confirm or reject prior to contract being signed. This is in addition to the original contract cost.

Options Exercised Adjusted Amount

This data point was manually calculated in order to set all program year dollars to 2006 so that they can be accurately compared. The calculation for the Options Exercised Adjusted Amount is as follows:

$$\text{Options Exercised Adjusted} = \left[\frac{2006 \text{ CPI}}{\text{Program Year CPI}} \right] * \text{Options Exercised Amount}$$

Original Contract with Options

This data point was manually calculated in order to calculate the complete original contract cost that includes options. The calculation for the Original Contract with Options is as follows:

$$\begin{aligned} \text{Options Exercised Adjusted} \\ = \text{Original Adjusted Contract} + \text{Options Exercised Adjusted} \end{aligned}$$

Final Contract Cost

This data point pulled directly from EDW the contract cost when the project was completed. It is in the dollar amount of it's program year.

Final Adjusted Contract Cost

This data point was manually calculated in order to set all program year dollars to 2006 so that they can be accurately compared. The calculation for the Final Adjusted Contract Cost is as follows:

$$\text{Final Adjusted Contract Cost} = \left[\frac{2006 \text{ CPI}}{\text{Program Year CPI}} \right] * \text{Final Contract Cost}$$

Cost Growth without Options

This data point was manually calculated in order to find the cost growth of the project from initiation to completion. The calculation for Cost Growth without Options is as follows:

$$\begin{aligned} &\text{Cost Growth without Options} \\ &= \frac{[\text{Adjusted Final Contract} - \text{Adjusted Original Contract}]}{\text{Adjusted Original Contract Cost}} \end{aligned}$$

Cost Growth with Options

This data point was manually calculated in order to find the cost growth of the project from initiation to completion. The calculation for Cost Growth without Options is as follows:

$$\begin{aligned} &\text{Cost Growth with Options} \\ &= \frac{[\text{Adjusted Final Contract} - \text{Adjusted Original Contract with Options}]}{\text{Adjusted Original Contract Cost with Options}} \end{aligned}$$

Amount Category

This is data is manually input and is labeled based off the dollar size of the Final Contract Cost. The categories are listed in Chapter 3.2.3.

Controllable Change Amount

This is data is pulled directly from EDW and is the total dollar amount (program year) of a projects controllable change. Controllable changes are listed as the following in RMS:

- 1 -- Engineering Changes (Includes possible and confirmed A-E Fault)
- 8 -- Value Engineering Changes
- G -- Deficient Government Furnished Property Corrections
- S -- Suspension of Work
- T -- Termination of Work
- V -- Construction Changes Necessary to Complete Contract (RMS, 2.36)

Controllable Change Adjusted

This data point was manually calculated in order to set all program year dollars to 2006 so that they can be accurately compared. The calculation for the Controllable Change Adjusted is as follows:

$$\text{Controllable Change Adjusted} = \left[\frac{2006 \text{ CPI}}{\text{Program Year CPI}} \right] * \text{Controllable Change}$$

Controllable Change Duration (Days)

This data is pulled directly from EDW and is expressed in calendar days.

Final Change Amount

This data is pulled directly from EDW and is the total dollar amount (program year) of a project's final change. Final changes are all a project's uncontrollable and controllable changes together.

Final Change Adjusted

This data point was manually calculated in order to set all program year dollars to 2006 so that they can be accurately compared. The calculation for the Final Change Adjusted is as follows:

$$Final\ Change\ Adjusted = \left[\frac{2006\ CPI}{Program\ Year\ CPI} \right] * Final\ Change$$

Final Change Duration (Days)

This data is pulled directly from EDW and is expressed in calendar days. It is a combination of all a project's uncontrollable and controllable changes.

Original Contract Time (Days)

This data is pulled directly from EDW and is expressed in calendar days. It is the originally agreed upon length of time a project will take to finish construction.

Options Exercised Time (Days)

This data point pulled directly from EDW the options exercised at the time a contract is signed and is expressed in calendar days. Options are additional design and/or construction needs that the government will either confirm or reject prior to contract being signed. This is in addition to the original contract time.

Original Contract Time with Options

This data point was manually calculated in order to calculate the complete original contract duration that includes options. The calculation for the Original Contract Time with Options is as follows:

Original Contract Time with Options

$$= \text{Original Contract Time} + \text{Options Exercised Time}$$

Final Contract Time (Days)

This data is pulled directly from EDW and is expressed in calendar days. It is the total amount of time a project took to finish construction.

Contract Time Overage with Options

This data point was manually calculated in order to calculate the amount of days over the original contract time a project went over schedule that includes options. The calculation for the Contract Time Overage with Options is as follows:

Contract Time Overage with Options

$$= \text{Final Contract Time} - \text{Original Contract Time with Options}$$

Contract Time Growth Percentage with Options

This data point was manually calculated in order to calculate the additional time a project went over schedule. The calculation for the Contract Time Growth Percentage with Options is as follows:

Contract Time Growth Percentage with Options

$$= \frac{\text{Final Contract Time} - \text{Original Contract Time with Options}}{\text{Original Contract Time with Options} * 100}$$

BoD Original (Days)

This is data is pulled directly from EDW and is expressed by a calendar date. It is the original contracted date that troops are expected to occupy a building.

BoD Actual (Days)

This is data is pulled directly from EDW and is expressed by a calendar date. It is the actual date that troops occupied a building

BoD Growth (Days)

This data point was manually calculated in order to calculate the amount of days over the BoD original time a project went. The calculation for BoD Growth is as follows:

$$\text{BoD Growth} = \text{BoD Actual} - \text{BoD Original}$$

BoD Growth (Percentage)

This is data is pulled directly from EDW and is the percentage of time a project comes above or below the BoD Original date.

Placement (Gransberg, 2002)

Placement is a metric that has been in use by USACE for many years in order to numerically articulate efficiency (Gransberg, 2002). High values in placement indicate construction management is being executed efficiently.

$$Placement = \left[\frac{Final\ Construction\ Cost}{Final\ Construction\ Time} \right]$$

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