AN EXPLORATION OF MILITARY HEALTH FACILITY DEVELOPERS' PERCEPTIONS OF EVIDENCE-BASED DESIGN, CHOOSING BY ADVANTAGES, AND LEAN CULTURE

A Thesis

by

RALPH TREVINO SALAZAR

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Chair of Committee,	Zofia Rybkowski
Committee Members,	Manish Dixit
	D. Kirk Hamilton
Head of Department,	Joe Horlen

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ABSTRACT

The requirement to implement Evidence-Based Design in all military hospital development was enacted in 2007. For almost a decade now, health facility developers have been formally educated on what EBD is, and how to apply it in the Military Health System. Many tools, such as the MHS EBD Checklist developed by The Center for Health Design, have been developed to assist facility planners in programming the right design interventions into the healing space. However, the trend of military medical facilities being delivered consistently behind schedule and over budget suggests that military planners are still struggling with EBD implementation, and its associated design decisions.

This qualitative study examined some of the causal factors that result in scheduling delays and cost overruns to assess how paramount a role decision-making plays in the lack of delivery performance. In it, three facets of achieving an EBD healing environment were investigated: cultural transformation, adapting clinical operations, and the EBD built environment, which requires that decisions be made relative to how, and why, design interventions are selected to achieve World class healthcare.

The purpose of this research was to investigate how inconsistent decision-making is a contributor to the degraded performance in military hospital construction, and determine whether Choosing by Advantages, a Lean Construction programming methodology, could be applied to improve Evidence-Based Design decision-making.

DEDICATION

To my family, April, Grady, and Garrett, whose unwavering support, love, and encouragement is my reason for being here.

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. Rybkowski, and my committee members, Dr. Dixit, and Prof. Hamilton, for their guidance and support throughout the course of this research. Additionally, I would like to extend my sincerest gratitude to the department head of Construction Science, Prof. Horlen, for allowing me multiple extracurricular opportunities to gain a better understanding of the market into which I was about to enter.

I greatly appreciate my Construction Management friends, colleagues and the department faculty and staff for making my return to Texas A&M University a valuable and enriching experience. To be immersed in a culture of professionalism, and create professional bonds that will last my entire career will prove invaluable as I endeavor to build complex hospitals in a dynamic and challenging environment. The counsel already provided, and the counsel that I will undoubtedly request in the future, will enable me to be the best Health Facility Developer that I can possibly become.

Many thanks go to the men and women of the United States Army Health Facility Planning Agency who welcomed me into their offices to accommodate my project, and to give me just a glimpse into the world in which they operate. These patriots make it their life's mission to build the best health and rehabilitative facilities that they can possibly build for the benefit of their brothers and sisters in arms. Their dedication, and commitment to excellence, reflects great credit upon the HFPA, and the United States Army.

Special acknowledgment should go to the Soldiers, Sailors, Airmen, and Marines who have given life and limb for each other, and for our freedom. We owe it to the ones who have come back mentally and physically scarred, to build the most advanced rehabilitative healing spaces that we can possibly afford.

Finally, thanks to my family for their encouragement, and to my wife for her patience, love, and proof-reading skills. Without her, this would not have been possible.

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Contributors

This work was supervised by a thesis committee consisting of Dr. Zofia Rybkowski (Chair) and Dr. Manish Dixit of the Department of Construction Science, and Professor Kirk Hamilton of the Department of Architecture and Fellow at the Center for Health Systems & Design. All work for the thesis was completed independently by the student.

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NOMENCLATURE

AAR	After Action Review
AHRQ	Agency for Healthcare Research and Quality
A&E	Architectural and Engineering
BIM	Building Information Modeling
CBA	Choosing by Advantages
CHD	Center for Health Design
CPI	Continuous Process Improvement
DHA	Defense Health Agency
DMLSS	Defense Medical Logistics Standard Support
DOD	Department of Defense
EBD	Evidence-Based Design
ECIP	Energy Conservation Investment Program
EHR	Electronic Health Record
FEMP	Federal Energy Management Program
HCAHPS	Hospital Consumer Assessment of Healthcare Providers and Systems
HFPA	United States Health Facilities Planning Agency
HRO	High Reliability Organization
HRP	Health Readiness Platforms
IFOA	Integrated Form of Agreement

IofA	Importance of Advantages
IO&T	Initial Outfitting & Transition
LC	Lean Construction
LCCA	Life cycle cost analysis
LEED	Leadership in Energy and Environmental Design
LSS	Lean Six Sigma
MDMP	Military Decision-making Process
MEDCOM	U. S. Army Medical Command
MHS	Military Health System
MILCON	Military construction
MRR	Modernization Repair and Renewal
MTF	Medical Treatment Facility
OEAC	Owner, Engineer, Architect, and Contractor
OTSG	Office of the Surgeon General
P3	Public Private Partnership
PED	Project Execution Division
PP&SD	Planning, Programming, & Support Division
RCM	Reliability Centered Maintenance
RMD	Restoration & Modernization Division
ROI	Return on Investment
SMD	Sustainment Management Division
SOP	Standard Operating Procedure

SRM	Sustainment, Restoration and Modernization
STC	Sound Transmission Class
TJC	The Joint Commission
TRADOC	U.S. Army Training and Doctrine Command
TVD	Target Value Design
UFC	Unified Federal Code

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CHAPTER 1

INTRODUCTION

The last decade of military health facility development has been earmarked by unprecedented growth. Due to enduring conflicts in both Iraq and Afghanistan, the need for improved quality of healthcare for our nation's veterans and their families has resulted in increased budgets appropriated to military health facility developers to achieve "world class healthcare." The world class medical facility definition, developed by the National Capital Region Base Realignment and Closure Health Systems Advisory Subcommittee of the Defense Health Board in May 2009, includes 18 conditions in 6 domains that must be met for a medical facility to be considered world class (World Class Facilities 2017):

(1) Basic Infrastructure

(2) Leadership and Culture

(3) Processes of Care

(4) Performance

(5) Knowledge Management

(6) Community and Social Responsibility

To accomplish this transformational change, senior Department of Defense (DOD) leaders implemented programming measures and mandates (Appendix A), such as the use of Evidence-Based Design (EBD), to ensure that the quality of care improved and that design and construction practitioners were making smart business decisions that would improve the lifecycle performance of design interventions relative to the cost of implementation. These mandates changed the way military designers and developers programmed hospitals, and the learning curves for using these techniques were steep. Recognizing that implementation would require formal training, program managers began sending their workforce through academic institutions to learn how to appropriately, and responsibly, implement the tools and techniques that they would be charged with using to deliver some the most innovative and efficacious health environments in the world.

The decision of senior health affairs officials to push the implementation of EBD was reinforced by a large body of research which suggested that EBD interventions improved the quality of care. In order to achieve the "world class" designation, it only stood to reason that the military would turn to Evidence-Based Design to earn that moniker. With the help of Noblis, a nonprofit science, technology, and strategy organization, the DOD began defining the scope of application for EBD in the Military Health System (MHS). Malone et al. (2007), working for Noblis on behalf of the DOD, authored a publication that became the training manual for health facility developers and practitioners to assist in understanding what EBD was, and how to apply it in a military medical setting. She and her team relied heavily on academia and industry to develop *Evidence-Based Design: Application in the MHS* (2007). In it, they reference Stichler and Hamilton's definition of EBD as "a process for the conscientious, explicit, and judicious use of current best evidence from research and practice in making *critical* *decisions*, together with an informed client, about the design of each individual and unique project (2008, p. 3)." Malone et al. developed a graphic in which they depict three organizational components that must be necessary in order to achieve an evidence-based healing environment (Figure 1.1).

Figure 1.1- EBD Healing Environment, adapted from Malone et al. 2007

Designing and constructing an innovative healing space, which uses industry best-practices to achieve an optimal environment for wellness, is but one component. Along with the evidence-based space is a potentially new operating process that must be enacted by the hospital workforce. Both clinicians and administrative staff must adapt to the newly designed space, or face sub-optimal performance in an environment that is designed to be used in a different manner than they are perhaps accustomed to. This adaptation is not always so simple, however. It may be particularly challenging in an organization such as the military, which is steeped in tradition, hierarchy, and esprit de corps. The EBD component that is perhaps the hardest to achieve is developing the transformational leadership that shapes the *culture* required to function optimally in an EBD space. One author who expertly enumerated the principles of culture that it takes to succeed in an EBD environment is Jeffrey Liker. In *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer* (2004), Liker itemizes the Lean organizational attributes that enable fostering an atmosphere of continuous improvement and learning, satisfying customers and eliminating waste, getting quality right the first time, and grooming transformational leaders. These tenets of the Lean culture would be necessary to establish in the MHS, if the military were to maximize the efficacy of the new EBD hospital facilities. Recognizing this, the U.S. Army Medical Command (MEDCOM) began to emphasize Lean and Six Sigma in all of its hospital operations to eliminate waste, minimize mistakes, and ultimately become a High Reliability Organization (HRO) in its new high performance environment (HRO 2014). This study evaluated military culture, a critical component to the implementation of EBD, to assess the feasibility of adopting Lean techniques that, if implemented, will ultimately impact the way it makes decisions while planning, programming, and operating military hospitals.

Unfortunately, when initially implementing these new construction programming techniques to apply EBD to military healthcare facilities in 2007, lack of EBD understanding existed among stakeholders (Participant A, personal communication, January 10, 2017). In spite of that, however, learning has occurred that helps assess the changes that need to be made to the system to improve efficiency in the future. Though EBD was not the cause of the performance degradation, it was lack of understanding about how to implement EBD, and the significantly increased scope of the projects (with corresponding increase in project budget) that added to the probability of poor performance. These contracting, programming, management, cultural, administrative and budgeting decision errors have resulted in consistent cost overruns and scheduling delays of virtually all of the medical facility megaprojects delivered by the DOD since 2007. There is not a sole entity to blame, but rather a myriad reasons why the government seems to consistently fail to meet their target budgets and time constraints in delivering these hospital replacement facilities. Most of the reasons are beyond the control of the actual facility developers, and are systemic issues within the layers of bureaucracy that exist at many levels of government. Among those that are specific to the military though, is the unique requirement of the military to frequently move service members from one duty to another, to allow for professional growth, and for a free exchange of ideas among the diverse workforce. This practice, however, is detrimental to the continuity in decision-making on large, enduring, projects that last five to seven years on average, and sometimes longer. This results in design team turn-over at a rate much higher than that seen in the private sector, and runs counter to the teaming principles of Lean Construction which, in most cases, require continuity (Zimina et al. 2012). This study examined some of the causal factors that contribute to the cost overruns and scheduling delays that are prevalent in military health facility development. Additionally, it investigated how inconsistent decision-making contributed to the degraded performance in military hospital construction to determine whether or not Lean Construction (LC) programming techniques can be used to improve continuity in design decision-making.

Research Goal

This study's main goal was to determine if a Lean Construction decision-making model, called Choosing by Advantages, could be applied to the design and programming of military healthcare facilities to improve decision-making. The semi-structured interview questions were designed to assess the applicability of Choosing by Advantages as the foundation for a decision framework upon which military health facilities planners and developers might systematically base programming and design decisions, relative to EBD intervention.

Research Objectives

While not the primary effort of the study, the following objectives were also researched to get a holistic sense of military healthcare facility development.

1) Gain a better understanding of the causal factors to cost overruns and scheduling delays of military hospital projects
2) Assess Army culture to determine compatibility, and feasibility, of Lean Construction programming implementation using Liker's Principles (Liker 2004)

3) Improve understanding of the current state of EBD implementation and management of EBD intervention selection

Definitions

To put the thesis into context, it is important to define several key terms so that the relationship between the concepts can be understood relative to military health facility development.

1) Lean Construction (LC) – “A combination of operational research and practical development in design and construction with an adaption of Lean manufacturing principles and practices to the construction process. Lean Construction is a project-based production process concerned with the alignment and holistic pursuit of concurrent and continuous improvements in all dimensions of the built and natural environment” (Abdelhamid et al. 2008, p.8). The programming methodology tries to manage and improve construction processes with minimum cost and maximum value by considering customer needs (Koskela et al. 2002).
2) Target Value Design (TVD) – A strategic project delivery method designed to reduce cost and maximize value by implementing a more team-centric approach when making design decisions on behalf of a client. TVD is an LC cost programming technique that was adapted from a proven manufacturing practice, which is used to manage cost variability during new product development, called Target Costing (Zimina et al. 2012).

3) Choosing by Advantages (CBA) – A subcomponent of TVD and a decision making tool developed by Jim Suhr (1999). The method can help construction planners visualize *why*, and on *what basis*, they are making a decision, based on the *Importance of the Advantages* between alternatives, while enabling them to capture that decision numerically (Parrish and Tommelein 2009).

4) Evidence-Based Design (EBD) – "A process for the conscientious, explicit, and judicious use of current best evidence from research and practice in making critical decisions, together with an informed client, about the design of each individual and unique project" (Stichler and Hamilton 2008, p.3). EBD implementation has been mandated for use in development of all Military Healthcare Facilities since 2007.

CHAPTER 2

LITERATURE REVIEW

The EBD Mandate

The entire Military Health System (MHS), only part of which the U.S. Army manages, is undergoing transformational change to achieve world class healthcare capability. Consequently, the entire DOD's medical infrastructure is being substantially adapted using proven, Evidence-Based Design interventions from throughout the healthcare industry to achieve that goal. Researchers from Texas A&M University, the Georgia Institute of Technology, and industry partners with The Center for Health Design (CHD) have been pivotal in developing an "EBD Checklist" (Appendix B) for planners and developers to consider using while programming a new health facility project (MHS 2010). However, even when implemented, little data exists capturing the effectiveness of these Military EBD interventions. Furthermore, little guidance or standardization exists to evaluate and shape the prioritization of these design decisions. It is critically important, in our current fiscally constrained environment, for medical planners to implement and invest in the right designs to address the specific problems plaguing today's military demographic.

In 2007, the Assistant Secretary of Defense for Health Affairs (Dr. William Winkenwerder), drafted a Memorandum for Record (Appendix A) to the General Officer Commanders of Engineering Operations in the Armed Services, mandating the implementation of Evidence-Based Design in all Military Medical Treatment Facilities

(MTF) within the Military Health System (Winkenwerder 2007). This prompted significant changes to the programming specifications and budget appropriations of hospital facility development. Specifically, the U.S. Army's Health Facilities Planning Agency (HFPA) was tasked with the oversight and commissioning of these new EBD implementations for Army health facilities in the absence of *standardized* decision matrices to guide them in managing these new requirements.

The HFPA's primary role is to serve as the U.S. Army Surgeon General's contracting agent and user representative for health facility development. The organization consists of a consortium of architects, engineers, project managers, and construction management professionals whose primary job is the planning, programming, design, and construction of military medical treatment facilities (MTFs) and medical research facilities. The organization is charged with the oversight of the capital improvement portfolio for all of MEDCOM's medical infrastructure. These buildings house the personnel who provide the general health, dental, veterinary, research, and rehabilitative care for all of the U.S. Army's Soldiers, retirees, and their beneficiaries. Consequently, the director of the HFPA also serves as the Assistant Chief of Staff for Facilities, is special staff to the Army Surgeon General, and handles all manner of medical facility capital investment and improvement. This includes managing plans and programs not only for the facilities' design and construction, but also for the maintenance, repair, energy management and sustainability of both the existing medical footprint, and new hospital replacement facility construction.

Divisions of the HFPA

While all members of the HFPA play an important role in the development of a hospital, four divisions are of particular importance with respect to design and material or equipment selection decisions that must be made on a daily basis, and should apply the tenets of Evidence-Based Design to those decisions. They are the Project Execution Division (PED); the Planning, Programming, and Support Division (PP&SD); the Restoration and Modernization Division (RMD); and the Sustainment Management Division (SMD). The members of these divisions were the target subjects interviewed for the purpose of this study.

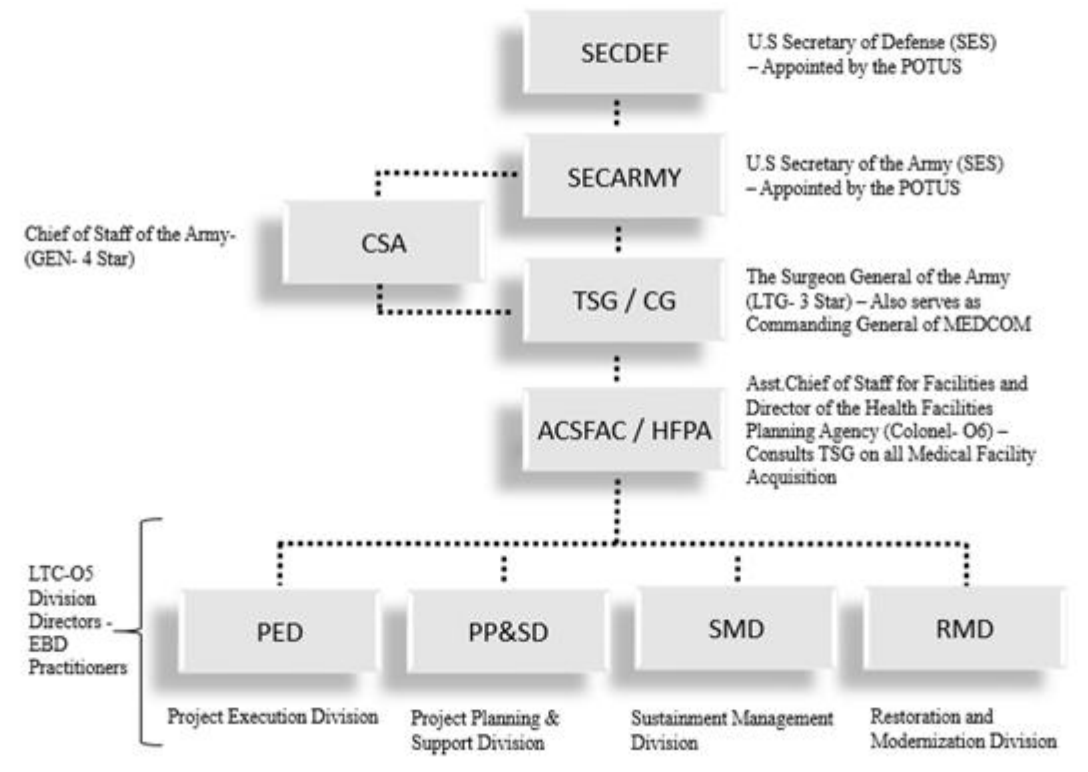

Figure 2.0 – HFPA Organizational Chart

The PED is the division which establishes health facility project offices on-site during new health facility construction. Their focus as field representatives, in addition to providing the Office of the Surgeon General (OTSG) with quality assurance of major capital investments, is communicating and coordinating medical project requirements to construction contract partners. Upon construction completion, they manage the Initial Outfitting & Transition (IO&T) budget to assist the MTF Commander in procuring and integrating thousands of pieces of medical equipment into the new facility. This process is extremely complex, and one that can introduce variability in the projects' time and budget if design decisions and material selections are made very late in the delivery process. Many of these decisions, such as room orientation, or medical equipment chosen, are based on the users' personal taste and previous experience (Participant C, personal communication, January 12, 2017). As is often the case, due to the long duration of a MTF construction project, it is not uncommon that the MTF Commander position be filled by two or three different Commanders over the course of construction. These MTF Commanders effectively serve as ad hoc members of the design team, and are representing the end users of the space in making decisions. As one might imagine, personal preference in space utilization, layout, and equipment selection can differ considerably from one Commander to the next. The PED Field Representative must artfully balance changes that are requested by an incoming MTF Commander, while delivering a product that adheres to the principles of EBD.

The Project Planning & Support Division (PP&SD) serves as the HFPA's capital investment planner. Most of the Architectural and Engineering (A&E) support resides in the PP&SD. This division is involved in the Evidence-Based Design of several key areas of Department of Defense Medical Military Construction (MILCON). Chief among those are the Modernization, Repair & Renewal (MRR), and the Sustainment, Restoration and Modernization (SRM) programs which they manage in concert with the Restoration and Modernization Division (RMD). The members of the RMD are co-located with the U.S. Army Corps of Engineers in what are called Medical Support Teams. What makes SRM particularly challenging is that the renewal and renovation budgets are often more constrained than those granted to new hospital replacement facility projects. Detailed Return on Investment (ROI) analysis and Life Cycle Cost Analysis (LCCA) must be done to ensure that funds are not misappropriated on a dilapidated building that does not have enough life left to recoup the renovation investment. An additional challenge is that in these projects, the planners and programmers are often constrained to the existing footprint of the obsolete building, and sometimes limited to retaining the antiquated building systems. Providing world class healthcare in a space that was not originally designed to do so can be an architectural and engineering feat that requires forward thinking designers and an immense amount of coordination. As with any renovation, the time and budgetary margins of error are small, and A&E professionals often uncover undiagnosed conditions after taking on the project that must be addressed from a patient safety standpoint. This can quickly lead to cost overruns and scheduling delays.

The Sustainment Management Division (SMD) is responsible for the policy and oversight of sustainment activities, including the Federal Energy Management Program

(FEMP) and Energy Conservation Investment Program (ECIP), throughout the entire MEDCOM footprint. They administer and fund the energy and sustainment policy, working closely with the Defense Health Agency and the Environmental Protection Agency to track and manage energy and sustainability initiatives such as Leadership in Energy and Environmental Design (LEED) Certification, and Health Readiness Platforms (HRP) Certification through The Joint Commission (TJC). The SMD is also the proponent, and provides subject matter expertise, for TJC accreditation. In general, the SMD insures that Army medical facilities are in top performing condition by managing regularly scheduled and preventative maintenance contracts. A key component of the SRM, from an Evidence-Based Design perspective, is that much of the data required to assess the efficacy of design, resides in databases managed by SMD. Because they manage the Reliability Centered Maintenance (RCM) program, they maintain the logistic software to manage wearable items, and failure prone components such as carpeting, tile, and wall coverings. With these databases, SMD's technical team can assist project integrators with space planning, critical infrastructure deficiencies, and initial outfitting requirements. Through their Defense Medical Logistics Standard Support (DMLSS) database and its companion software suite, BUILDER, which the 2D AutoCAD as-built drawings are fed into (an effort is underway to use BIM models in the near future), they can monitor the health and wellness of MEDCOM's buildings, while tracking real-time consumption in power, water, and sewage through a system of sensors and meters installed on the buildings themselves. Figure 2.1 depicts a screenshot of the

Facility Management capability of DMLSS, which is an important database from which to draw EBD evaluation criteria.

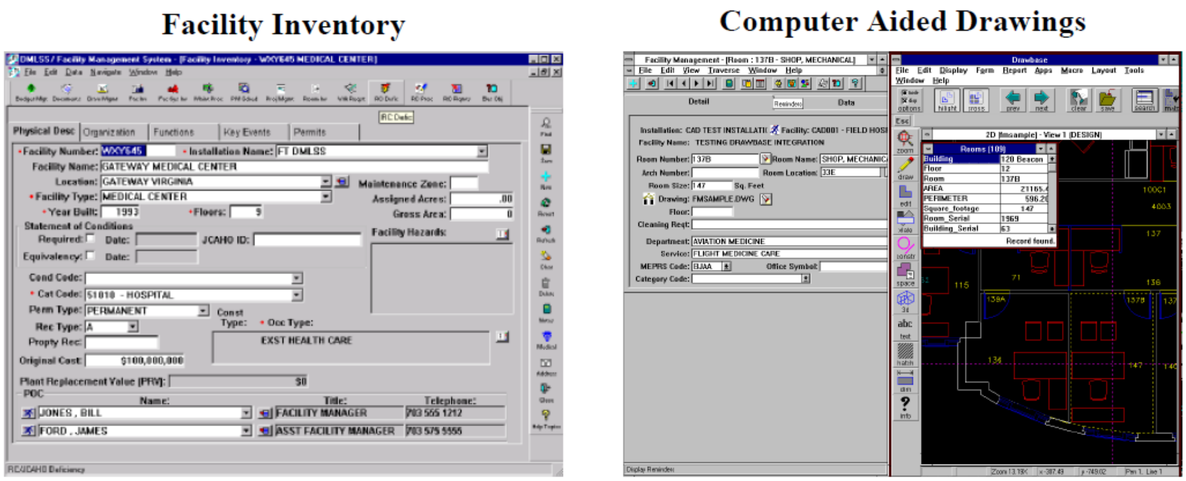

Figure 2.1 – DMLSS Facility Management, reprinted from Office of the Under Secretary of Defense for Acquisition (DMLSS 2017)

Since the 2007 EBD mandate (Appendix A), the Army has built seven Hospital Replacement Facilities, and renovated numerous existing MTFs, implementing the mandated EBD interventions. Thus, there are now military hospitals that are operating in the new EBD environment from which to draw performance conclusions, and base design decisions. However, a conceptual framework still needs to be developed on which to systematically base EBD decisions during programming phases of future Medical Treatment Facility construction. In addition to measuring the right metrics to validate the efficacy of design, the method that is used to capture the *rationale* for the design decision is important, because preserving the ideas behind the decisions help bridge the knowledge gap created when military members transfer off the job, and new construction programmers and planners are moved onto it. There are many tools at the facility planner and programmer's disposal to make design decisions and material selections now, but none captures the true value of those design decisions, neither in the business sense (from an ROI perspective), nor from an impact to patient health perspective. The "EBD Checklist" (Appendix B), for instance, was designed to organize and categorize the different principles of Evidence-Based Design, and give the facility planner some research proven options to consider using when trying to achieve a specific design driver. The shortcoming of a clearing house of many options is that it cannot deduce which of those options are the best fit for a specific project when time, cost, and quality factors are taken into account. Another tool at the military health facility developer's disposal are products referred to as design "guide plates" which are companion drawings of medical suites to be used with written specifications. The latest revision of these medical design templates was developed in January, 2015 to accommodate changes to the Unified Federal Code (UFC) 4-510-01, which are the specifications to which all military medical facilities must be built. These design guide plates, available in .pdf or .rvt (AutoDesk® Revit – BIM) files on the DOD's Whole Building Design Guide web portal, are a great design point of departure for a modularly designed hospital space (WBDG 2017). However, these are only a suggested orientation and space utilization for most spaces, and material selection decisions and orientation must be developed and refined for each specific hospital. Figure 2.2 depicts an example of a design guide plate for an Exam Room, and Figure 2.3, a companion guide plate, gives a suggested equipment orientation for the Exam Room.

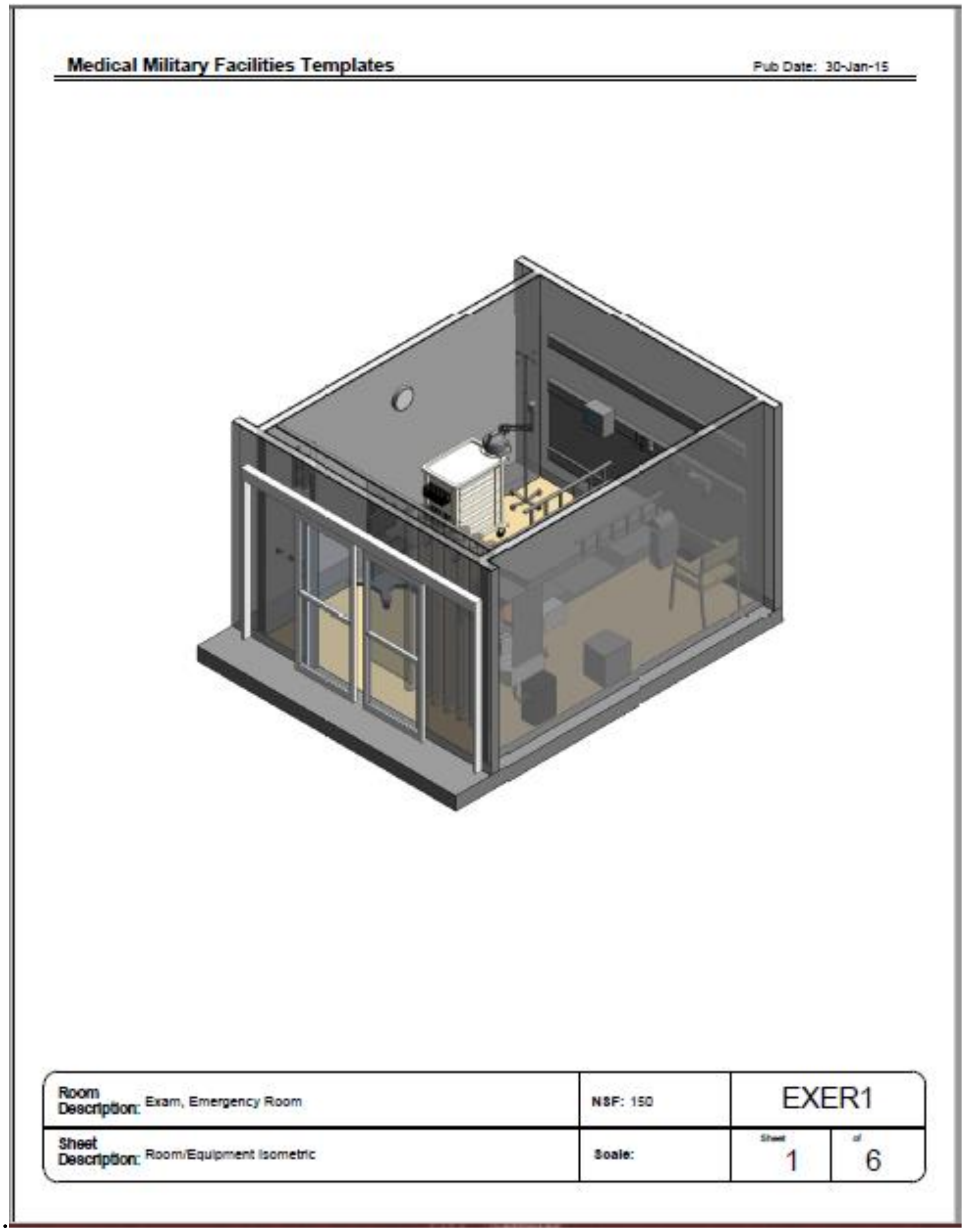

Figure 2.2 – MHS Design Guide Plate for Exam Room, reprinted from the Whole Building Design Guide (WBDG 2017).

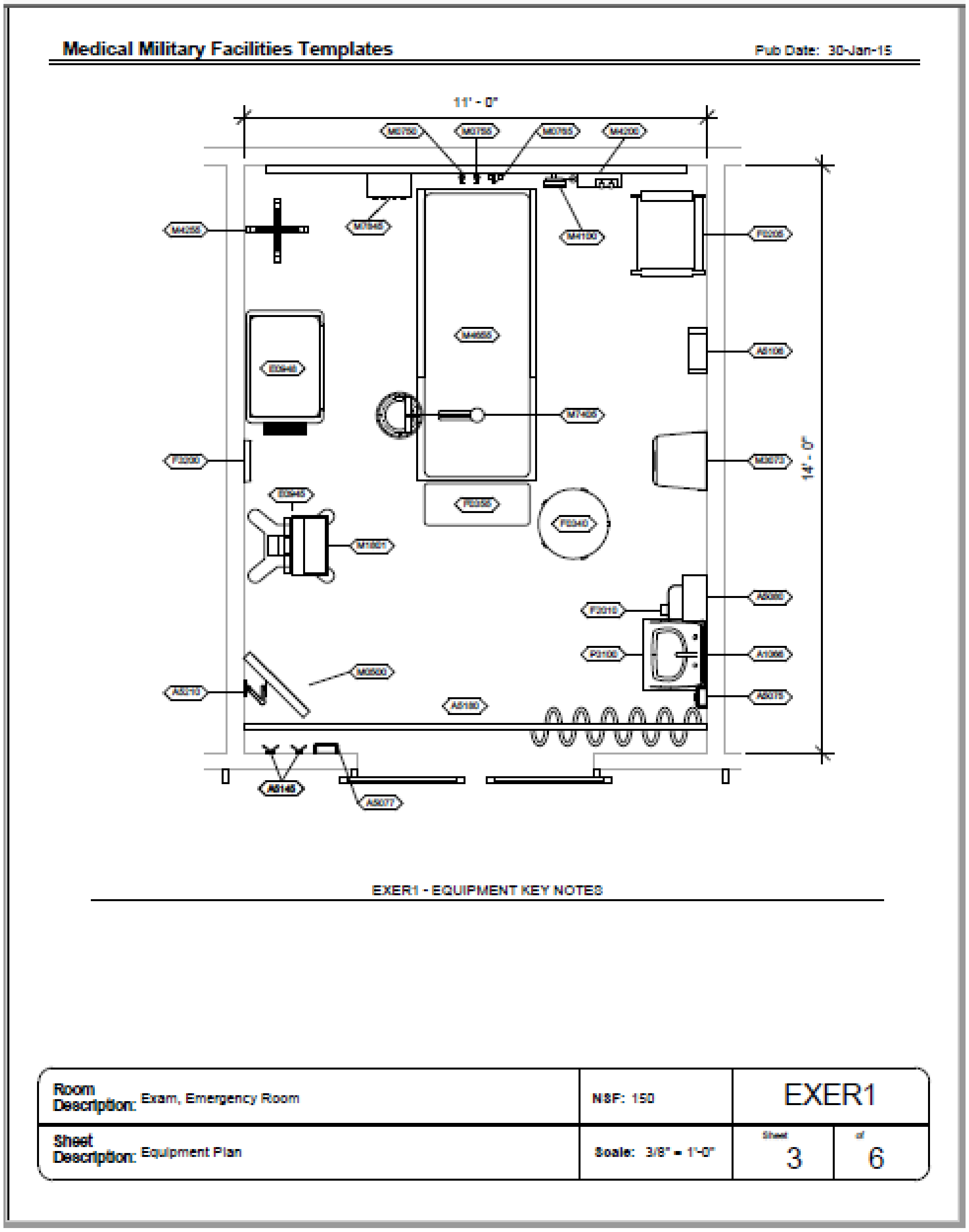

Figure 2.3 – MHS Design Guide Plate for Exam Room Equipment, reprinted from the Whole Building Design Guide (WBDG 2017).

Additionally, when new technologies emerge, such as high performance wall coatings that reduce Hospital Acquired Infection for example, the decision to use these materials are often made in the field, long after the design guide plate was crafted. So how does a facility planner and programmer decide which of the Evidence-Based Design interventions to implement to achieve the desired high-performance health environment? How does one evaluate the life cycle advantages per invested dollar of one over another?

Lean Construction

Evidence-Based Design decisions are made on construction sites, and in design studios across the globe every day. The speed, accuracy, clarity, and ultimate effectiveness of those decisions vary considerably from one firm and one project to the next, however. The Lean Construction community advocates for a collaborative decision-making environment, where all stakeholders are brought into the planning phases of design very early in the project (Zimina et al. 2012). This spawns creativity and bottom-up refinement of ideas by the trade-craft team members, end users, and OEAC enterprises alike. In an LC management practice called Target Value Design (TVD), which is a strategic project delivery method designed to reduce cost and maximize value, researchers promote a more team-centric approach when making design decisions (Zimina et al. 2012). TVD is an LC cost programming technique that was adapted from a proven manufacturing practice, that is used to manage cost variability during new product development, called Target Costing. In this novel, construction specific costing concept, presented in *Target value design: using collaboration and a Lean approach to reduce construction cost*, Zimina et al. (2012) research twelve construction projects that apply TVD to deduce the specific benefits, downfalls, and organizational requirements necessary to execute TVD. They contend that TVD's main goal is “to make a client’s value (specific design criteria, cost, schedule, and constructability) a driver of design, thereby reducing waste and satisfying, or even exceeding the client’s expectations” (Zimina et al. 2012, p. 387). In order to accomplish this, however, they make some key observations about project organization and risk management. The first is that there must be full engagement of the entire team in the design process, and there must be continuity in the staff in order to retain the knowledge necessary to base future decisions. Additionally, the team must embrace an “all-for-one” mentality with respect to risk versus reward, and the decisions must be collaborative in order for TVD to work (Zimina et al. 2012). While they do not cite any specific contractual organizations that are incompatible with TVD, they do suggest a team-centric organization and delivery method, such as the Integrated Form of Agreement (IFOA) or perhaps Public Private Partnership (P3), which may be more naturally conducive to the success of TVD as a cost programming method (Zimina et al. 2012). Again, the goal of this managerial tool is to minimize waste, and make design decisions that maximize value to the customer, thereby bringing cost down. A subcomponent of TVD, and the method of making informed design decisions to reduce waste as a design team, is a tool called Choosing by Advantages (CBA).

Waste in the healthcare industry comes in many forms, including (but not limited to) waste of motion, conveyance, time (waiting), inventory, overproduction, errors (defects) and processing (Sullivan, Smith, Derr and Davey 2011). These wastes are, in fact, party to the stressors that both patients and clinical providers are subjected to in the hospital environment. What is worse is that these wastes are sometimes *designed* into the building. One of the tenets of Lean is the eradication of waste, thereby enabling the seamless execution of tasks, or processes, without barriers to progress (Ballard 2008). A critical component of Lean Construction is the breaking down of barriers through innovative design such that the end user can more effectively execute his or her tasks, and derive increased *value* from the designed space.   This maximization of value is accomplished by employing various Lean programming techniques, but at the heart of this research project is Target Value Design and its decision-making subcomponent called Choosing by Advantages. Some researchers believe the collaborative, Lean programming approach, when coupled with EBD, has redefined the way we understand what healthcare practitioners deem truly valuable in a healthcare facility over the long-term (Rybkowski et al. 2012).

The waste that was investigated in this study is caused, in part, by the frequent personnel turn-over that military hospital projects are often plagued with, and the resultant loss of continuity in decision-making. The virtually constant turn-over results in changes being made very late in the delivery process due to differing opinions, viewpoints, and personal bias of incoming design team members or new facility commanders. This results in a proverbial two steps forward, one step back approach to building hospitals that negatively impacts both time and cost. In a military hospital programming application, Choosing by Advantages may serve as a bridging strategy between design team members to promote continuity in decision-making.   Inconsistent decision-making, without capturing the rationale for design decisions, is partly to blame for scheduling delays and cost overruns due to lack of shared understanding, and lack of clear intent, or prioritization of design interventions. The best way to overcome late change requests on a project, is to develop a network of decision makers who can adhere to the agreed upon design implementation, and show the critical analysis (CBA) that was performed by the team, to refute the need for a late change order.

By validating a more structured decision-making process in selecting EBD interventions, the business objective of this study is to propose a way to save time, money, and energy during the pre-construction phase of MHS health facility development, such that those resources can be appropriated elsewhere. Choosing by Advantages, developed by Jim Suhr (1999), can improve clarity and transparency in decision-making. In construction, its benefits have been cited by LC pioneers as enabling construction planners to visualize *why,* and on *what basis,* they are making a decision, while enabling them to capture that decision numerically (Parrish and Tommelein 2009). When choosing between two alternatives, CBA's goal is to base decisions on the *Importance* (weighted value) of Advantages, rather than on "pros and cons," or simply on advantages versus disadvantages (Abraham et al. 2013). A research objective of this study is to apply the tenets of Choosing by Advantages to an EBD decision, to assess whether or not it may help the HFPA become more efficient in the evaluation and application of EBD interventions in the military health environment.

The efficiency achieved through Lean Construction, though not a universally accepted practice in the construction industry, is hard to refute. The practice of analyzing process, and flow, early in the programming phases of design and construction, with the involvement of the end user, is cited as a tangible benefit to Lean

Construction, and a departure from more traditional health facility delivery methods employed by the United States Army Health Facility Planning Agency (Ballard 2008). Thus, this study explored through semi-structured interview the application of a Lean Construction technique that has been shown to improve efficiency in decision-making, to determine if it may help to eradicate the waste in MTFs that hinder the military planner's ability to maximize the environment's healing and rehabilitative potential, and leads to poor cost and schedule performance.

Background to the Research Design

The issue of cost overruns and scheduling delays in delivering military hospitals is a complex and multi-facetted problem. On its face, it may seem as though military health facility developers are simply poor project managers, and inefficient executers of work due to lack of experience or training. That could not be further from the truth. In fact, the military has an established pipeline for the professional development of its A&E workforce to achieve higher performance, and to stay abreast of the emerging technologies in the construction field. While the design and construction professionals bear some of the performance responsibility, the delays and missed cost targets are also due to many other reasons including a complicated, hierarchical governmental structure, timeliness of budget appropriations, and the checks and balances imposed by the U.S. Congress to insure the responsible use of taxpayer dollars. Add to that the EBD requirement, which prompted retraining with an associated change to the health facility design schema, and it led to a tumultuous roll-out of the first military world class healthcare facilities.

This phenomena is not uncommon of governmental megaprojects it seems. A Danish professor, and co-author of *Megaprojects and Risk*, Bent Flyvbjerg, concluded that "cost overruns of 50 percent to 100 percent in real terms are common in public megaprojects (Flyvbjerg et al. 2003, p.136)." As a leading authority on public project cost overruns, Flyvbjerg et al. (2002) paint a bleak and ominous outlook on the reasons for target cost failure on governmental projects in *Underestimating Costs in Public Works Projects: Error or Lie*? In that study, the authors examined 258 public transportation projects, executed in 20 different countries, and found that 90 percent were over budget. Though investigating a different market (transportation), the reasons cited in those cases may have applicability in the military health facility arena as well. Some of these reasons will be queried as part of an interview process of HFPA subject matter experts in this study. The causes include (Flyvbjerg et al. 2002):

- Strategic Misrepresentation (The main cause according to the authors);
- The costs of materials, labor, or other inputs may change in unexpected ways over long execution timelines;
- Unforeseen environmental or geological issues may arise;
- Federal agencies do not have to earn profits, so they have little reason to restrain costs;
- On government projects, there are few consequences if funds are not used efficiently (the projects are typically given additional funds to get well);

- Federal employees' pay is generally tied to longevity, not performance;
- Contractors know that low bids will help win federal business; they have an incentive to underestimate project costs knowing that is only a "floor";
- Politicians are spending taxpayer money, which they do not spend as carefully as their own (in fact, long, enduring projects in their voting districts mean a favorable job market for voting constituents); and
- Decisions made early in the project planning phases do not have validity when they are finally executed (circumstances influencing the decision change)

The authors cite "Strategic Misrepresentation," which they define as project promoters, such as special interest groups, consultants, and politicians, creating pressure for governmental project planners to lower their initial cost estimates in order to garner public support, as the main reason for cost overruns (Flyvbjerg et al. 2003). They point to the consistency, and high percentage of the costing error to the high side as proof of unscrupulous intent. Flyvbjerg et al. claim that governmental project estimators and managers could not possibly be so obtuse as to underestimate their projects so consistently. If it were "an honest mistake," the ratio of cost overruns to projects that came in under budget would be more normally distributed: an equal ratio of under-budget to over-budget (Flyvbjerg et al. 2003).

CHAPTER 3

METHODOLOGY

Research Approach

In an Ishikawa Fishbone diagram (Figure 3.1), adapted for military healthcare facilities, it illustrates some assumptions of this research regarding the reasons for cost overruns and scheduling delays, based on Flyvbjerg et al. It should be noted that while this list of causes is likely valid, not all of these reasons for poor performance in military hospital delivery have been researched and confirmed, through actual analysis, to be relevant. This Fishbone Diagram is populated with anecdotal evidence based on interviews and personal experience.

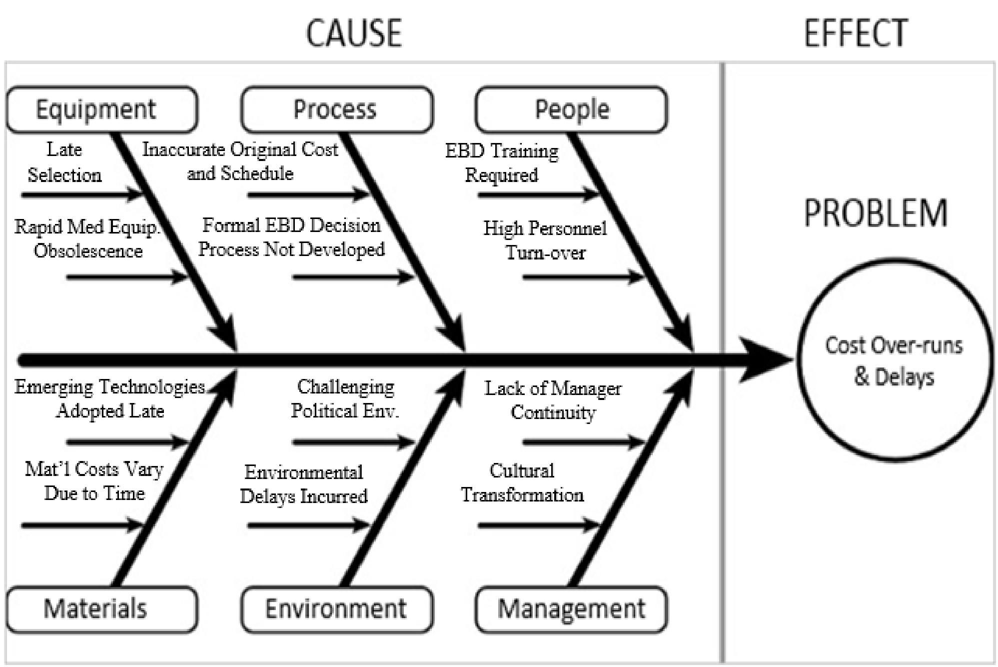

Figure 3.1 – Causes for Cost Overruns and Scheduling Delays in Military Hospitals

The causal component of the cost overruns and scheduling delays explored more deeply was the EBD decision-making process. This was due to an assumption about the span of control that the military health facility developer has within their sphere of influence. The intent of this study was to make recommendations that could affect change at the practitioner level. The high-level, systemic issues that are prevalent throughout the upper echelons of government are outside the scope of this study, and ones that the military health facility developer could not easily effect.

Method

Through semi-structured interviews (Salazar, personal communications, December 20, 2016- January 20, 2017) the intent of this exploration was to understand where subject matter experts within the Health Facilities Planning Agency felt the organization had evolved with respect to EBD implementation, design decision-making, and organizational culture since the 2007 EBD mandate. Ten professionals were selected from a cross-section of the organization which included representation from the four targeted divisions of the HFPA (Table 2.0 – Bottom Tier). As was noted in the Chapter II, the divisions assumed to have the most working knowledge of EBD in practice were the PED, the PP&SD, the RMD, and the SMD. Thus, seven of the interviews were conducted in person (face-to-face) with experts assigned to Joint Base San Antonio's contingent of the HFPA staff, while the other three were conducted with members of the HFPA headquarters in Falls Church, Virginia. Due to travel and budgetary constraints, the three interviews conducted with members in Falls Church, VA were conducted via telephone. Prior to the interviews, an excerpt of the proposal for this project was sent to the subjects detailing what CBA was, and how it was used, entitled "CBA Read-Ahead" (pages 36-40 of this thesis) . This gave each subject a foundational understanding of the decision-making method, and an idea of how it may be applied to design decisions in military medical construction. Additionally, a series of questions (Appendix C) was provided that might be discussed during the interview portion of the visit, and each participant was informed that the conversation was not limited to only those questions, and that the subjects themselves could choose the direction, and breadth of content coverage during the interview.

The interviews were essentially conducted in two parts. The first part was an exercise to gauge the potential utility of CBA as a tool to improve clarity in EBD decision-making, and as a medium to capture the reason for EBD decisions in order to help bridge the decision-making continuity gap generated by personnel turn-over. The second part was a conversation in which the interviewer and subject discussed their general thoughts on CBA, and on EBD as a whole. The intent was to gauge the participants' understanding of EBD implementation requirements, level of responsibility relative to making design or programming decisions, their impressions of Army health facility culture, and problems that they felt were hindering productivity. The observations were captured in a legal note pad over the course of the approximately one hour long interviews with each of the ten subjects.

Development of Hypothetical CBA Exercise

In order to assess whether or not the Choosing by Advantages method was perceived to improve the level of understanding, visualization, and analytic capability of an EBD decision, a realistic CBA exercise was generated. It was important that a real-world design problem was presented to the participants to convey practicality, and applicability. Thus, a hypothetical design decision was chosen for the exercise based on a relevant evidence-based issue that currently exists in military hospitals. In Table 3.2, results of an HCAHPS survey question were recorded from 2011 to 2015. The answers to Question #9: *How often was the area around your room quiet at night?*, indicate that noise pollution in military hospitals is problematic. The percentages indicate the average of all respondents' ratings of the quietness of the hospital environment. As an example, in 2014 at the San Antonio MEDCEN, survey participants reported that the area around their room was quiet for only 65% of the night time period.

Table 3.2 – MHS Inpatient Experience Metric

Category	Data Period	Fort Belvoir Community Hospital	Walter Reed Nat'l Military MEDCEN	San Antonio Military MEDCEN	Naval Hospital Camp Pendleton	Centers for Medicare and Medicaid Services Benchmark
Quietness of Hospital Environment	April 2011-March 2012	65%	56%	60%	57%	59%
	CY 2012	75%	59%	63%	60%	60%
	Fiscal Year (FY) 2013	79%	63%	66%	70%	61%
	FY2014	83%	64%	65%	75%	61%

Adapted from U.S. Department of Defense MHS Report, 2012-2015

The metrics depicted in Table 3.2 drove the decision to develop a CBA exercise that would analyze three options for a high-performance wall, such that a facility planner would choose a design implementation to combat the transmission of sound through patient rooms. As was mentioned previously, an evidence-based material solution is only one component of achieving the desired healing environment. For example, a patient room constructed of high-performance walls must be accompanied by an operationally noise conscious staff, whose leadership establish a culture of respect for patients' peace and quiet. Table 3.3 illustrates that the built environment is not a single-source solution to combating noise pollution in military hospitals.

Table 3.3 – Three Domains of an EBD Healing Space to Combat Noise

INFRASTRUCTURE	CULTURE	PROCESS
Built Environment • Single patient rooms • Use sound absorbing materials (high-performance walls) • Design to separate noisy entities (ice machine) • Operations, maintenance activities follow same practices, use the same sound absorbing materials	**Identify Desired End-State** • Identify current state: decibel level, HCHAP score, & staff satisfaction re: noise • Establish sense of urgency • Identify target goals	**Staff Interventions** • Nighttime care guidelines • Quiet voices (modify behavior) • Resupply and equipment movement (timing) • Implement a decibel measurement program to provide objective data
Technology • Hands-free communication • Pagers on vibrate • No overhead paging • EHR templates that reflect evidence-based practice guidelines and enable data collection	**Develop Noise Reduction Campaign Plan** • Set the stage using research and best practices • Clarify values, vision	**Patient Engagement** • Rights • Issue Earplugs • Television and radio headphones
Equipment • Fix noisy equipment (squeaks) • Decrease equipment volumes – link to hands-free devices	**Measure and Reward Progress** • Celebrate successes • Find and tell the best stories	**Family & Visitor Engagement** • Orientation to noise reduction • Cell phone use

Adapted from DHA-Health Report Opportunities for Design, presentation by COLI Eileen Malone on 2 FEB 16

This study ascertained the degree to which the subjects felt that there is clarity in EBD decision-making while planning, programming, and constructing military hospitals. Additionally, the research determined the extent to which existing data collection platforms can be used to develop weighted Importance of Advantages (IofA's) of EBD interventions within the MTF built environment by discussing data collection efforts, and post-occupancy evaluation with the subjects. Existing data collection instruments include a litany of nationally accredited, but independent surveys such as: the Healthcare Effectiveness Data and Information Set (HEDIS®), ORYX National Hospital Quality

Measures, Hospital Consumer Assessment of Healthcare Providers and Systems, etc. These assessments attempt to capture the patient satisfaction aspects of the healthcare environment, but this is only a portion of the necessary evaluation criteria for choosing between design interventions. Subsequently, questions were asked to determine if the logistics data currently being collected through systems like DMLSS can be used to extract metrics that could also be used as evaluation criteria in a CBA matrix to compare design alternatives. In order to recommend CBA for implementation by the Health Facilities Planning Agency in evaluating EBD options, the research evaluated whether sufficient measurable data is being collected to develop a CBA table with credible evaluation criteria across the five principles of EBD that the MHS has adopted. Those principles are (Malone et al. 2007):

- Create a Patient and Family-Centered Environment
- Improve the Quality and Safety of Healthcare
- Enhance Care of the Whole Person (Contact with Nature & Positive Distractions)
- Create a Positive Work Environment
- Design for Maximum Standardization, Future Flexibility and Growth

The following are brief descriptions of some of the survey instruments** that were reviewed, and combined with stakeholder feedback, to develop the test CBA matrix that was introduced to the subjects during the interview. These instruments,

** Extracted from the Military Health System Final Report dated August 29, 2014 along with post-occupancy evaluation data, and metrics harvested from facility databases like DMLSS served to provide the evaluation criteria (data input) for the CBA table.

- **Healthcare Effectiveness Data and Information Set (HEDIS®):** The MHS compares its performance in selected measures against national HEDIS® benchmarks for this measure set, which is utilized by more than 90 percent of health plans in the United States.
- **ORYX National Hospital Quality Measures:** ORYX is a set of measures used by TJC in its hospital accreditation process, in which all military hospitals participate.
- **Experience of Care**: The experience of care measures use survey data to determine beneficiary satisfaction with MHS health care. AHRQ CAHPS and Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) comparable questions were used to allow comparison to civilian systems and benchmarks.

The data harvested from the instruments listed above were cross-walked through ROI analysis tables developed by The Center for Health Design (CHD) and the Georgia Institute of Technology and marketed as the "Evidence-Based Design Leader's Toolkit" and the "MHS EBD Checklist v2.2" in the whitepaper series entitled *The Business Case for Building Better Hospitals Through Evidence-Based Design* (Sadler et al. 2008). By doing so, a hypothetical CBA table was developed with reasonable evaluation criteria to apply to a CBA demonstration exercise during the semi-structured interviews. The intent of the exercise was for the researcher to critically analyze how *each subject* truly assigns *value* to a specific EBD intervention, and then ask a series of questions to ascertain the degree to which the exercise helped the subject understand the reason for their decision. Additionally, the application would demonstrate how conducting the practice CBA exercise enabled the decision maker to capture the rationale for their individually scaled Importance of Advantages. This ability to capture and analyze the decision rationale is a key component of CBA that may help overcome a trend of late change requests on military hospital construction projects which implement EBD due, in part, to frequent personnel turn-over.

The MHS EBD Checklist v2.2 (Appendix B) was used as the backbone of the notional CBA decision table. This checklist, developed by the Center for Health Design (CHD) for the military, lists the various design interventions that should be considered to achieve a desired healthcare goal. For instance, if an owner desires to improve the stress reduction aspects of their health facility, the designer and project programmers can, through the MHS EBD Checklist, access a list of interventions (with its supporting research) to help achieve that end state. For stress reduction, the list includes interventions such as providing positive distraction (art, music, views of nature), noise reduction through high performance building materials, central "green zones" (atriums) to provide a soothing respite from the hospital atmosphere, and interior design elements that belie the spaces' true purpose as a hospital. A design challenge exists due to budget constraints in hospital facility development, particularly in those projects classified as Modernization, Repair and Renewal (MRR) projects. When constructing a Hospital

Replacement Facility, it is far easier to program *all of* the listed EBD interventions into the project to achieve the desired performance end state. In MRR projects, careful selection of interventions is more critical in order to maximize the desired effect within the constraints of the existing footprint (in most cases) and the planned obsolescence of the building.

One objective of the study was to provide a *proof of concept* for a decision-making system that may aid designers and developers of military health facilities in prioritizing interventions and appropriating money. To do so, a Choosing by Advantages table (Table 3.4) was developed for one “Design Driver” (MHS Goal). The Design Driver that was investigated was Reduce Stress, which has three EBD subcomponents, or categories: provide positive distraction, provide access to nature, and reduce noise (according to the EBD Checklist v2.2). Through review of existing performance measurement tools and a series of interviews with senior Army Health Facility Developers, the researcher developed the criteria by which to evaluate the alternative interventions within each category. In the interview(s) with each subject, that particular participant’s Importance of Advantage scale, which yielded a prioritization of available alternatives within each category, and ultimately determined the efficacy of the tables in aiding a design decision relative to the Design Driver. Table 3.4 is the interview example of a CBA table for the MHS goal: Reduce Stress-Noise Reduction. In a practical application, a design consultant would apply this table while working to assist an owner or space user in choosing between three options of high-performance wall with a Sound Transmission Class (STC) rating of between 50 and 60.

In Table 3.4, three high-performance walls are being evaluated for use in a standard 300 SF patient room. The evaluation criteria (variable criteria developed as a design team for a specific decision), by which the three wall options are to be compared, are in the far left-hand column of the table.

Table 3.4 – High Performance Wall Comparison

Objective: Reduce Stress-Noise Reduction (300 SF room)	16 ga.Staggered Metal Stud, 4 layer Gyp Board, w/ Blown-in Cellulose Ins.	16 ga. Standard Metal Stud, 1 layer MLV, 3 layer Gyp Board w/Green Glue, Mineral Wool Ins.	16 ga. Standard Metal Stud w/ 2 layer QuietRock 530, Owens Corning R19 Fiberglass Ins.
	Option 1	**Option 2**	**Option 3**
Cost	$2.32 / sf	$3.87 / sf	$6.25 / sf
ManHr Install / L.F.	0.4	0.5	0.2
Payback Period	2 years	3 years	2.5 years
Wall Depth	8"	7"	6"
Floorspace / L.F.	0.2 sf	0.08 sf	0 sf
# Drywall Screws/ sf	18	12	9
# Fire Code Insp.	2	2	1
Est. STC Rating	51	50	53
Waste Scrap / Rm	150 lbs.	90 lbs	50 lbs

After capturing the comparison criteria of each wall, analysis was done to determine the difference in the advantages. Meaning, the “best” value for each of the criteria was identified, and the difference in the other options, or alternatives, was annotated (Table 3.5). Note that all values in bold (right justified in the column) are the difference between the “best” value in that evaluation criteria category and the value of the alternative option.

Table 3.5 – High Performance Wall CBA Table

		Alternatives		
		Option 1	Option 2	Option 3
Fewer Hrs. is		0.4	0.5	0.2
Better	ManHr. Install / L.F.	**-0.1**		**-0.3**
Faster is		2 yrs.	3 yrs.	2.5 yrs.
Better	Payback Period	**-1 yr**		**-0.5 yr**
Narrow is		8"	7"	6"
Better	Wall Depth		**-1"**	**-2"**
Less used is		0.2 sf	0.08 sf	0 sf
Better	Floorspace Consumed		**-0.12**	**-0.2**
Fewer is		18	12	9
Better	# Drywall Screws / L.F.		**-6 screws**	**-9 screws**
Fewer is		2	2	1
Better	# Firecode Inspections			**-1**
Higher is		51	50	53
Better	Est. STC Rating	**+1**		**+3**
Less is		150 lbs.	90 lbs.	50 lbs.
Better	Waste Scrap / Rm.		**-60lbs**	**-100lbs**
	TOTAL			

The next step was to work closely with the stakeholder to develop their scaled Importance of Advantages for each alternative option. Each participant plotted the differences found in Table 3.5 (for this example) on a CBA Importance Scale. This process was subjective, and captured each subject's personal perceptions of the value of each of the differences between alternatives. In order to baseline the scalar plot of each of the differences, the subject was asked to identify which value they deem most critical. This value was placed at "100 %" along the CBA Importance Scale, and all other values were plotted relative to this "most critical" value. The scores generated from the CBA Importance Scale were plugged back into the High Performance Wall CBA Table to generate a score for that option. In Figure 3.6, the CBA Importance Scale, hypothetical values are placed on each of the differences for illustration purposes. The subject in this example selected Payback Period as the most critical value on the scale, and all other values were plotted relative to Payback Period which was given a 100% weight of importance.

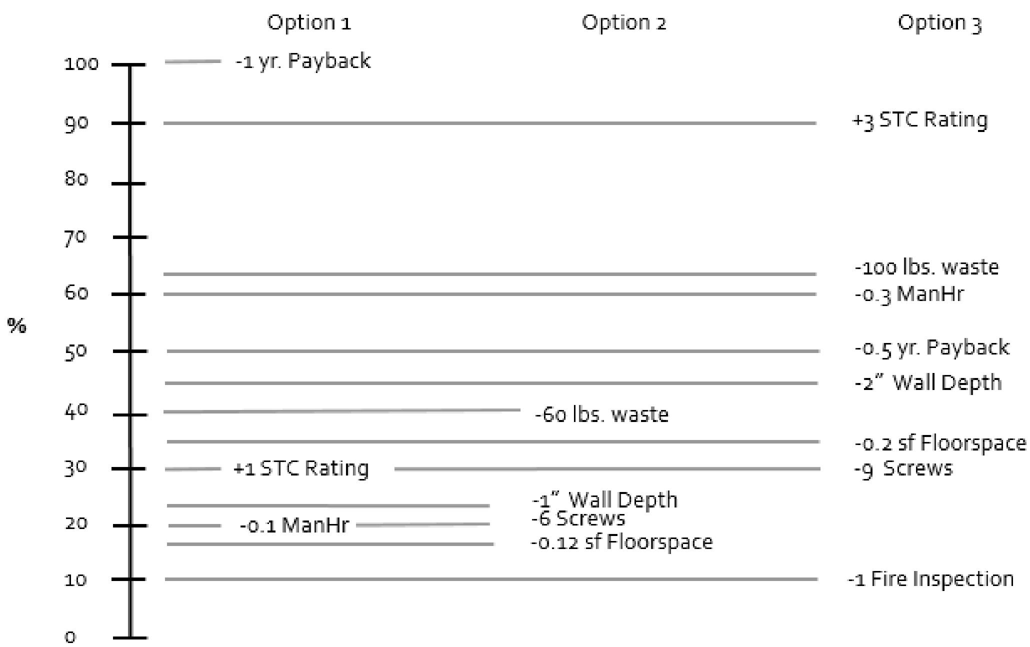

Figure 3.6– High Performance Wall CBA Importance Scale

After plotting the values on the CBA Importance Scale, the numerical values were tabulated using the CBA Table to get a raw "score" for each of the options (Table 3.7).

Table 3.7 – High Performance Wall CBA Table with Scores

		Alternatives					
		Option 1		Option 2		Option 3	
Fewer Hrs. is		0.4		0.5		0.2	
Better	ManHr. Install / L.F.	**-0.1**	**20**			**-0.3**	**60**
Faster is		2 yrs.		3 yrs.		2.5 yrs.	
Better	Payback Period	**-1 yr**	**100**			**-0.5 yr**	**50**
Narrow is		8"		7"		6"	
Better	Wall Depth			**-1"**	**23**	**-2"**	**45**
Less used is		0.2 sf		0.08 sf		0 sf	
Better	Floorspace Consumed			**-0.12**	**17**	**-0.2**	**35**
Fewer is		18		12		9	
Better	# Drywall Screws / L.F.			**-6 screws**	**20**	**-9 screws**	**30**
Fewer is		2		2		1	
Better	# Firecode Inspections					**-1**	**10**
Higher is		51		50		53	
Better	Est. STC Rating	**+1**	**30**			**+3**	**90**
Less is		150 lbs.		90 lbs.		50 lbs.	
Better	Waste Scrap / Rm.			**-60lbs**	**40**	**-100lbs**	**60**
	TOTAL	**150**		**100**		**380**	

At first glance, it may seem obvious which of the alternatives clearly possesses the most value. However, the final step was to graph the score in relation to the cost. In Choosing by Advantages, maximum value is achieving the most advantage per invested dollar. The option that provides the most value is the one which has the steepest slope (Figure 3.8).

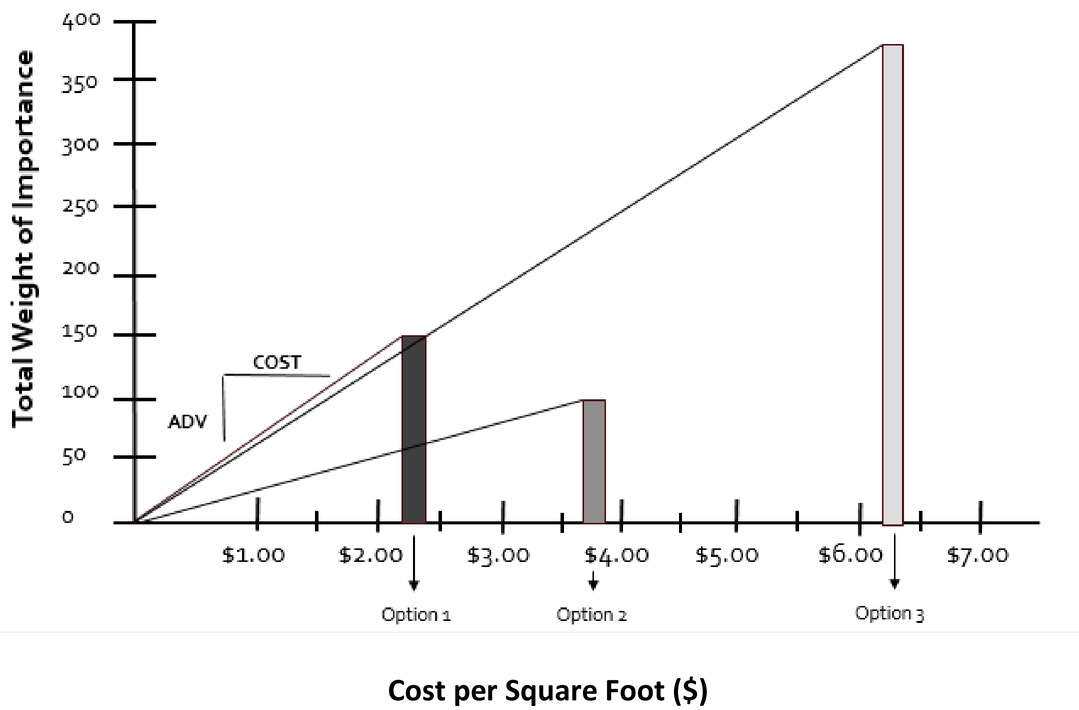

Figure 3.8 – High Performance Wall Weight of Importance Graph

In spite of having the highest numerical score (a value of 380 points), Option 3 did not provide the most value. In this example, the recommendation to the stakeholder would be to install Option 1: The 16 Gauge Staggered Metal Stud wall with two layers of standard Gypsum Wallboard (double layer on both sides), and blown-in Cellulose Insulation.

In actual practice, this process would be repeated for many of the other critical Evidence-Based Design interventions that the designer felt could reduce noise such as sound attenuating ceiling tiles, and impact noise reduction flooring. It is important to note that some of these interventions, when coupled together, can have a synergistic effect on improving the healing space, and CBA is not meant to pit one against another (Hamilton 2010). This process will enable a facility developer to help shape a stakeholder's design selections by aiding the visualization and critical analysis of "what really matters." The intent is to gain a better understanding of how each stakeholder truly assigns value to each specific Design Driver. By taking a holistic approach to "Reduce Noise," a developer can build "packages" of EBD interventions to achieve the design goal while capturing the rationale for the decisions a set of CBA tables. This analysis would be preserved for future planning and programming of Military Health Facilities. The end-state of this project was to determine if CBA is a viable tool on which to base an EBD decision-making system. If deemed viable, the long-term vision of this project was to iteratively develop the CBA Table 3.5, which evaluates one Design Driver, into a series of pre-constructed CBA tables to aid the developer in consultation of EBD interventions. The intent in doing so is to establish a framework for implementing Choosing by Advantages as a broader decision-making tool in Military Health Facility Development. This system of decision-making (and decision-shaping) offers the potential to build a comprehensive plan of action to achieve the MHS goal of Reduce Stress, and validates a model that can be used to aid designers and developers of military health facilities in prioritizing interventions across the full spectrum of Design Drivers.

CHAPTER 4

FINDINGS

The ten subject matter experts had similar opinions and experiences with respect to the challenges they faced as an organization, in spite of their various specialties, duty stations, and assigned divisions within the HFPA. The organizational cohesion seemed tight, and the morale was quite high, which resulted in the “problems” stated sounding like constructive criticism, rather than complaints. It was evident from the description of the projects executed that there was particular pride taken in their product, which is not always seen in military units that provide a service, rather than those that produce, or develop, an idea from inception through tangible fruition like the HFPA.

During the interviews, field notes were taken capturing the responses to some of the questions that were sent in advance. Some of the participants had particular interests in specific areas of the research, which led to only three questions (of the 9 questions presented) being answered by all ten of the participants. In almost all cases, the participants dwelled on the topics that they were most familiar with based on their assigned duty within the HFPA (which was expected). It was for this reason that a cross-section of the organization was selected to participate.

An unexpected aspect of the study which resulted in fewer questions being answered was that the participants exhibited a genuine interest in learning CBA. Therefore, more time was spent “teaching” the decision-making methodology, rather than asking questions about its potential utility in making EBD decisions. Out of respect for the subjects' time, interviews were strictly limited to one hour. More time spent on the CBA exercise, meant fewer questions answered after the demonstration was completed.

The first three to five minutes of the interview consisted of capturing the participants' work experiences and qualifications. They described their roles within the agency, and began to frame the experiential context and their familiarity, or lack thereof, with EBD. Table 4.0 shows the demographic breakdown of the participants and lists their job title within the HFPA.

Table 4.0 – Interview Participant Demographics

Rank	Gender	Position	Location
COL	M	G9	Falls Church, VA
LTC	M	DEP G9	JBSA
LTC	M	Director of Proj. Programming (PP&SD)	Falls Church, VA
GS13	M	Director of Engineering, HFPA	NCR
GS13	F	Director of Sustainment, HFPA	JBSA
GS9	M	General Engineer	JBSA
GS11	F	Sustainability Program Manager	JBSA
GS11	M	Senior Project Integrator	JBSA
GS9	M	Facility Operation Specialist	JBSA
GS13	F	Senior Health Facility Planner	Falls Church, VA

After collecting the field notes, qualitative analysis was done using Grant McCracken's five step analytic model for interviews as enumerated in *The Long Interview* (1988). In it, he establishes a process to begin formulating conclusions from interview data harvested while taking notes or generating transcripts. These five steps were completed for each of the ten HFPA subject matter experts:

Step 1). The interview field notes were thoroughly read, and additional notes made in the margins. These additional notations capture what McCracken refers to as "utterances," or short statements describing the key points of an interviewee's soliloquies as they convey their thoughts (1988). This is an opportunity for the interviewer to begin parsing out useful information, from that which does not pertain to the research topic, in the margins.

Step 2). Next, observations were grouped into descriptive categories. In this case, an attempt was made to shape the responses to coincide with the research objectives about Lean Culture, CBA, and EBD.

Step 3). As the notes were reviewed, patterns began to emerge that allowed coding of the data. Some of the responses were very easy to code, while others had to be scrutinized and paired with contextual information to derive the actual meaning of what the subject was trying to convey. For instance, some questions were met with a simple "yes or no" answer, leaving no ambiguity to the meaning. However, other questions were more opinion based, and required more scrutinized analysis of the participants' statements to derive a conclusion.

Step 4). This step required the clustering of "utterances" into themes, or meaningful statements, that ran through the entire pool of respondents. In this study, a simple "CBA," "EBD," or "LC" was placed by the phrases to code it for sorting.

Step 5). The final step was to collect data quotes that spelled out themes that were pervasive through the group. As an example, when reviewing the notes pertaining to CBA, descriptive terms such as "tedious," "cumbersome," "complex," and "time consuming," were frequently coded. In fact, CBA was one research area that was unambiguous. 0 out of 10 respondents had ever heard of CBA prior to the interview, and 8 out of 10 classified it as an "arduous" task (two respondents did not comment on the difficultly, or lack of difficulty, that they experienced with the CBA exercise).

After the interview notes were organized, it became evident that the responses could generally be grouped into three broad categories:

1. General EBD implementation observations and findings
2. CBA perceptions, applicability, and likelihood of adoption
3. Cultural findings (most important)

It was not the intent of this study to collect *empirical data* to support, or validate, whether CBA was a viable tool to combat the trend of cost overruns and scheduling delays in military hospital construction. Rather, the data of most value was the subjects' feedback on the *process*, more so than on the numerical outcomes of the CBA exercises. The intent was to get to the heart of the decision-making challenges plaguing military hospital construction while also getting to the heart of the subject. Through these interviews, the intricacies of building hospital campuses whose square footage numbers in the millions, and whose price tags can sometimes eclipse one billion dollars was evident. Table 4.1 shows the general responses, formulated from pervasive themes and data quotes from the group, to the nine questions that were asked during the interview.

Table 4.1- Consolidated Answers to Interview Questions

QUESTION	ANSWER(S)
How are decisions between EBD intervention options made?	Knowledge is shared among planners and programmers through the AAR / Consultation (site visit) of a PM from another project.
Please describe the process of vetting EBD options and alternatives.	Recommendations are made based on adaptations from an existing hospital in the inventory, or the decision(s) are left to the PED Field Representative and the MTF Commander to make on site.
With whom do you consult (positional), and when (during the planning phases of construction) on EBD decisions?	Other PM's and MTF Commanders (User Representative); the Architect of the private firm on the project.
What are the metrics that validate design decisions and to whom do y ou answer about the efficacy of design?	(Answers varied widely on this question). No consensus, but some answers given were "patient satisfaction surveys", and "post-occupancy evaluation results".
How paramount a factor is Cost, in the implementation of a design decision?	Answers seemed to be split into two camps: Subordinate employees predominantly answered that "Cost is the #1 decision factor", while more senior agency members (presumably with a more strategic view) said, "EBD costs what ever it costs."
When programming a Military Hospital, "where do you start / what is the design point of departure" when selecting EBD interventions?	(Answers varied widely on this question) Some answers included the Whole Building Design Guide (design guide plates), the SEPS (Space and Equipment Planning System), or the UFC 4-510-01 (Military Medical Facility Design Specs)
What barriers (cultural, political, economic, etc.) have you encountered in implementing EBD interventions?	The majority of respondents answered that there are economic barriers and political barriers (though the term "political' was never defined). None of the respondents cited cultural barriers.
Had you heard about Choosing-by-Advantages before this interview?	8/10 answered "No". 2/10 did not provide an answer.
Do you feel there is a gap between the way a design is intended to function, and the way healthcare practitioners are actually operating in it?	7/10 answered "Yes", 2/10 answered "No", 1/10 answered "Unsure". Answer indicates the majority of respondents feel that there is an operational disconnect between the hospital staff and their practices, relative to the built environment.

Evidence-Based Design: General Findings

Ten years ago, the Army embarked on a journey to improve the standard of medical care that it was providing to its Soldiers and families in its built infrastructure. EBD seeks to use proven, evidence-based data, to shape both the quality, and safety, of the hospital environment. In that regard, the Army's newest hospital replacement facilities, and those hospitals that have been renovated under the MRR program, have succeeded. However, the Army has adopted many of its "best-practices" from the health industry's private sector. While the efficacy of those designs are validated in civilian hospitals, it is assumed that they will have the same impact in military health facilities in some cases. One anecdote that highlights the fallacy of that assumption, is the lack of use of the patient lifts at the new Fort Belvoir Community Hospital in Virginia. During a Post Occupancy Evaluation, surveyors noted that the military nursing staff were not using the ceiling mounted lifts very regularly. When they inquired why, the nurses cited two reasons: 1) The nursing staff felt they had a very good "team-lift" procedure to safely move patients without the use of patient lifts, and 2) they felt that the exercise that patients experienced while struggling to get to the bathroom, assisted by nursing staff, was in some ways rehabilitative and therapeutic.

A similar sentiment was expressed by one of the subjects of this study relative to an automated patient control system that was proposed for military hospitals. These touch-screen tablet innovations in patient rooms enable the patient to watch movies on demand, call a nurse, adjust the window shades or room temperature, and Skype® with their families. In addition to that, the system was linked to the patient EHR, and the data relative to their ailment would automatically adjust their menu options when ordering a meal through the system. For instance, if the patient suffered from high cholesterol, only those meals designated as low cholesterol would be available on the digital menu board. The subject's concern was twofold. He asked rhetorically, "How are we going to keep our military nutritionists trained, since they will no longer have a job?" Then from a broader perspective he noted, "If we automate the whole hospital, the staff are no longer going to experience the human interface opportunities that develop their bed-side manner (Participant E, personal communication, January 13, 2017)." This is an unintended EBD by-product in the military hospital that will need to be investigated. The sense of control that a patient feels they have over their situation, and their environment, can directly affect their level of stress, which can speed, or hinder, the healing process. But, granting the patient ultimate control can in some ways write the clinician or medical practitioner out of the equation.

In the case of the Fort Belvoir nurses, they felt the use of patient lifts would have impeded an important team exercise that strengthened the bond between the nursing staff, and the bond between the patient and the nurses. These bonding mechanisms are an important part of building the Lean culture in a hospital, which is a necessary component of EBD. It remains to be seen whether the increased reliance on automation, and electronic innovation, will potentially be a detriment to the professional development of hospital staff in the long run, which would ultimately be self-defeating to the goal of maximizing the potential of the healing space.

Military hospitals are, without question, better after the implementation of EBD than they were before it. That said, there are many ways to improve the use of EBD during the programming phases of MTFs. EBD is not the *cause* of any of the cost overruns or scheduling delays that are experienced in military hospital construction. Rather, the additional scrutiny placed on the design interventions results in more key design decisions having to be made, which introduces the possibility of additional variability to the time and schedule factors of a hospital project. This can be avoided through more deliberate planning at the beginning of the project. A more robust planning and programming effort before breaking ground, followed by a more rapid execution of the construction timeline, can minimize the loss of shared understanding of decisions and the effect on the continuity in management of a project due to military turn-over.

The length of time allowed to elapse between initial programming and project execution results in a very different operational landscape between EBD selection and EBD implementation. This is due to several factors outside the span of control of a health facility developer. One, is that medical technology innovation is outpacing the build time of most military hospitals. Due to this immediate obsolescence of medical technology, there is virtually no way to avoid changes on a project that lasts five to seven years. Another factor effecting design are the changes in geopolitical landscape that occur when key policy makers and military members retire or are replaced. The change in operational tempo can also drive design changes. For instance, if a military unit is slated to deploy to a theater of combat, or move to a different Army post due to the Base Realignment and Closure initiative, it can change space utilization requirements, which impacts the hospital footprint. A shift in focus of the type of medical care provided can also have an effect on the medical built environment. As an example, the HFPA is currently assessing the possibility of reducing hospital space, and minimizing certain functional areas of a military hospital, due to an emphasis on telemedicine. The Patient Centered Medical Home initiative seeks to offload the burden of the military hospitals by automating, and providing via the United States Postal Service and Video-Conferencing, recurring prescriptions, and non-emergent consultation with clinical providers. This will have an effect on the throughput of military hospitals that will manifest itself in different Evidence-Based Design decisions being made on a military hospital project.

CBA Perceptions and Applicability Findings

With respect to CBA adoption, the general consensus among the subjects was that the process was "tedious." Given that the community is predominantly "behind schedule," it would seem logical that inundating them with another complex tool would imply that *more time* would be taken to make EBD decisions – something they feel there is not enough of to begin with. The challenge in this study was to illustrate CBA's capability to *speed up* the selection process after the system is in place. The theory is that once CBA evaluation tables have been built for all of the Design Drivers, very minor tailoring is required for them to account for each project's peculiarities. Additionally, by capturing the design rationale for EBD decisions on a visual medium, such as the CBA table, it would enable the design team to make selections from an advanced "point of departure." Meaning, the team would not be starting the EBD vetting process from scratch each time they began programming a new hospital and decision results from previous projects would be more readily available.

The subjects reviewed the CBA material and completed the CBA exercise, but few of them experienced a "lightbulb moment." While all of them agreed it refined the decision process, and would likely result in better continuity in EBD decision-making from one hospital to the next, they embraced CBA with guarded skepticism. In retrospect, the example should not have been so realistic, which resulted in a fairly complex demonstration of CBA. As with other Lean simulations, it is not uncommon to have to simplify the teaching moment for subjects to "get it." This was evidently the case with CBA. It can be a relatively complex decision-making system, which fits within a larger cost programming framework (TVD). The recommendation for future research would be to develop a more simplistic, iterative simulation that conveys the benefits of CBA through meaningful repetition. Based on the study results from the ten subject matter experts within the HFPA, a single practical example is not likely to win the hearts and minds, nor promote adoption of any Lean programming tool, among a network of professionals who have been using other methodologies for their entire careers. This illustrates the most important point. Without evolving to a Lean organizational culture, applying Lean programming methods is challenging at best.

Cultural Transformation Findings

Because the United States armed forces have been engaged in protracted conflict for over 15 years, the state of high operational tempo has eroded the readiness, capability, and, in some cases, the productivity of the force over the last decade. The negative effects on a war-weary workforce may be evident, due in part to a pernicious cycle of executing a wartime mission followed by stateside reset and recovery. It was on the home-front that this degradation became most apparent. In response to the decline in the efficiency of the Department of Defense, strategists at the Pentagon's Office of the Deputy Chief of Staff-Business Transformation Division began searching for solutions to the dwindling productivity. On May 15, 2008 the DOD issued Directive number 5010.42. This directive served as a mandate to all DOD branches to establish a Continuous Process Improvement (CPI) and Lean Six Sigma (LSS) program which was to be the primary means to assess and continually improve the effectiveness and efficiency of DOD processes. The program's initiative was to strengthen the military's capabilities and improve the following lines of effort: Productivity, Performance, Safety, Flexibility and Energy Efficiency (DOD Directive 2008). This mandate would, of course, come with funding to support the educational and implementation requirements of such a program. The rationale was that it sometimes costs money to save money, and ultimately improve the way the Army does business. In accordance with Jeffrey Liker's first principle of basing "management decisions on a long-term philosophy, even at the expense of short-term financial goals," the DOD invested in Lean programs (2004, p. 37). CPI/LSS was the vehicle to achieve transformation, in spite of a few inconsistencies in Lean philosophy when compared to the military hierarchical structure of making decisions and executing work.

In fulfillment of the requirement, MEDCOM began a concerted effort to train and equip its workforce with the knowledge required to implement a CPI/LSS program. At Joint Base San Antonio, the MEDCOM Lean Six Sigma deployment director, and her colleagues, developed an academic pipeline to produce certified Lean Six Sigma leaders who could apply the waste mitigating and performance measurement techniques learned in the classroom to their respective organizations. Lean operations became the gold standard in U.S. Army Medicine and while many systems were streamlined, and billions of dollars saved, there were still some aspects of the Lean philosophy that were incompatible with Army culture (Lopez 2016). As the organization begins to apply Lean to more widespread facets of Army Medicine, specifically Health Facility Development and Military Medical Treatment Facility Construction, it will become even more important that we understand the dissimilarities between traditional Lean philosophy and current Army culture.

To assess the military's current capacity to implement Target Value Design and Choosing by Advantages to improve the way that EBD decisions are made, it is necessary to explore ways in which the military and Lean are compatible while striving to understand what cultural adaptations could be made to more effectively implement Lean. The idea that parallels can be drawn between Lean and military strategy is not new.

Low and Teo (2005) suggest that Lean production principles may have been influenced by Sun Tzu's *Art of War*. They did not analyze, however, how U.S. military culture may change the way Lean is implemented and enacted. While the United States Army has begun to implement Lean operations in the healthcare environment, it has yet to fully implement many of the tools at the disposal of a Lean Construction practitioner while undertaking military health facility development. Several peer-reviewed articles in The Military Engineer, the official professional journal of the Society of American Military Engineers, call for an over-haul of military construction delivery methodology. Specifically, Peter Cholakis, in his article "Rethinking Construction Delivery" (2015), contends that "Leaner" construction practices and tools such as BIM may be precisely what military constructors need to implement to ensure project success. Lean tools notwithstanding, in order to take full advantage of the methodology, an organization must adapt their culture, as necessary, to embrace a more Lean-centric way of thinking. Another objective of this study was to examine U.S. Army Medicine and, using *The Toyota Way* (Liker 2004) and Liker's Management Principles, determine which of those principles are already being successfully implemented, while highlighting those that present a greater challenge. Table 4.2 lists those *Toyota Way* principles that the U.S. Army has already implemented, or already exhibits.

Table 4.2: Principles from Liker's 14 Management Principles (Liker 2004)

Principle Number	**Content**	**Military Applicability**	**Compatibility (Deployed / Peacetime)**
1	Long-Term Philosophy	Decision to invest in Lean Six Sigma	Low / High
13	Make decisions slowly by consensus, execute rapidly	Army post-war leadership transformation initiative	Medium / Medium
9	Grow Leaders with thorough understanding of the philosophy	Formal pipeline to train Lean practitioners	Low / Medium
10	Develop exceptional people and teams	Professional Military Education focuses on developing people	High / High
14	Become a learning organization	Assess current state and evolve to world class (healthcare)	Medium / High
5	Stop to Fix Problems	High Reliability Organization	High / High
6	Standardize Tasks / Continuous Improvement	Standard Operating Procedures	High / Medium

In this cultural exploration, only those principles that focus on the collaborative aspects of Lean will be addressed (i.e. those shown in Table 4.2). Those principles that are more operationally oriented (i.e. process flow), and do not deal with building consensus or making decisions, have been omitted, and represent areas for further exploration.

Managing Change

The dichotomy of grooming leaders to give orders in a wartime environment compared to the way that same leader is asked to build consensus and make decisions in a peacetime environment is striking. There is a time and place for consensus building.

The middle of a kinetic and tactical environment, where the stakes are life or death, is not necessarily one of them. An entire generation of warfighters has been baptized in the crucible of combat, in some cases leading to a rigid and inflexible hierarchy resistant to soliciting ideas or innovation from its subordinates. This is sometimes necessary in a combat environment, but can be detrimental to an organization in a stateside business environment. In 2006, when General David Petraeus penned the U.S. Army Counterinsurgency Field Manual 3-24, he recognized then that even in tactical situations, soliciting bottom-up refinement can be a healthy, team-building event (FM 3-24 2006). The manual reads:

> Open channels of discussion and debate are needed to encourage growth of a learning environment in which experience is rapidly shared and lessons adapted for new challenges. The speed with which leaders adapt the organization must outpace insurgents' efforts to identify and exploit weaknesses or develop countermeasures (p. 7-9).

This concept is in line with Liker's 13th Principle of "making decisions slowly by consensus, thoroughly considering all options; and implementing decisions rapidly" (Liker 2004). "Speed" is a relative thing in a warzone, but the premise is that if the appropriate time is taken to discuss decisions with the team, trust is built. With buy-in and trust built through consensus, a leader will more aptly be able to manage his or her team. The same is true of decisions in Health Facility Development while conducting peacetime operations. Rather than decisions being made solely “at the top,” design and construction professionals should develop a network of decision makers to collectively agree on design interventions in military hospitals. One of the organizational challenges that the U.S. Army has to overcome is that units (hospital organizations) experience fairly rapid turn-over. On average, Commanders change command every two years, which often results in a changing of the guard in the middle of enduring multi-year megaprojects. Health Facility Developers who build a network of decision makers may preclude some of the issues that arise when a new Hospital Facility Commander takes command shortly before the commissioning of a new hospital. There are occasions when the new commander decides to make sweeping changes to the design resulting in significant delays and cost overruns due to change-orders and rework. When a design decision rests with “the team,” it is much harder for the “new Boss” to over-turn it. With the implementation of Lean Six Sigma, organizations are having to address the impact of combat on leadership development, and critically assess how decisions are made. This is a healthy exercise for an organization that is transforming to a more Lean and agile institution.

Building the Bench

The U.S. Army Training and Doctrine Command (TRADOC) has a large role to play in the Lean transformation as well. This major command is responsible for “training the force,” and manages all of the professional military education courses in the U.S. Army. In these courses, student Soldiers learn through experiential case study, and evolve as men and women who understand servant leadership. Hard conversations are engaged in about the types of leaders whom they have served, and the leader that they have become, or wish to become. Understanding culture is the foundation of the advanced courses, and white papers are studied relative to what it means to be in the Profession of Arms (TRADOC 2010).

In these environments, rank is metaphorically removed, and honest assessments about the state of the organization are given. This is a crucial step in evolving as a Lean organization. Leaders must be willing to accept, and even celebrate, failure in an effort to truly understand why a specific mission or business initiative did not go as planned. For more than a decade, the U.S. Army has embarked on this journey, only to battle a silent resistance to flattening the hierarchy. Brilliant men and women who spent entire careers watching the evolution also acknowledge the need for change. General Peter Chiarelli, the 32nd Vice Chief of Staff of the U.S. Army who served in that capacity from August, 2008 to January, 2012, made the following inference in his article on Modern Wars, implying inherent issues with current Army culture:

> The military must continually look at ways to flatten their organizational structures… increase opportunities – and rewards – for leaders to serve in assignments outside the traditional military structure…and then retain only those Americans who have the potential to succeed in tomorrow's complex operating environments… they must ensure all views are welcomed to the

debate and that junior leaders have no fear of career retribution for freely stating their opinions. (Chiarelli and Smith 2007 p. 41)

The U.S. Army Field Manual 101-5 Chapter 5: "The Military Decision-making Process" (MDMP), which is taught extensively at TRADOC schools, describes in detail, the art and the science of decision-making (MDMP 1997). It delineates between those things that can be operationally measured (the science), while acknowledging that there are other complex and intangible aspects of decision-making that are simply more subjective (the art), and rely on the decision maker having the experience, institutional knowledge, and leadership capability to execute the task. The challenge for many army leaders, is taking a system (MDMP) designed to function in a tactical, or combat, environment, and adapting it to a stateside mission. It is in this construct that CPI/LSS excels at bridging the gap, and enables teams to do the analysis necessary to build multiple courses of action to accomplish both business goals and combat missions. Lean, and its philosophy of Continuous Improvement, champions the notion of measuring where you are at today, so that you can assess where you want to be tomorrow, and have the tools to implement the plan to get there. Moreover, it does so by advocating a culture of cooperation and shared reward without sub-optimization between the various components of the organization. This is one aspect of Lean at which the U.S. Army excels. The Army mantra of "One Team, One Fight" is the phrase that best describes the willingness to selflessly operate in concert with sister units and organizations to accomplish a common goal, regardless of who is ultimately left paying the bill. In this regard, the U.S. Army is already well on its way to achieving Liker's 9th and 10th principles of "growing leaders who thoroughly understand the work, and live the philosophy," while "developing exceptional people and teams who follow your company's philosophy" (Liker 2004).

Climbing the Kaizen Stairway

Another aspect of U.S. Army culture that is congruent with Liker's 14th Principle of becoming a learning organization through relentless reflection (Hansei) and continuous improvement (kaizen) is the Army's steadfast adherence to the practice of conducting After Action Reviews (AAR). The tenets of conducting an AAR are simple. There are four questions asked in every discussion (TC 25-20 1993):

1. What did we set out to accomplish? (Identify the objectives of the mission)
2. What actually happened? (Assess each phase of the mission)
3. Why did it happen? (Without placing blame, assess what went well, and what failed during the mission)
4. What are we going to do next time? (What will change/remain the same in the planning phases and process execution for the next mission)

The AAR is conducted per the guidance in U.S. Army Training Circular 25-20: "A Leader's Guide to After Action Reviews," by an objective third party, not one of the first-line leaders who led the mission (TC 25-20 1993). Additionally, feedback from the group begins with the lower ranking members first to prevent their opinions and observations from being over-shadowed by more senior ranking Soldiers. A comprehensive list of "sustains" and "improves" for each phase are generated, and subsequently drafted into an executive summary for each mission conducted. In rare cases (if mission execution was particularly poor), the facilitator may conduct separate sensing sessions with the different rank structures independently of one another. This autonomy to critically examine the successes and failures of a mission is key to developing a cohesive unit where everyone, from the lowest ranking to the highest, feels like their vote matters. This empowerment to shape operations is also important in establishing a sense of "ownership" in the organization through team endorsed, command level decisions. The role of the Executive Director (Commander) is to then ensure that the next mission adheres to the best practices of the AARs that were generated by the team. Reading previous executive summaries of similar missions should be the first step a commander and his staff take when planning the current mission. In this way, army units continue to climb the Kaizen Stairway (Rybkowski and Kahler 2014; Seed 2015) and solidify themselves as a "learning organization."

Becoming a High Reliability Organization

Simply cataloging successes and failures through the AAR process is not enough to become great. An organization must go further if it hopes to establish a climate where all employees truly feel empowered to make "on-the-spot" corrections of deficiencies, and in some cases halt the mission altogether. This initiative has recently been implemented in the operation of military hospitals under the command of Lieutenant General Patricia Horoho, the 43rd Surgeon General of the U.S. Army and previous Commander of MEDCOM. In an effort to achieve High Reliability Organization (HRO) status, LTG Horoho began breaking down the barriers of rank structure and military hierarchy to reduce errors, and emphasized placing the customer (patient) first. An HRO is defined as an organizational "environment of collective mindfulness in which all workers look for, and report, small problems or unsafe conditions before they pose a substantial risk to the organization, when they are easy to fix" (Weick and Sutcliffe 2007 p. 38).

The Army suggests there are three components to high reliability: continuous improvement, leadership development, and establishing a culture of safety that empowers everyone in the organization to make safety decisions (HRO 2014). General Horoho was quoted while testifying to the Senate Committee for Defense Appropriations on the state of Army Medicine in March, 2015 as saying, "A High Reliability Organization is committed to achieving zero preventable harm by successfully limiting the number of errors in an environment where normal accidents can occur due to the risk factors and complexity of the practice" (Horoho 2015, p.17). Part of the preventable harm solution is also designing military hospitals in such a manner as to assist practitioners and clinicians in this HRO commitment. By "slowing down to get quality right the first time" and designing the ability to "detect problems" into the built environment (Jidoka and Liker's 5th Principle), Army Medicine can achieve its HRO and world class healthcare goals (Liker 2004).

Standardization Is Key

The final principle examined was Liker's 6th principle that states that "standardized tasks and processes are the foundation for continuous improvement and employee empowerment" (Liker 2004). This is another strong suit for the military. The natural inclination for a military person is to execute tasks within a set framework of codified conditions and standards. In fact, the U.S. Army has a Standard Operating Procedure (SOP) for virtually everything it does. However, given the relative infancy of some of its Lean implementations, those SOPs, in some cases, are still in the process of being written. There is precedent for developing SOPs to capture Lean mechanisms within the army culture and its operations. The "Army Standardization Policy," prescribes responsibilities for implementing standardized programs with respect to procedure, organizational operations, and training. The proponent for this policy is the Deputy Chief of Staff for Operations and Plans headquartered at The Pentagon. The Army defines standardization as "the management principle which fosters the development and sustainment of a high state of proficiency and readiness among Soldiers and units throughout an organization" (AR 34-4 1984). The objectives of the policy are to improve the productivity and development of both the individual Soldier, and the team (unit) as a whole. Due to reassignment of individual Soldiers throughout the Army every 2-3 years, it is also imperative that the Army standardize practices to reduce the adverse effects of personnel turbulence. To that end, the Army refines its practices, and ensures that only those methods of practice that are fully vetted for efficacy endure from generation to generation. These "best practices" are captured in both Army policy (Army Regulation or "AR" manuals) and unit SOP manuals. The delicate challenge is to ensure that while standardization serves as an integral part of the way the Army operates, that it does not stifle initiative or innovation. Careful evaluation of the mechanisms for enforcement and current applicability of the standard is routinely scrutinized for relevancy as the mission, and the culture, changes. This is very analogous to the concept of Climbing the Kaizen Stairway in which Rybkowski and Kahler (2014) suggest, "Effective use of collective kaizen and standardization capitalizes on the ability of individuals to innovate, to learn from one another, and to improve their effectiveness, thus helping managers improve time, cost, quality, safety and morale by engaging the employees they already have" (p.1).

CHAPTER 5

CONCLUSIONS

Discussion

While the MHS has made a concerted effort to implement EBD since 2007, there exists much room for improvement before the optimal performance gains can truly be felt. There is a significant departure between simply implementing the industry's best design practices, and actually being an EBD practitioner. As was denoted in *Evidence-Based Design: Application in the MHS* (Malone et al., 2007), it takes growth and development of all three facets of Evidence-Based Design: environmental, cultural, and operational, before the healing spaces' improved utility is felt by the most important customer, the patient. The patient, in this case, happens to be the United States Soldier. Currently, the geopolitical climate is very "pro Soldier," and many influential decision makers feel passionately about improving military healthcare. While doing so, it is important to understand how the Soldier is effected by Evidence-Based Design decisions, and in what areas targeted interventions should be prioritized. Figure 5.1, an adapted form of The Johns Hopkins' Environment-Outcome Interface Model from *Status Report (1998): An Investigation to Determine Whether the Built Environment Affects Patients' Medical Outcomes*, shows the segments of the hospital environment that can positively or negatively impact the Soldier, and the areas where evidence-based decisions must be made in order to maximize the quality of care in military hospitals (Rubin et al. 1998).

Figure 5.1 – Soldier in the Center Concept, adapted from Rubin et al. 1998

Unfortunately, little progress has been made in the arena of decision-making methodology tailored specifically to EBD in military hospitals. The 2007 mandate of the implementation of these principles during the construction of all new MHS medical infrastructure has now yielded data that has not existed in the past. Data collection opportunity not with-standing, it is still challenging to quantify the impact of EBD on health facilities due to their individual complexity and uniqueness. This exploratory study aimed to answer the question, "Can Choosing by Advantages be used as the backbone of the decision methodology by which Health Facility Developers select Evidence-Based Design interventions in Military Hospitals?" The qualitative findings suggest that there would not be opposition to implementing a more comprehensive method of selecting EBD interventions, as long as it does not impose a time constraint to an already challenging schedule. Furthermore, the subject matter experts agreed that the AAR is not necessarily the ideal method of applying lessons learned from one health facility project, to another. A graphic representation of the rationale for a design decision assisted in solidifying a decision with the subject during the CBA Exercise, and improved the ability to articulate *why* a decision was made among a team, or to a third party. Therefore, the study concludes that CBA as a bridging strategy between design professionals *could* be helpful in overcoming the knowledge gap created on project hand-off between outgoing and incoming personnel. Furthermore, it would seem that a technical method of capturing EBD decisions, such as CBA, would be a better presentation medium of decision lessons learned to apply from one project to another, than simply a textual executive summary, or AAR. In its current capacity, however, it seems that CBA is good for visualizing decisions that were made, and not as likely to be used to make future decisions (Participants, personal communication, January 20, 2017).

The diverse mission set and culture of the Army will make it challenging, but not impossible, to adopt Lean construction practices such as TVD and subsequently, CBA. The duality of the stateside institutional army, versus the wartime operational army is a unique aspect of the business that must be overcome if the Army is to thrive in the EBD health facility market. It is as though military organizations have to reinvent themselves each time they deploy to a theater of combat, and then return to a stateside mission. The application of Lean thinking and Lean managerial methodology is not necessarily possible in some tactical environments. Furthermore, without a wholesale cultural transformation, it may be challenging for the U.S. Army to ever be a truly Lean organization philosophically, rather than merely an organization which happens to implement a few Lean techniques. That said, there are many cultural norms in the Army that lend themselves quite well to fitting into the Lean organizational framework. In this study's investigation into Army culture as part of a deeper dive into the requirements to successfully implement EBD in its hospitals, seven of the fourteen Lean principles were addressed, and deemed to correlate well with the attributes Liker says a Lean organization should exhibit. A strong argument can be made that the other seven principles are at least partially fulfilled by certain facets of U.S. Army business. Perhaps the current climate of proposed budget reduction is conducive to the Army's willingness to implement more Lean cost saving measures. As Womack and Jones (1996) wrote, "Lean provides a way to do more and more with less and less—less human effort, less equipment, less time, and less space—while coming closer and closer to providing customers with exactly what they want." (p.36) Unfortunately, in the same way that the construction industry has sometimes struggled to develop analogous systems to Toyota's manufacturing processes, so too is the Army challenged with applying all of Liker's Lean principles to its varied and diverse mission portfolio. It is the researcher's belief, that establishing the right *culture* is the underlying requirement necessary to implement

Lean Construction in general. That is not to say some Lean tools, when implemented in spite of the culture, may still function to improve cost, schedule, and quality, but that is not the way it was necessarily intended to function. Lean Construction, specifically, should be viewed as a system. There is synergy in the system that cannot be realized by "cherry-picking" the programming tools that are needed to modify a particular aspect of the project, or simply to solve a specific problem. One of the study's objectives was to assess whether the Army culture had evolved to the point where LC could be implemented. The conclusion here is that the Army is so diverse, and subordinate to so many other branches of government, that it would be extremely challenging to implement LC at the Army level. Rather, LC would have to be adopted all the way up the civilian chain of command, through the U.S. Congress and the Budget Appropriations Committee, in order to be truly effective. The timeliness, type (pool), and disbursement of money is a significant driver in the speed and efficiency with which military hospitals are, or are not, built. Specifically with respect to EBD, research and development monies (a special pool of funds) would have to be earmarked within the heath facilities themselves to appropriately collect the data from which to generate future *evidence*. Short of that, the Army will not be a true EBD practitioner. Regardless, it is still well worth the effort to try to establish the Lean Army culture necessary to achieve optimal performance in an EBD health facility, to maximize the efficacy of those design decisions, and gain greater return on the taxpayer's investment.

Limitations

The U.S. Army has only recently begun to collect data from its hospital facility projects implementing EBD. Therefore, little data or analysis exists cataloging the specific impacts of EBD in military medical treatment facilities to the military workforce or its patients. While the Center for Health Design, in conjunction with the Georgia Institute of Technology, have developed cost-benefit and Return on Investment analysis (ROI) tables, there has been little progress in implementing the Post Occupancy Evaluations (POEs) that yield the EBD efficacy metrics, specific to the military population, that are needed to make informed design decisions. Currently, performance data in the MHS is focused predominantly on the patient care experience and health outcomes affected by operations, rather than the impact of the built environment on patient health outcomes. Therefore, the minimal review of only a few of the patient satisfaction survey data was hardly exhaustive enough to determine if sufficient data exists to build CBA Tables for all of the Design Drivers. Only those data that were necessary to develop the CBA example for this study were harvested.

Were cost and time no factor, an attempt would have been made to interview far more HFPA, and non-HFPA, subject matter experts. The pool of participants would have included members of the U.S. Army Corps of Engineers, members of the Defense Health Agency, and clinicians or practitioners of military hospitals, who also play a role in EBD decision-making. Due to resource constraints, however, only ten participants were selected from the HFPA alone.

Time was a much larger factor during the course of the interviews than was expected. This was due to a complex CBA example being demonstrated before questions were asked. The participants all learned at different rates, which resulted in several subjects spending most of the one hour interview period working through the CBA demonstration, rather than answering questions about EBD, or culture. This resulted in incomplete data sets for some of the participants.

Significance of the Study

The significance of this study is that it tested the feasibility of implementation of a decision framework that could enable DOD policy makers and facilities developers to target specific design elements to achieve specific advantage per invested dollar results in military hospital facilities. Most construction professionals would concur that it makes sense to base designs on evidence that suggests that those elements provide increased value to the customer throughout the life-cycle of the building (Rollins 2004). What is not entirely known, however, is whether those interventions that have been implemented since the MHS 2007 EBD mandate have actually yielded the expected results in military treatment facilities. Due to the unique demographic, which includes an increased population of Wounded Warriors, who have additional orthopedic and psychological healthcare needs, research has yet to be conducted to validate that the U.S. Army's Health Facilities Planning Agency is placing the appropriate design emphasis in the areas that will yield the highest ROI. The project's long-term objective is to develop a series of CBA tables that will assist in making informed, fiscally responsible, decisions, in all five EBD principle domains, that will add value to DOD healthcare environments and potentially those in the civilian sector as well. This would enable HFPA members to:

1) Maximize the value of the EBD intervention to the operators, and more importantly the patients, of Military Medical Treatment Facilities (MTF), to remain good stewards of fiscal resources while achieving world class healthcare.

2) Begin to identify data gaps that need to be closed through Post Occupancy Evaluation, DMLSS databases, or Patient Satisfaction Surveys that would enable planners to assess EBD performance objectives in the military medical environment

To do so, however, would require that the Army begin measuring what counts, which would entail a Post Occupancy Evaluation program overhaul. Even if CBA is not adopted as an improved method of evaluating EBD decisions, there is real value in the dialogue that will be generated between the Lean Construction community and the Military Health System in programming health facilities of the future as a result of this study.

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APPENDIX A

Dr. Winkenwerder EBD Mandate

THE ASSISTANT SECRETARY OF DEFENSE

1200 DEFENSE PENTAGON
WASHINGTON, DC 20301-1200

HEALTH AFFAIRS

JAN 2 2 2007

MEMORANDUM FOR COMMANDER, NAVAL FACILITIES ENGINEERING COMMAND
COMMANDER, UNITED STATES ARMY CORPS OF ENGINEERS

SUBJECT: QDR Roadmap and Evidence-Based Design

As BRAC implementation drives the acquisition of new medical facilities in San Antonio and the National Capital Area, I request that you instruct the respective design teams to apply patient centered and evidence based design principles across all medical MICLON construction projects. A growing body of research has demonstrated that the built environment can positively influence health outcomes, patient safety, and long-term operating efficiencies to include reduction in staff injuries, reduction in nosocomial infection rates, patient falls, and reductions in length of hospital stay. Incorporating the results of this research along with changes in concepts of operations into the design of some of our most significant facilities will allow the Military Health System and the patients entrusted to our care to reap substantial health and system wide benefits for many years to come.

The Military Health System Office of Transformation was established by the Deputy Secretary of Defense to ensure that recommendations from the Quadrennial Defense Review are effectively implemented. QDR Roadmap 17 mandates leveraging and integrating evidence-based medicine with effective patient partnerships to ensure judicious use of resources while promoting healthy individuals and communities. In support of QDR Roadmap 17, the Office of Transformation has assumed leadership of a Tri-Service interdisciplinary team with substantial knowledge of patient centered and evidence based design. This team can be made available to provide any support or guidance that might be required.

My points of contact are COL Keith E. Essen, Deputy Director Army, and Military Health System Office of Transformation and Mr. Clay Boenecke, Chief, Capital Planning Branch, Portfolio Planning and Management Division, TMA. COL Essen can be reached at (202) 762-3098 or keessen@us.med.navy.mil. Mr. Boenecke can be reached at (703) 681-4324 or clayton.boenecke@tma.osd.mil.

William Winkenwerder, Jr.

William Winkenwerder, Jr., MD

APPENDIX B

EBD Checklist v2.2 (MHS EBD Checklist 2010)

A	D	F	H	J	K	L
[PROJECT PHASE H						
[NAME(S) OF CHECK						
CHD RESEARCH (Sco	studies, need additional research		*** = relatively fewer studies	**** or ***** = good studies, or some strong studies		
PHASES:	P = Programming	SD=Schematic Des.	DD=Design Developm't	CD = Construction Document CA = Construction Admin.	FM = Facility Management	
TRADES:	E = Electrical	P = Plumbing	M = Mechanical	I = Interior IT= Information Technology		
CARE TYPES:	Amb = Ambulatory	Both = Amb & Inpt				
SPACE TYPES:	FS = Family Space	SS = Staff Space	CS=Circulation Space	WB = Whole Building		
DESIGN GOALS:	No			*[This is a result of User Entry at some phase of the process.]*		
USERS:	F = Family	S = Staff				
MHS RATINGS:	ce + busine ss case	Good = Literature supports recomending.		Low = *Anecdotal* evidence for strategy is good.		

Evidence-Based Design Checklist for the MHS

Design Drivers (MHS Goals)	Trade	Care Type	Space Type	Design Goal	User	MHS Research Rating	Design Strategies	Strategy Metric	Comments
Increase Social Support	A	Both	WB		P,F,S		Include patients, family, and staff in the design process		
	A	Inpt	PR		P	Compelling	Provide a family zone in the patient room		
	I	Both	FS		F		Provide a variety of comfortable and moveable furniture arranged in small, flexible groupings to accommodate the widest range of persons and families		
	A	Both	SS		S		Provide private staff areas for staff communication other than the staff break room		
	A	Inpt	SS,FS,PR		P,F,S		Provide visual connections to facilitate information seeking and interaction (see driver re:unit visualization)		
	A	Both	FS		F		Provide waiting rooms, lounges, and private family respite spaces		
Maximize Efficiency	A	Both	WB		S		Study layouts and workspace ergonomics to maximize work pattern efficiency		
Increase Bedside Time	A	Both	CS		S	Good	Decentralize staff support spaces (i.e., charting, supplies, medications) proximate to patient rooms (pod configuration) to minimize staff walking		
	A	Both	CS		S		Improve wayfinding cues		
Increase Unit Visualization	A	Inpt	CS		S		Minimize floor to ceiling partitions in public staff areas		
	A	Inpt	PR		P,F,S		Outboard and Midboard bathrooms can allow for more visual access to patient rooms from hallways		
	A	Inpt	PR		P,F,S		Provide min. 4' doors and/or windows into patient rooms		
Increase Privacy	A,I	Inpt	PR		F		Provide a visual barrier between care space and family space in the patient room (wall, curtain, etc.)		
	A	Both	CS		P	Compelling	Provide full height walls with high acoustic ratings in spaces where patients would be asked to disclose confidential information		
	A	Inpt	PR, FS		P, F		Provide private family spaces, either in the patient room or outside the patient room		
	A	Both	CS		S		Provide private staff areas for staff communication other than the staff break room		
	A	Inpt	PR		P,F	Compelling	Provide single patient rooms		
	A,I	Both	WB		P,F,S	Compelling	Use high-performance, sound-absorbing ceiling tiles		
	A	Amb	PR		P		Consider sight angles into and out of exam rooms for visual privacy		
Provide Adequate Light	A	Inpt	PR		P	Compelling	Orient patient rooms to maximize early-morning sun exposure and natural light		
	E	Both	CS		S	Good	Provide high lighting levels (1,500 lux) for complex visual tasks		
	A	Inpt	PR		P, F		Provide inboard bathrooms to maximize glazable dimension on outside wall		
	A	Both	FS,CS		P,F,S		Provide interior light wells to allow for natural light in interior spaces (integrate with healing gardens)		
	A	Inpt	PR		P	Good	Provide large windows for access to natural daylight in patient rooms (control glare and temperature)		
	A	Both	WB		P,F,S	Compelling	Provide natural light in as many occupiable spaces as possible		
	A	Both	SS,FS		S	Good	Provide windows in staff break rooms and all family areas		
Provide Optimal Nutrition	A	Inpt	CS		P, F	Good	Conveniently locate nourishment centers		
	A	Inpt	PR		P, F		Provide a family zone in patient room to encourage family participation in patient nutrition		

Improve Sleep	I	Inpt	PR		P,F		Comfortable beds and bedding		
	A	Both	WB		P	Compelling	Maximize exposure to daylight		
	A	Inpt	PR		F		Provide family sleeping space in patient rooms		
	A	Inpt	PR		P, F	Compelling	Provide single patient rooms		
	A,I,IT,M	Both	WB		P,F,S	Compelling	Reduce Noise (see design driver Reduce noise & Improve Intelligibility)		
Decrease Exposure to Harmful Chemicals	E	Both	WB		P,F,S		Install low-mercury florescent lamps		
	I	Both	WB		P,F,S	Good	Minimize use of furniture and furnishings that contain more than one: PBDE, PFA, urea-formaldehyde, phthalate and plasticizers		
	A,E,I	Both	WB		P,F,S		Use 100% lead and cadmium-free roofing, wiring and paint		
	A,I	Both	WB		P,F,S		Use low-emitting VOC and PFC materials		
	A,I	Both	WB		P,F,S		Use materials with no PBDE or phthalates		

Improve Communication	A	Both	CS		S	Good	Provide flexible work spaces that accommodate a multitude of staff tasks		
	A	Both	CS		S	Good	Provide spaces for interactive team work of varying sizes		
	A	Both	PR,CS,CI		P,F,S		Provide visual connections to facilitate information seeking and interaction (see driver re:unit visualization)		
Decrease Stress	A	Inpt	FS		F		Explore Fisher-house-like support and child care options		
	A	Both	FS		P,F	Good	Provide multiple spiritual spaces and haven areas		
	I	Both	WB		P,F,S	Good	Provide positive distractions (i.e., art, music, views of nature, etc.)		
	A	Inpt	CS,FS		P,F,S	Good	Provide secure access to nature (i.e., central green zones)		
	A	Inpt	PR		P	Compelling	Provide single patient rooms for personalization of patient environment		
	A,I,M	Both	WB		P,F,S		Reduce Noise (see design driver re:noise)		
	A,I	Both	WB		P,F,S	Good	Strive for a comfortable and welcoming, non-institutional, visual aesthetic		

Decrease Back Pain and Work Related Injuries	A	Both	PR,CS		S	Good	Ergonomically evaluate work areas		
	A	Inpt	PR		S	Compelling	Install ceiling-mounted lifts		
	A	Inpt	SS		S		Provide on site staff exercise facilities		
	I	Inpt	WB		S	Good	Use carpet and rubber floors where appropriate		
Reduce Airborne Infections	M	Both	WB		P,F,S	Good	Effective control measures during construction		
	M	Inpt	WB		P,F,S	Compelling	Maximize HEPA (99.97%) filtration for appropriate hospital areas		
	A	Inpt	PR		P	Compelling	Provide single patient rooms		
	M	Inpt	PR		P,F,S		Use UVGI on drip pans and cooling coils in ventilation systems		
	M	Both	WB		P,F,S	Good	Well-maintained and -operated ventilation systems		
	A	Both	WB		P,F,S		Windows that open		

Increase Social Support	A	Both	WB		P,F,S		Include patients, family, and staff in the design process		
	A	Inpt	PR		P	Compelling	Provide a family zone in the patient room		
	I	Both	FS		F		Provide a variety of comfortable and moveable furniture arranged in small, flexible groupings to accommodate the widest range of persons		
	A	Both	SS		S		Provide private staff areas for staff communication other than the staff break room		
	A	Inpt	SS,FS,PR		P,F,S		Provide visual connections to facilitate information seeking and interaction (see driver re:unit visualization)		
	A	Both	FS		F		Provide waiting rooms, lounges, and private family respite spaces		
Reduce Contact Infections	A,I	Both	WB		P,F,S		Careful selection of materials with clean-ability a key consideration		
	FM	Both	WB		P,F,S	Good	Frequent cleaning of high-contact surfaces		
	A	Inpt	PR		P,F,S	Compelling	Provide single patient rooms		
	A	Both	PR,CS,SS, FS		S	Good	Support hand washing with a conveniently placed sinks, hand washing liquid dispensers and alcohol rubs		

Reduce Waterborne Infections	A	Inpt	WB		P,F,S	Good	Avoid decorative water fountains in high-risk patient areas		
	FM	Both	WB		P,F,S	Good	Fountain water temperature should be kept cold and fountains should be regularly cleaned and maintained.		
	FM	Both	WB		P,F,S	Good	Regular maintenance and inspection of water supply system to minimize stagnation and back flow and for temperature control		
	FM	Both	WB		P,F,S	Good	Regularly clean and maintain faucet aerators to prevent and control for Legionella		
	FM	Both	WB		P,F,S	Good	Use proper water treatment		
Reduce Medication Errors	A	Inpt	PR		F		Provide a family zone in the patient room		
	E	Both	CS		S	Good	Provide adequate lighting levels in staff work areas		
	A	Both	CS		S	Good	Provide adequate space for private work to minimize distractions and interruptions		
	E	Both	CS		S		Provide high lighting levels (1,500 lux) for complex visual tasks		
	A	Inpt	PR		P		Provide single patient rooms		
Reduce Room Transfers	A	Inpt	PR		P	Good	Provide acuity adaptable rooms		
	A	Inpt	PR		P,S		Provide larger patient zone to support more in-room procedures		
Improve Access and Reduce Spatial Disorientation	A	Both	WB		P,F		Carefully consider external wayfinding building cues		
	I	Both	WB		P,F,S		Provide visible and easily understood signage (i.e., theme approach)		
	I	Both	WB		F,S		Use common language in signs with logical room numbering		
Reduce Noise and Improve Intelligibility	A,M	Both	CS				Provide adequate space for private work to minimize distractions and interruptions		
	A,M	Amb	CS		P,S	Compelling	Provide full height walls with high acoustic ratings in spaces where patients would be asked to disclose confidential information		
	A,M	Inpt	PR		P,F	Compelling	Provide single patient rooms		
	A,I,IT,M	Both	WB		P,F,S	Good	Remove or reduce loud noise sources through use of noiseless paging and alarm systems, equipment placement, etc.		
	I,M	Both	WB		P,F,S		Use carpet and rubber floors where appropriate		
	A,I,M	Both	WB		P,F,S	Compelling	Use high performance sound-absorbing ceiling tiles		
Reduce Falls	A	Inpt	PR		P, F		Assistive devices (e.g., headwall rails, larger bathroom doors, bathroom location).		
	IT	Inpt	PR		P		Bed alarms		
	A	Inpt	CS		P		Decentralize staff support spaces (i.e., charting, supplies, medications) proximate to patient rooms (pod configuration) to minimize staff walking		
	A	Inpt	PR		P, F	Compelling	Provide a family zone in patient room		
	A	Inpt	PR		P	Compelling	Provide single patient rooms		*Need to add latest references from YS Choi's Falls Prevention Paper*
Reduce Waiting Times and Wait related Stress	I	Both	FS		F		Provide a variety of comfortable and moveable furniture arranged in small, flexible groupings to accommodate the widest range of persons and families		
	A,I	Both	FS		F		Provide clear spatial boundaries for waiting areas		
	I	Both	WB		P,F,S		Provide positive distractions (i.e., art, music, etc.)		
	A	Amb	FS		P		Provide self-service kiosks		
	A,I	Both	WB		P,F,S		Strive for a comfortable and welcoming, non-institutional, visual aesthetic		
Facilitate Care Coordination	A	Both	CS		P		Collocate related services into Care Centers (i.e., musculoskeletal, cancer)		
	A	Both	CS		S		Provide flexible work spaces to encourage multidisciplinary use		
Facilitate Patient Services Coordination	A	Both	CS		P		Collocate related services into Care Centers (i.e., musculoskeletal, cancer)		
Increase Public Space Utility	A	Both	WB		Visitors		Create flexible public spaces to support multiple missions (i.e., MASSCAL, health fairs)		
Maximize Spatial Standardization and Flexibility	A	Inpt	PR		P,S		ICU-Convertible Rooms		
	A	Both	CS		S		Provide both public and private space to allow for increased staffing needs as models of care or levels of care evolve.		
	A	Inpt	PR		P,S		Same-handed patient rooms		
	A	Both	CS		S		Standardize nurse station designs throught the nursing unit		
	A	Inpt	WB		S		Standardize nursing floor layouts		
	A	Both	CS		S		Standardize treatment and exam room designs		

Maximize Technology Integration	A,IT	Inpt	CS		F,S		Provide adequate technology distributed throughout the nursing floor		
		Both	CI		F,S		Provide data connections in all circulation spaces to allow for functional flexibility		
	A,IT	Inpt	FS		F		Provide data connections in all family spaces		
	A,IT	Both	SS		S		Provide data connections in all staff support spaces		
	A,IT	Both	CS		S		Provide technological flexibility to enable changing models of care		
	A,IT	Inpt	PR		F,S		Provide the ability to conduct bedside data entry		
Provide Surge Preparation	A	Inpt	CS		S		Provide storage for surge preparedness (gurnies, haz-mat suits, etc.)		
		Inpt	CS		P,F,S		Have a surge plan in place (Receiving, Caring, Releasing, Information, etc.)		
	A	Inpt	FS		P,S		Plan for waiting areas to be used as multi-bed exam and treatment rooms		
	A	Inpt	PR		P,S		Provide for multiple patient capacity in treatment and exam rooms		
	A	Inpt	CS		P		Provide large scale decontamination capabilities		
	A	Both	CI		P,S		Provide Provisions for halls to accommodate gurnies on either side		

APPENDIX C

Evidence Based Design / Choosing-by-Advantages Possible Questions

- How are decisions between EBD intervention options made?
- Please describe the process of vetting EBD options and alternatives.
- With whom do you consult (positional), and when (during the planning phases of construction) on EBD decisions?
- What are the metrics that validate design decisions and to whom do you answer about the efficacy of design?
- How paramount a factor is Cost, in the implementation of a design decision?
- When programming a Military Hospital, “where do you start / what is the design point of departure” when selecting EBD interventions?
- What barriers (cultural, political, economic, etc.) have you encountered in implementing EBD interventions?
- Had you heard about Choosing-by-Advantages before this interview?
- Do you feel there is a gap between the way a design is intended to function, and the way healthcare practitioners are actually operating in it?

APPENDIX D

TAMU IRB Approval Letter

DIVISION OF RESEARCH

TEXAS A&M UNIVERSITY

Submission Approval DATE:	February 14, 2017
MEMORANDUM	
TO:	Zofia K Rybkowski, PhD TAMU - College Of Architecture - Construction Science
FROM:	Dr. David Martin Chair, TAMU IRB
SUBJECT:	Approval for Submission Response for Initial Review Submission Form REF: 044052

Study Number:	IRB2016-0752D
Title:	VALIDATING EVIDENCE BASED DESIGN THROUGH CHOOSING BY ADVANTAGES: A MILITARY HEALTHCARE FACILITY APPLICATION
Initial Application Approval Date:	02/14/2017
Continuing Review Due:	01/01/2018
Expiration Date:	02/01/2018
Documents Reviewed and Approved:	Only IRB-stamped approved versions of study materials (e.g., consent forms, recruitment materials, and questionnaires) can be distributed to human participants. Please log into IRIS to download the stamped, approved version of all study materials. If you are unable to locate the stamped version in IRIS, please contact the IRIS Support Team at 979.845.4969 or the IRB liaison assigned to your area.

Submission Components			
Study Document			
Title	Version Number	Version Date	Outcome
EBD Questions	Version 1.0	12/09/2016	Approved
CBA Read-Ahead	Version 1.0	12/09/2016	Approved
Sample Recruitment Email	Version 1.0	12/09/2016	Approved
Study Consent Form			
Title	Version Number	Version Date	Outcome
NEW Informed Consent for SURVEY	Version 1.1.0	01/04/2017	Approved

Document of Consent: Waiver approved under 45 CFR 46.117 (c) 1 or 2/ 21 CFR 56.109 (c)1

Comments:

- This IRB study application has been reviewed and approved by the IRB.

750 Agronomy Road, Suite 2701
1186 TAMU
College Station, TX 77843-1186
Tel. 979.458.1467 Fax. 979.862.3176
http://rcb.tamu.edu