Contract: W912EF23D0002

Quantifying the MILCON Cost Premium (MCP)

Evaluation and Cost Comparison of Barracks Design and Construction Cost, Private vs Government and similar MILCON facility types.

The U.S. Army Corps of Engineers (USACE) and the Naval Facilities Engineering Systems Command (NAVFAC) commissioned this study and report to provide a third-party review of the Military Construction (MILCON) Cost Premium and underlying cost drivers. The report's author - MOCA Systems, INC. - was selected through a competitive contracting process. Distribution of this report is not an endorsement of the author by USACE or by NAVFAC.

MOCA Systems, Inc. (MSI)

2-14-2025

MOCA SYSTEMS, INC.

Table of Contents

Table of Figures

MOCA SYSTEMS, INC.

Table of Tables

Table of Equations

1 Background

This investigation evaluates and compares the costs of designing and constructing barracks and similar structures by private sector entities versus government-led projects. Commissioned by the U.S. Army Corps of Engineers (USACE), Naval Facilities Engineering Systems Command (NAVFAC), and other Department of Defense (DoD) entities, the study aims to understand the cost premiums associated with federal construction. These premiums, referred to as the Military Construction (MILCON) Cost Premium (MCP), can be influenced by factors such as sustainability standards, wage determinations, and federal design requirements. A similar 2013 study by L3 Stratis indicated that MCP can exceed 35% or more.[1] Using the 2013 study as a basis for investigation we have provided contemporary updates to factors and taken a data-centric approach to analysis. Identified key factors impacting MCP include:

- Sustainability/Energy Standards
- PLAs/Wage Determination
- Federal Design Requirements – Anti-Terrorism/Force Protection (AT/FP)
- Federal Design Requirements – General
- Staffing Requirements (Div 01 Spec)
- Bonding Requirements – Miller Act
- Federal Contract Requirements
- Limited Federal Procurement Options
- Base Security/Access Requirements
- Planning and Scoping Process
- Quality Management Requirements

MOCA Systems, Inc. (MSI) focused on deriving the MCP and analyzing components for Unaccompanied Housing Permanent Party (UHPP) referred to as dorms in the private sector and barracks in DoD, a building category which has received considerable attention. Referred herein simply as “dorms” they represent an attractive cost of living benefit for enlisted personnel who often would have difficulty locating reasonably priced quality housing in the private market. Additionally, this on-base housing has the advantage of security and unit cohesion benefits.

An October 2024 Government Accountability Office (GAO) report recommended that housing personnel should fall within the DoD's scope rather than private industry. The report provided several recommendations, including clarifying oversight roles, developing and updating a list of critical housing areas, gathering feedback on housing effects, and developing response plans for housing issues.[2]

Understanding the total costs of construction and ownership in both private and DoD sectors is crucial for maintaining the DoD portfolio and aligning with the 2024 GAO report recommendations.

[1] https://www.acq.osd.mil/eie/imr/mc/Downloads/2013-Report-on-Construction-Unit-Costs-Characterizing-the-MILCON-Cost-Premium.pdf

[2] GAO-25-106208, MILITARY HOUSING: DOD Should Address Critical Supply and Affordability Challenges for Service Members

2 Objective

The objective of this study is to conduct a thorough evaluation of the costs associated with the design and construction of UHPP/barracks facilities by DoD and compare them to their private sector counterparts which are dorms and student housing. An additional objective was to include additional facility types for analysis. As most cost factors apply to all MILCON this extension was a logical addition to research. More detail is provided in Analysis Framework.

2.1 Scope

This report directly addresses the Statement of Work (SOW) as described in contract number W912EF23D0002 and we have divided it into two sections:

1. **Assessment of Cost Factors (Qualitative Analysis):** Identify and document factors affecting cost differences between the DoD and private sector investments, categorizing them as controllable or uncontrollable.
2. **Cost Comparison (Quantitative Analysis):** Evaluate the costs of private sector projects and compare them with DoD-constructed and operated facilities. This includes analyzing design, construction, and other contributing cost differences.

Additional elements of this report include:

- **Quality Control**: Implement a Quality Control program to ensure the accuracy and reliability of the study, including the organizational structure, scheduling, quality checks, and technical reviews.
- **Coordination**: Coordinate all work with designated USACE Team Leads and ensure compliance with the provided guidelines and standards.
- **Deliverables**: Prepare and submit draft and final reports, including an executive summary, detailed chapters addressing each task, and supporting data tables or materials.

MSI has worked collaboratively with DoD stakeholders to achieve the study's objectives and provide actionable insights for future construction projects.

2.2 Analysis Framework

The contract is divided into two options – Base and Option 1. The Base contract focuses on UHPP; further referred to as “dorms”, while Option 1 extends the analysis to other facility types. The Base contract included analysis on controllable and uncontrollable characteristics in the MILCON process Figure 1 Visual Guide to Contract and Analysis Framework shows in high-level detail the framework for this analysis.

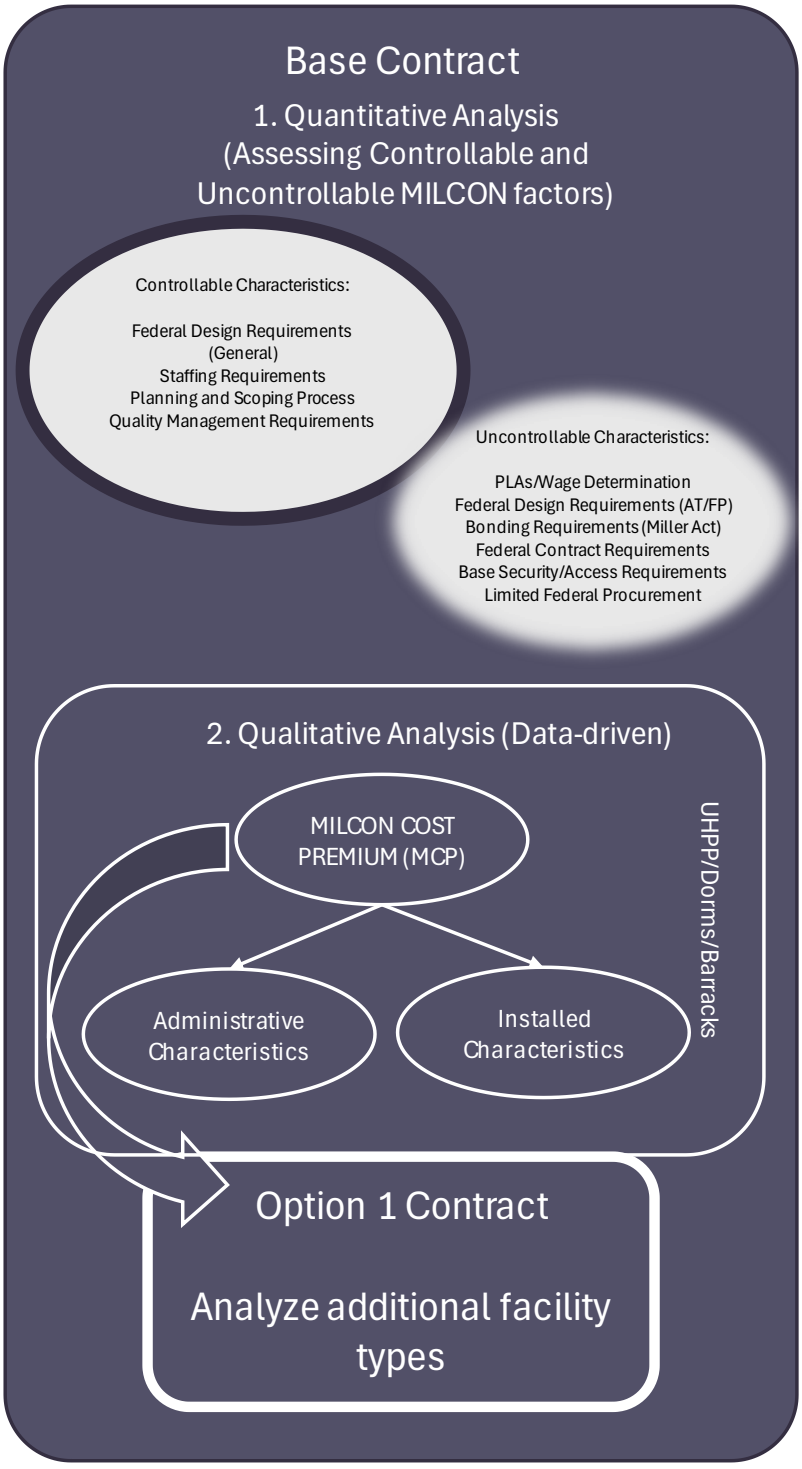


Figure 1 Visual Guide to Contract and Analysis Framework

2.2.1 Base – Barracks Analysis

The Base contract investigates dorm contracting and construction processes to identify cost differences between private sector and MILCON. Each military branch has different standards for dorms, as noted in the 2013 L3 study.

Private dorms and student housing was chosen as an analogue for UHPP because they have similar function; to provide housing to unaccompanied individuals at a large scale. Layout of dorms is often similar with multiple beds in a bedroom and can have two or more bedrooms in one unit with common kitchen and living spaces.

2.2.2 Option 1 – Analysis of Other Facility Types

The Option 1 contract extends the analysis to include the following facility types with their simplified naming conventions:

1. Admin Buildings – “Admin”
2. Medical Clinics – “Medical”
3. Parking Garages – “Parking”
4. Hangars – “Hangar”
5. Physical Fitness Centers – “Physical Fitness”
6. Miscellaneous – “Misc”

We considered additional facility types for analysis, but high-quality and sufficiently comparable data were unavailable for the following types. We subsequently grouped them under the Miscellaneous/”Misc” category:

1. Police Stations
2. Courthouses
3. Child Development Centers
4. Dining Facilities
5. Fire Stations
6. IT Facilities
7. Community Fire Stations

3 Purpose Summary

In summary, this report provides a detailed qualitative and quantitative comparison between federal and private sector construction costs, identifying the cost premiums associated with federal requirements. By evaluating a representative sample of facilities, the findings will support future planning and budgeting. This is particularly important in the context of rising costs due to inflation and the increasing emphasis

on sustainable infrastructure within the Army Climate Strategy[3] and Army Building Resilience Policy[4] which both cite objectives that could ultimately lead to higher costs.

4 Assessment of Cost Factors (Qualitative Analysis)

MSI has investigated the qualitative factors that impact MCP; identified as controllable or uncontrollable and provides suggestions where appropriate to mitigate some of these cost impacts. Additional information has been provided on life cycle analysis quality of life impacts.

4.1 Characterizing the MCP by Assessment of MILCON Laws, Regulations, and Guidance

This section provides a comprehensive assessment of the qualitative characteristics associated with the MILCON process, with a focus on dorms.

- **Legal** requirements are mandates that are established by law. These are binding and enforceable by legal authorities.
- **Regulatory** requirements are rules or directives made and maintained by an authority to regulate conduct. These are often detailed in regulations and must be followed to comply with the law.
- **Guidance** documents provide advice or recommendations on how to comply with legal and regulatory requirements. They are not legally binding but are often used to ensure best practices.

These elements collectively influence the cost and execution of federal construction projects by setting the legal and procedural framework within which these projects must be carried out.

Understanding the differences between private sector and government-led construction forms the foundation for the deeper data study in this report and the justification of cost ranges referenced in Cost Comparison (Quantitative Analysis) and Appendix I – Administrative Component Factor Tables respectively.

MSI examined both the Administrative and Installed characteristics that contribute to the MCP. Generally, Administrative components can be classified as either controlled or uncontrolled, while Installed components are often dictated by the specific location or the functional requirements. Although these factors are frequently interrelated, this study aims to clearly delineate and independently define them as much as possible. Factors are illustrated in Figure 3: Controllable vs Uncontrollable Characteristics in MILCON and are further explored in detail in Appendix IV – Controllable vs Uncontrollable Factors Case Studies.

[3] https://www.army.mil/e2/downloads/rv7/about/2022_army_climate_strategy.pdf
[4] DA_Policy_Guidance_Resilient_Buildings.pdf

4.2 Administrative Characteristics

- **Definition**: Specific processes or procedures prescribed by the MILCON process that dictate standards. They can be legal, regulatory, or guidance, and while they may dictate the final installed construction, they are typically procedural.
- **Examples**: Staffing levels, planning and scoping processes, quality management practices, and specific design choices such as Leadership in Energy and Environmental Design (LEED) certification.

4.3 Installed Characteristics

- **Definition**: Elements of construction that are directly observable as components or structural features of a facility.
- **Examples**: Exterior finishes; concrete quality; mechanical, electrical, and plumbing requirements (MEP); and heating, ventilation, and air conditioning (HVAC) design.

4.4 Controllable Characteristics

- **Definition**: Elements or conditions within a project that can be influenced, adjusted, or managed by the design and construction agent or project managers. Controllable factors are typically within the scope of the project's planning, execution, and decision-making processes. These are typically Administrative characteristics.
- **Examples**: Staffing levels, planning and scoping processes, quality management practices, and at times specific design choices.

Supporting case studies are detailed in Appendix IV – Controllable vs Uncontrollable Factors Case Studies.

4.4.1 Federal Design Requirements – General

- **Explanation**: Federal design requirements encompass a broad range of standards and specifications that must be adhered to in the construction of DoD facilities. While these requirements are non-negotiable, the specifics of their implementation can be adjusted. For instance, the choice of materials, construction methods, and design approaches can be optimized to meet standards in a cost-effective manner. This might involve using innovative materials that provide the same level of protection at a lower cost or adopting construction techniques that reduce labor and material expenses such as modular design or precasting.
- **Impact**: By carefully selecting design solutions that meet federal standards while minimizing costs, DoD project managers can exert some degree of control over expenses related to design requirements. This can lead to limited savings without compromising the safety and functionality of facilities. Optimizing design solutions can streamline the construction process, reduce delays, and improve overall project efficiency.

4.4.2 Staffing Requirements (Division 01 Specification)

- **Explanation**: Division 01 Specifications[5] in conjunction with general and District[6] engineering criteria[7] outline the general requirements for construction projects, including staffing levels and roles. These specifications are crucial for ensuring that projects are adequately resourced and managed. The DoD can influence these specifications by adjusting the number and type of staff required based on the specific needs and goals of each project. This might involve deploying a more flexible staffing model that can be scaled up or down as needed or cross-training staff to handle multiple roles, thereby increasing efficiency.
- **Impact**: Optimizing staffing levels can lead to cost savings by ensuring that resources are used efficiently and effectively. This approach can help avoid overstaffing, which can inflate costs, and understaffing, which can lead to delays and quality issues. By aligning staffing with project needs, the DoD can maintain high standards of quality and timeliness while controlling labor costs. Additional studies focusing on analyzing two concurrent projects could provide further clarity on the quantitative impact of staffing adjustments.

4.4.3 Planning and Scoping Process

- **Explanation**: The planning and scoping process involves defining the project's scope, objectives, deliverables, and timelines. This foundational phase is critical for setting clear expectations and ensuring that all stakeholders are aligned. Effective planning and scoping identifies potential risks, allocates resources, and establishes a roadmap for project execution. This process can be managed internally, with strict time allocations and set objectives and defined areas of responsibility for each specific project; allowing the DoD to streamline and create accountability in the process.
- **Impact**: Effective planning and scoping can prevent scope creep, which occurs when project requirements expand beyond the original objectives, leading to increased costs and delays. By clearly defining the project scope and setting realistic timelines, responsible parties, and budgets, the DoD can ensure that resources are used efficiently and that projects stay on track. This proactive approach can also enhance communication and coordination among project teams, reducing the likelihood of misunderstandings and errors. Defining concisely what is required from each project and assigning a dedicated project lead can further enhance the effectiveness of this process.

4.4.4 Quality Management Requirements

- **Explanation**: Quality management involves setting standards and procedures to ensure that construction projects meet specified requirements for performance, safety, and durability. This includes regular inspections, testing, and documentation to verify that all aspects of the project comply with established quality standards. The DoD can tailor quality management practices to balance cost and quality, ensuring that projects are completed to a high standard without unnecessary expenses. A mitigation strategy example would be to hire an external contractor versed in DoD quality management to provide independent analysis and reduce liability.

---

[5] Introduction to CSI MasterFormat and Division 01 | Swiftlane

[6] Savannah District > About > Divisions and Offices > Engineering Division > Engineering Design Criteria > Design Manual for Military Construction

[7] https://www.sas.usace.army.mil/Portals/61/docs/Engineering/EngineeringCriteria/2020%20District%20Eng.%20design%20criteria/V2_a11%20specifications%20-%20July%202020.pdf?ver=hxLxHOZAtyoK5T2GM8Tiow%3D%3D

- **Impact**: Implementing efficient quality management practices can lead to cost savings by reducing schedule delays. High-quality construction reduces the likelihood of future repairs and maintenance, leading to lower life-cycle costs. Additionally, a strong focus on quality can enhance the reputation of the DoD's construction projects, leading to greater stakeholder confidence and support. Developing a comprehensive quality management plan, implementing robust training programs, and utilizing technology for real-time monitoring can further enhance the effectiveness of quality management practices.

4.5 Uncontrollable Characteristics

- **Definition:** Elements or conditions beyond the influence or control of the organization or project managers. Uncontrollable factors are often dictated by external regulations, laws, or mandatory requirements that must be adhered to without modification. Long-term feedback possibilities do exist wherein changes to uncontrollable characteristics may be proposed and adopted by the appropriate governing body.
- **Examples**: Federal wage determinations, statutory bonding requirements, anti-terrorism/force protection mandates, and federal procurement regulations.

4.5.1 Project Labor Agreements (PLAs)/Wage Determination

- **Explanation**: Project Labor Agreements (PLAs) and wage determinations are governed by federal and state laws, such as the Davis-Bacon Act, which sets prevailing wage rates for public works projects.
- **Impact**: These regulations ensure fair wages and labor practices but can increase project costs. The DoD must comply with these laws, making them uncontrollable. A 2021 study by the RAND Corporation which focused on multi-unit housing, similar to dorms/barracks in this study, concluded PLAs led to a 14.5% increase in construction costs.[8]
- **Note**: MSI completed the 2024 Regional Market Survey report to support USACE's evolving mission requirements. This report featured a novel approach to calculating the impact of PLAs on craft wages and is characterized in Federal Wage Impact Analysis (EO 14026 & SCA). While the total survey-wide impact to labor rates was listed as 1.4%, Region 2 (Southeast US) showed significant increases between 0.6% and 10.0% depending on the labor type. For clarity, this study focused solely on labor impacts and not the overall administrative burden to construction analyzed by the RAND report.

4.5.1.1 Federal Wage Impact Analysis (EO 14026 & SCA)[9]

Federal legislation and Executive Order requirements have impacted wages provided on construction projects which influences the cost of labor. Specifically Executive Order 14026 (EO 14026, or EO) which stipulates that contracts performed on behalf of the Federal government pay at minimum $17.20/hour (On January 1, 2025, this rate has increased to $17.75/hour). We have also included in this analysis the

[8] The Effects of Project Labor Agreements on the Production of Affordable Housing: Evidence from Proposition HHH

[9] MOCA Systems, Inc. (2024). *Development of Market Conditions and Cost Adjustment Factors: Regional Market Survey Report (Option 1: Final Report)*. USACE Walla Walla District.

McNamara-O'Hara Service Contract Act (SCA) health and welfare fringe benefits which total $4.98/hour (On July 16, 2024, this rate has increased to $5.36/hour).

On one hand, the immediate impact of the EO and SCA is that they will add cost to complete Federal work. On the other hand, labor may seek preference on Federal contracts for the premium it provides, potentially prioritizing Federal projects. Across all observed professions and states[10] the impact of EO 14026 and SCA led to an increase of 1.4% over Davis-Bacon wages as many states are already above the minimum levels required by these acts.

To calculate the impacts of wage on Federal projects the following procedure was executed:

1. All Davis-Bacon wages adjusted upward to $17.20/hour if below that level.
2. Further adjust $4.98/hour fringe benefit.
3. Diminishing wage increase from $17.20/hour to $24.00/hour[11] was imparted on the Davis-Bacon data.
4. This equation, shown in Equation 1, was adapted to Microsoft Excel.

Equation 1: EO 14026 and SCA Calculation

$$f(x) = \begin{cases} \$17.20 & \text{if } x < \$17.20 \\ x + \$4.98 \cdot \left(1 - \min\left(\frac{x - \$17.20}{\$24.00 - \$17.20}, 1\right)\right) & \text{otherwise} \end{cases}$$

[12]

EO 14023 Wage Adjustment (Percent, Summary)

	Rodmen, (Reinforcing)	Truck Drivers, Heavy	Laborers, (Semi-Skilled)	Pile Drivers	Carpenters	Equip. Operators, Crane/Shovel	Equip. Operators, Medium	Equip. Operators, Oilers
Region 1	0.0%	0.7%	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Region 2	4.9%	10.0%	7.9%	7.5%	5.8%	0.6%	5.4%	2.6%
Region 3	0.6%	1.5%	1.0%	0.7%	0.7%	0.5%	0.8%	1.2%
All Region Weighted Average	1.0%	2.6%	2.1%	1.6%	1.3%	0.4%	1.3%	1.0%

Red = Increase, Green = Decrease, No Change = No Fill

While this PLA assessment covers wages and benefits, it does not address additional administrative impacts from this requirement such as contractor premiums and additional staff requirements. Please see information on RAND Corporation report in 4.5.1 Project Labor Agreements (PLAs)/Wage Determination. For more information on regional breakdown please see Figure 2: Regional Market Survey States and Regions.

Additionally, while these values represent simple averages for each category, the exact project labor demand may substantially shift the overall impact of PLAs. Detailing the specific ratio of labor requirements is important to determining the impact of PLAs.

[10] As determined in the 2024 Regional Market Survey Report which included 20 states.
[11] $24.00/hour was determined as fair cutoff wage across all labor categories and regions; some variation likely exists though the impact is perceived to be nominal.
[12] *f(x)* = EO 14026 and SCA-adjusted wage, x = Davis-Bacon wage

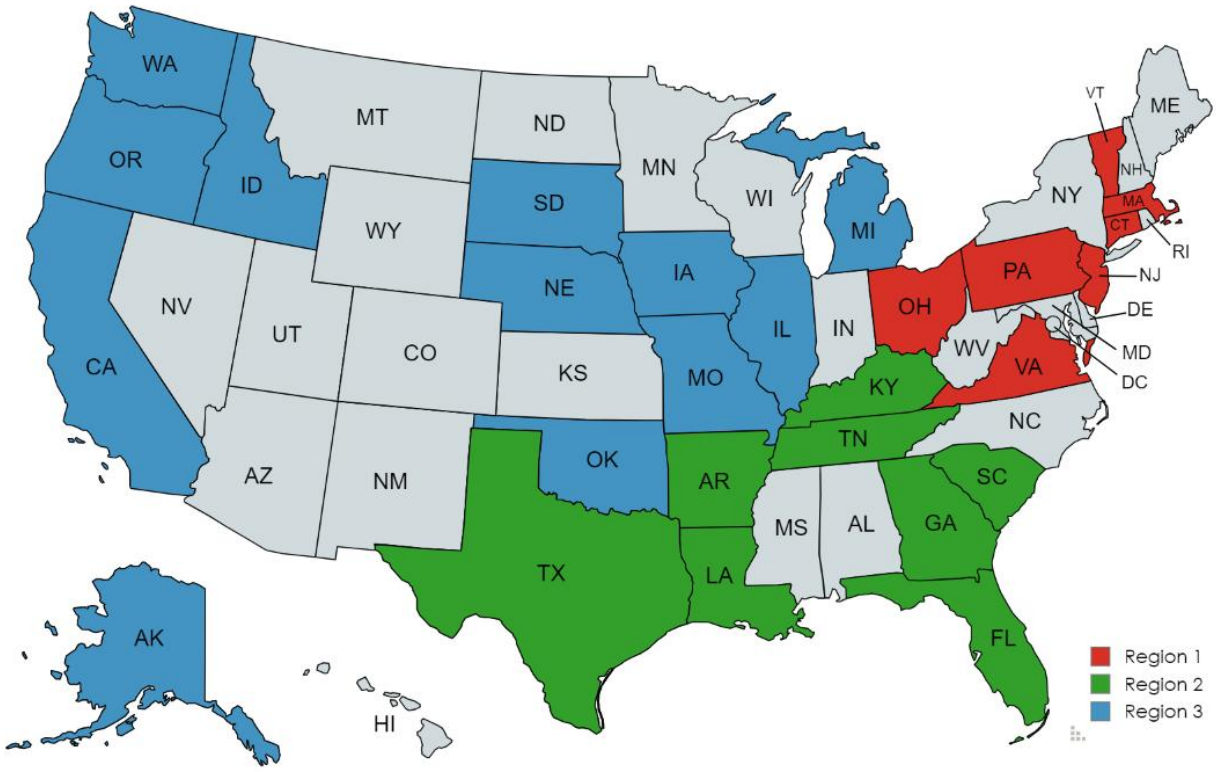


Figure 2: Regional Market Survey States and Regions

4.5.2 Federal Design Requirements – Anti-Terrorism/Force Protection (AT/FP)

- **Explanation**: Anti-Terrorism/Force Protection (AT/FP) requirements are mandated and are critical for ensuring the safety and security of military personnel and assets. These standards are non-negotiable and must be strictly followed.
- **Impact**: While necessary for security, these requirements can add significant costs to construction projects. The DoD cannot alter these mandates.

4.5.3 Bonding Requirements – Miller Act

- **Explanation**: The Miller Act requires contractors on federal projects to obtain performance and payment bonds. These bonds protect the government and subcontractors but add to project costs. The private sector is also required to provide bonding to contracts as further highlighted in Bonding/Insurance.
- **Impact**: Bonding requirements are legally mandated; the DoD and private contractors alike have no control over these costs.

4.5.4 Federal Contract Requirements

- **Explanation**: Federal contracts are governed by the Defense Federal Acquisition Regulation Supplement (DFARS) and other statutory requirements. These regulations dictate procurement processes, contract types, and compliance requirements. Private contractors must adhere to contract requirements dictated by locality and are also uncontrollable.

- **Impact**: These requirements ensure transparency and fairness in federal contracting but can limit flexibility and increase costs. The DoD must adhere to these regulations.

4.5.5 Base Security/Access Requirements

- **Explanation**: Security and access protocols for military bases are stringent to protect personnel and assets. These requirements can include background checks, security clearances, and restricted access areas.
- **Impact**: These protocols are essential for security but can add to project costs and complexity. The DoD cannot modify these requirements.

4.5.6 Limited Federal Procurement Options

- **Explanation**: Federal procurement processes are often rigid and complex. While opportunities are currently designed to ensure competition and fairness, they can also limit the options available for sourcing materials and services. Private contractors are rarely bound by procurement stipulations at the same level as federal contractors.
- **Impact**: Current limitations in suppliers and process complexity can lead to higher costs and longer procurement times. The DoD has limited ability to change these processes.

4.6 Controllable and Uncontrollable Requirements Summary

Following review of controllable and uncontrollable characteristics in the Controllable Characteristics and Uncontrollable Characteristics sections, MSI has summarized findings in Figure 3: Controllable vs Uncontrollable Characteristics in MILCON below. Focusing on known controllable factors will provide the best path forward to reducing the MCP. Controllable and Uncontrollable requirements have been grouped differently in the quantitative portion of this study to simplify analysis.

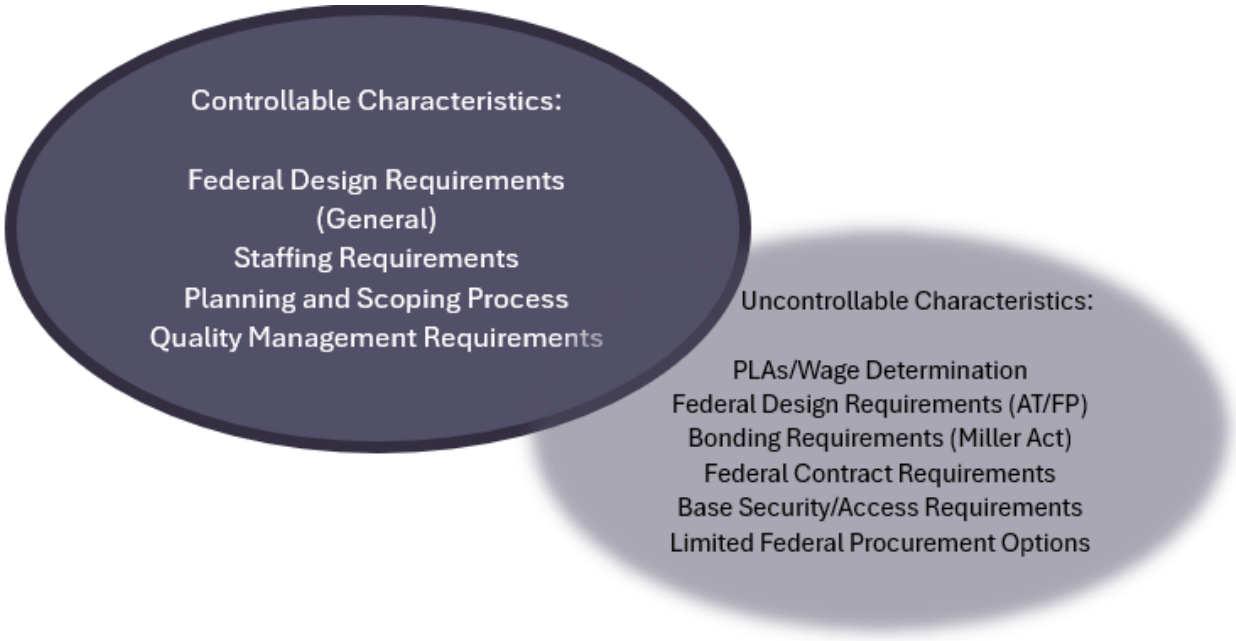


Figure 3: Controllable vs Uncontrollable Characteristics in MILCON

4.7 Contracting Process-Driven Requirements Analysis

4.7.1 Unified Facilities Guide Specifications UFGS for Construction Materials Used on DoD Facilities

The Unified Facilities Guide Specifications (UFGS)[13] ensure that construction materials used in Department of Defense (DoD) facilities meet stringent standards for durability, sustainability, and performance. Improvements in UFGS could focus on integrating more advanced materials and technologies, such as high-performance concrete and sustainable building materials, which can enhance the longevity and environmental impact of DoD facilities. Additionally, incorporating more comprehensive life-cycle assessments can help in selecting materials that offer the best long-term value and performance.[14] Proposed FAR amendment to statutory acquisition-related thresholds have been updated after a five-year period and may provide some relief on procedural aspects of DoD contracts.[15,16] Additionally, the Coalition for Government Procurement has addressed their perspective on contracting policy and requirements. From AI to sustainability their work is a viable resource for contractors who wish to participate in DoD contracts.[17] In general, MSI anticipates that while stringent specs create a standardized ecosystem for materials and a predictable life-cycle cost, there may be individualized solutions that are more appropriate for individual facilities. While UFGS is a medium for standardization, it may contribute to MCP by increasing the up-front cost. Further study is recommended to determine the impact to life-cycle cost and how that relates to MCP.

4.7.2 Statutory Contracting Requirements

Statutory contracting requirements, governed by regulations like DFARS and the Competition in Contracting Act (CICA), ensure transparency and fair competition in government contracts. Recent updates to these regulations aim to streamline procurement processes and adjust thresholds for inflation, which can reduce administrative burdens and improve efficiency.[18] One example contained within the yet-passed FY25 NDAA outlines a process for requiring unsuccessful protesters at GAO to reimburse the DoD for costs incurred in processing the protests.[19] Further improvements could include the adoption of more flexible contracting methods and the use of digital tools to enhance transparency and reduce procurement cycle times. A case example is Washington state, which rolled out a similar tool

[13] UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard, with Changes 1-4; replaced with UFC 1-300-02 dated 4/1/14

[14] Unified Facilities Criteria and Unified Facilities Guide Specifications for Sustainable Military Construction : Concrete, Asphalt, Wood, and Life-Cycle Assessment Perspectives > Engineer Research and Development Center > ERDC Publication Notifications - New Releases

[15] Proposed FAR Amendment: Adjusting Statutory Acquisition-Related Thresholds for Inflation | Insights | BRG

[16] Coalition-EPA-Letter-Final.docx

[17] Contract Policy & Requirements – The Coalition for Government Procurement

[18] Proposed FAR Amendment: Adjusting Statutory Acquisition-Related Thresholds for Inflation | Insights | BRG

[19] FY25 NDAA to Explore a Souped-Up "Loser Pays" Rule for GAO Bid Protests, Raise Pleading Standards and Jurisdictional Threshold to Protest DoD Procurements | Insights | Venable LLP

that helped local governments identify and understand their statutory legal requirements for purchasing and contracting.[20]

4.7.3 USACE's Division 01 Specifications

The U.S. Army Corps of Engineers (USACE) Division 01 Specifications[21] outline general requirements for construction projects, including administrative procedures, quality control, and safety measures. Enhancements in these specifications could involve the integration of more robust project management tools and techniques, such as Building Information Modeling (BIM), to improve project coordination and efficiency[22]. Additionally, updating safety protocols to reflect the latest industry standards can further enhance worker safety and project outcomes.[23] A proscribed process may both reduce MCP in certain standardized facilities, but increase MCP with administrative burden in non-standardized facilities. Further study is recommended to determine the exact cost of Division 01 Specifications on MCP.

4.7.4 Labor Requirements (Davis-Bacon Act, Legal Status, etc.)

The Davis-Bacon Act mandates the payment of prevailing wages to laborers on federal construction projects, ensuring fair compensation. Recent updates to the Davis-Bacon regulations aim to modernize wage determinations and improve enforcement mechanisms.[24] Further improvements could include more frequent updates to wage rates to reflect current market conditions and enhanced training programs for contractors to ensure compliance with labor standards.[25] The Davis-Bacon Act has been shown to increase construction costs by 7.2% and labor costs by 20.2%.[26,27]

4.7.5 Small Business, Women-Owned, HUBZone, Veteran-Owned, and Other Contracting Requirements

Government-led construction projects often include specific contracting requirements to promote the participation of small businesses, women-owned businesses, HUBZone businesses, and veteran-owned businesses. Enhancements in these programs could involve increasing the visibility and accessibility of contracting opportunities for these businesses through improved outreach and support services including set-aside contracts.[28] Additionally, implementing more robust tracking and reporting mechanisms can ensure that these programs effectively meet their goals and provide meaningful opportunities for underrepresented businesses.[29] Expanding competition would improve supply

[20] MRSC - MRSC, SAO Update Online Contracting Requirements Tool
[21] UFGS 01 11 00 Summary of Work
[22] Effect of Building Information Modeling (BIM) on reduced construction time-costs: a case study | Request PDF
[23] Contract Policy & Requirements – The Coalition for Government Procurement
[24] Update: Current Status of Davis-Bacon Final Rule - Hinckley Allen
[25] US Department of Labor implements final rule to modernize Davis-Bacon Act regulations, better meet construction workers' needs | U.S. Department of Labor
[26] Newsline | DOL Increases Costs for Contractors and Taxpayers With
[27] Microsoft Word - FINAL-BHI-DBA-2022-05-16.docx
[28] Types of contracts | U.S. Small Business Administration
[29] 2025 Government Contracting Trends: What Government Contractors Should Expect and Focus On to Maximize Opportunities

redundancy and create a high-performing subcontractor base.[30] Ultimately, partitioning contracts outside of a free competitive market increases costs.

4.7.6 Variances Between Private Sector and Government-Led Construction Delivery Methods

The primary differences between private sector and government-led construction delivery methods can be summarized as follows:

1. **Regulatory Compliance**: DoD projects must adhere to strict regulatory requirements, including the DFARS and Davis-Bacon Act, ensuring transparency, fair competition, and fair wages. Private sector projects have more flexibility but must still comply with local and state regulations.
2. **Material Specifications**: The UFGS ensures that materials used in DoD facilities meet high standards for durability and performance. Private sector projects may have varying standards depending on the project's scope and budget.
3. **Contracting Requirements**: Government projects often include set-asides for small, women-owned, HUBZone, and veteran-owned businesses to promote diversity and economic growth. Private sector projects may not have such requirements but may still engage in diverse contracting practices.
4. **Labor Standards**: The Davis-Bacon Act ensures that workers on federal projects are paid prevailing wages. Private sector projects may have different wage standards based on market conditions and company policies.

4.8 Life-Cycle Analysis

4.8.1 Non-Federal Infrastructure Owners' Life-Cycle Cost Analysis (LCCA):

- **Definition**: Life-Cycle Cost Analysis (LCCA) is a data-driven tool that evaluates the total costs of a project over its expected life, including initial construction, operation, maintenance, and disposal costs. The American Society of Civil Engineers provides LCCA recommendations, and these are used by private civil engineers to quantify cost over the life of a project.[31]
- **Application**: Major non-federal owners, such as state and local agencies, as well as private owners use LCCA to make informed decisions about project funding and design. This approach helps identify the most cost-effective options by considering both short-term and long-term costs.[32,33]
- **Examples**: Lythouse, an Environmental, Social, and Governance (ESG) consulting firm cites using LCCA on a case in Chicago on a commercial property with renovations translating into LEED Gold results. The upfront investment and efficiencies gained with working through both single building

[30] OFPP-Memorandum-Increasing-Small-Business-Subcontracting-Participation-in-the-Federal-Marketplace.pdf
[31] Policy statement 451 - Life-cycle cost analysis | ASCE
[32] lcca_asce_eno.pdf
[33] Life-Cycle Cost Analysis (LCCA) | WBDG - Whole Building Design Guide

and portfolio-wide LCCA are tangible, and many firms offer solutions to fit individual needs.[34] MSI provides similar services through Facility Condition Assessment (FCA) offerings.[35]

4.8.2 MILCON LCCA Process:

- **Definition**: The MILCON process involves planning, programming, budgeting, and executing construction projects for military installations. This process is governed by public law and specific military regulations. Specific requirements for the LCCA are detailed in UFC 3-410-01 and 1-200-02.[36]
- **Life-Cycle Cost Considerations**: The DoD incorporates life-cycle cost-effectiveness practices into many aspects of the MILCON process. This includes evaluating the total cost of ownership for facilities, such as barracks and administrative buildings,[37] as well as the Economic Analysis (EA) as part of the planning process for DD 1391s. For MILCON projects, decisions regarding the selection of major building components, such as HVAC systems, are based on the lowest life-cycle cost. A LCCA is required to be conducted prior to the 35% design phase, with the results included with the 35% design submittal. DoD chooses materials and components which gain more service years versus private. This may contribute to a higher MCP, but lower life-cycle cost.
- **Example:** For MILCON projects, the LCCA typically evaluates three different types of HVAC systems, such as hydronic (with chilled water for cooling and hot water boilers for heating), direct expansion, and geothermal. In most instances, the hydronic system is shown to have the lowest life-cycle cost. The initial construction cost of a hydronic system can be two to five times higher than that of a direct expansion (DX) system. However, the energy efficiency and longer lifespan of the hydronic equipment as compared to a DX system result in a lower operating and maintenance cost which offset the higher initial construction cost, resulting in an overall lower life-cycle cost over the 40-year analysis period of the LCCA.
- **Challenges**: Despite efforts to integrate LCCA, the DoD faces barriers such as funding constraints, information gaps, and organizational issues that can hinder the full realization of life-cycle cost benefits.[38]

4.8.2.1 Private and MILCON Life-Cycle Cost Analysis (LCCA) Comparison

- **Scope and Integration**: Non-Federal infrastructure owners often have more flexibility in applying LCCA comprehensively across various projects. In contrast, the DoD must navigate a more rigid and complex regulatory environment, which can limit the extent to which engineering judgement can balance practical design solutions and budgetary guidance.
- **Barriers**: Both private and MILCON face challenges, but the DoD encounters additional hurdles related to aligning incentives and removing barriers at different stages of the MILCON process.

[34] Life-Cycle Cost Analysis (LCCA) for Optimal Project Management and Savings
[35] Facility Condition Assessments - MOCA Services
[36] UFC 1-200-02 High Performance and Sustainable Building Requirements with Change 2
[37] Obtaining Life-Cycle Cost-Effective Facilities in the Department of Defense | RAND
[38] Obtaining Life-Cycle Cost-Effective Facilities in the Department of Defense | RAND

4.8.3 DD Forms 1391 and Life-Cycle Costs

DD Form 1391:

- **Purpose**: This form is used to document and justify military construction projects, including cost estimates and project descriptions.
- **Life-Cycle Cost Details**: While the form includes detailed cost estimates, it may not always provide comprehensive life-cycle cost data. The focus is often on immediate construction costs, with less emphasis on long-term operational and maintenance expenses. Private construction may tilt even more to the short-term as contractors have incentive to build at the lowest price and quickly to move on to the next project.

In summary, while both non-Federal infrastructure owners and Military Departments recognize the importance of life-cycle cost analysis, their approaches and the extent of integration differ. The development of DD Form 1391 includes cost estimates but may not fully capture life-cycle costs, highlighting an area for potential improvement in the MILCON process. Thus, aligning the incentives of the various entities at each step of the MILCON process and removing funding, information, timing, and resource barriers would enable the DoD to obtain facilities that are more life-cycle cost-effective.[39]

4.9 Quality-of-Life Risks Assessment

MSI addresses how the DoD can increase the quality of life and comparisons between DoD facilities and private industry. The 2024 GAO report referenced in Background cited the DoD for "not learning lessons" from construction issues[40] and cited that strengthened oversight was required to make achieve stated goals.[41] In a timely and direct manner the DoD has issued a strategy to build resilient, healthy environments for service members.[42] The following section outlines those quality-of-life comparisons between private industry and the DoD.

4.9.1 Durability

- **DoD Facilities**: Military facilities often face unique durability challenges due to their exposure to harsh environments and operational demands. Issues such as poor initial planning, design errors, and insufficient quality control have led to significant delays and increased costs. For example, some barracks have experienced severe issues like mold, sewage overflow, and structural deficiencies.
- **Private Sector Facilities**: Private operations typically benefit from more flexible and innovative construction practices. They often employ advanced materials and technologies to enhance durability. However, the private sector also faces challenges, such as balancing cost and quality, which can impact long-term durability.

[39] Obtaining Life-Cycle Cost-Effective Facilities in the Department of Defense | RAND
[40] DoD Not Learning Lessons from Problems in Construction Projects, GAO Says
[41] https://www.gao.gov/assets/gao-23-107038.pdf
[42] DOD Releases Strategy to Build Resilient, Healthy Environments for Service Members and Families > U.S. Department of Defense > Defense Department News

4.9.2 Availability

- **DoD Facilities**: Availability of military facilities can be hindered by bureaucratic processes and funding constraints. Delays in construction and maintenance can reduce the availability of essential infrastructure, impacting the quality of life for service members.
- **Private Sector Facilities**: Private operations generally have more streamlined processes, allowing for quicker construction and maintenance. This can lead to higher availability of facilities, ensuring that they meet the needs of users more effectively.

4.9.3 Sustainability

- **DoD Facilities**: The DoD has made strides in incorporating sustainability into its infrastructure projects, but challenges remain. Efforts to build resilient and energy-efficient facilities are ongoing, but the integration of sustainable practices can be inconsistent.[43]
- **Private Sector Facilities**: The private sector often leads in sustainability initiatives, driven by regulatory requirements and market demand. Sustainable practices, such as green building certifications and renewable energy integration, are more commonly adopted.

4.9.4 Lessons Learned from Nonstandard DoD Construction

4.9.4.1 Experiments and Challenges:

- **Nonstandard Construction**: The DoD has experimented with nonstandard construction methods to improve efficiency and reduce costs with limited success.[44] However, these projects have often faced some issues, including poor initial planning, design flaws, and inadequate oversight.[45]
- **Case Studies**: For instance, a GAO report highlighted that a quarter of DoD construction projects were delayed due to issues like design errors and insufficient quality control.[46] These delays not only increase costs but also negatively impact the quality of life for service members. Continued success in building quality structures does involve nonstandard methods and USACE has a history of developing a knowledge base for alternative construction methods.[47] Private industry construction could experience delays and challenges from nonstandard construction; these are not well-documented.

[43] DOD Releases Strategy to Build Resilient, Healthy Environments for Service Members and Families > U.S. Department of Defense > Defense Department News
[44] Defense Infrastructure: DOD Needs to Determine and Use the Most Economical Building Materials and Methods When Acquiring New Permanent Facilities | U.S. GAO
[45] Report No. DODIG-2025-017: (U) Audit of Cost Increases and Schedule Delays of Military Construction Projects Managed by Naval Facilities Engineering Systems Command
[46] Military Construction: Better Information Sharing Would Improve DOD's Oversight | U.S. GAO
[47] Development of a Knowledge Base on Alternative Construction Methods

4.9.4.2 *Recommendations:*

- **Improved Planning and Oversight**: Enhancing initial planning and increasing oversight can help mitigate many of the issues faced in nonstandard construction projects. This includes better coordination between different stakeholders and more rigorous quality control measures.
- **Information Sharing**: The DoD could benefit from better information sharing and documentation of lessons learned from past projects. This would help identify and address systemic issues, preventing repeated mistakes.[48]

In summary, while both DoD and private sector facilities face challenges related to durability, availability, and sustainability, the private sector often has more flexibility and innovation in addressing these issues. The DoD can improve by enhancing planning, oversight, and information sharing, particularly in nonstandard construction projects, to better support the quality of life for service members.

5 Cost Comparison (Quantitative Analysis)

5.1 MILCON Cost Premium (MCP) Definition

- **Definition:** Military Construction (MILCON) Cost Premium or MCP represents the cost premium the DoD pays up-front for MILCON facilities compared to the cost for their private sector counterparts. MCP does not include impacts to life cycle costs. In this study MSI has defined MCP in $/SF or $/Space depending on the structure and a percentage was calculated for universal application by standard facility type.

Equation 2 MILCON Cost Premium (MCP) USD$/SF Calculation

$$\$/SF_{MILCON} - \$/SF_{Private} = MCP\ (\$/SF)$$

Equation 3 MILCON Cost Premium (MCP) Percent % Calculation

$$\frac{\frac{\$}{SF}_{MILCON}}{\frac{\$}{SF}_{Private}} - 1 = MCP\ (\%)$$

- **Example:** Structure A costs $50/SF to build in the private sector and $75/SF to build MILCON; the premium is $25/SF and 50%.

This report further subdivides MCP into Administrative and Installed components to quantify MCP to the lowest extent possible.

For clarity MSI has defined the following:

- Factor – An applied function or scaled value mathematically applied to determine MCP or its components.

[48] GAO-24-106499, MILITARY CONSTRUCTION: Better Information Sharing Would Improve DOD's Oversight

- Component – A part of element of the larger whole of MCP.
- Characteristic – A distinguishing feature or quality that defines or identifies MCP.

5.2 Investigation to Determine MILCON Cost Premium (MCP)

5.2.1 Approach

MSI investigated the MCP using an aggregated data approach. First, we collected a large sample set and normalized it using various factors to determine the MCP on an aggregate level. Next, we decomposed MCP into Administrative and Installed components to analyze MCP in as much detail as practical. This process is fully detailed in the Assumptions and Limitations section. Using the aggregated data approach, we can provide stakeholders with an understanding of the costs independent of individual facility designs.

The 2013 L3 study used a case study approach which investigated costs of a smaller number of facilities at an individual facility level which provided assumptions that those were standardized across MILCON.

5.2.2 Data Sourcing and Criteria

Data collected for this investigation was obtained from DoD stakeholders (USACE, NAVFAC, and USAF), MSI's proprietary database, and GlobalData's contract service. Data was collected over the period of August – November 2024. Data characteristics are fully detailed in the Data Characterization section.

- DoD data was delivered via DoD SAFE and was in the form of estimates and drawings that provided robust detail on facilities.
- MSI data was in the form of estimates and sourced from internal database.
- GlobalData data was in the form of reported total project value or capital cost for the project. GlobalData's information is limited to projects greater than $25 million.

To meet the scope of the analysis facilities were required to meet the following requirements:

1. Location within the territory of the United States
2. Project estimated/completed on or after January 1, 2013
3. Facility data must include price (estimated or actual), gross square footage (SF), personnel accommodation (dorms), rooms (dorms), beds (dorms), and spaces (parking facilities)

5.2.3 Assumptions and Limitations

While a large data set approach has many advantages, there are inherent limitations that must be considered:

- **Data Availability**: Several administrative characteristics lack available data or fall outside the scope of this investigation. For example, quantifying the quality-of-life improvements for enlisted personnel provided with housing is challenging. MSI has focused on quantifiable factors.
- **Cost Assumptions**: All project costs are assumed to be the same; project estimates are assumed to be actual final costs. This assumption has limitations, as market factors,

programming decisions, and scope changes can significantly alter the final construction cost from initial estimates.

- **Exclusion of Non-UHPP Features**: In private sector dorms, costs of physical features not part of UHPP were assumed or approximated to exclude them from the study. For example, study rooms and commercial spaces were approximated and costs removed. This approach allows for an apples-to-apples comparison by making general assumptions about the costs of these features but sacrifices a limited degree of accuracy in the process.
- **Mutually Exclusive MCP Components**: MCP components were assumed to be mutually exclusive. For example, design life and HVAC systems were treated as separate factors, even though the robustness of the HVAC system can be a component of the design life. Overlap was reduced where practical, but this approach may lead to an overestimation of the combined MCP. To address this, ranges for the MCP components are provided.
- **Administrative Characteristics**: Justification was provided for the range of values for administrative characteristics, though actual values for each facility may vary. Further detail on these ranges is provided in Appendix I – Administrative Component Factor Tables.
- **Sample Size and Representativeness**: A larger sample might better characterize the private to MILCON comparison. Limitations in geography, building type, and project cost may impact similar analyses. All reasonable efforts to select high-quality, representative data were carried out.
- **Professional Judgment**: Our staff are highly credentialed and among the top tier in MILCON estimating and design, with extensive experience. While their assessments fall within normal confidence levels, there may be slight differences in approach that could lead to varying results. MSI has provided sufficient justification where available alongside these professional approximations to support findings.

By acknowledging these assumptions and limitations, the study provides clear and realistic understanding of the factors influencing the MILCON process and the potential areas for cost control and efficiency improvements.

5.2.4 Methodology

The process below highlights the methodology to quantify the MCP and further subdivide into its Administrative and Installed components.

5.2.4.1 MCP Quantification Process

1. Obtained construction cost data from DoD, MSI, and GlobalData. DoD information was selected and sourced directly from DoD stakeholders.
2. Facilities outside of the conditions of this study and statistical outliers were excluded (ex: $/SF exceeded range of similar facilities).
3. Created a database with each facility and details such as category (Dorm, Administrative, Hangar, etc.), budget, and location, etc.
4. Civil/Sitework costs were removed to focus exclusively on vertical facility construction using PACES estimations detailed in the PACES Civil Works Adjustments section.

5. Normalized facility cost.
    a. PAX Area Cost Factor (ACF) adjustment was applied and is detailed in PAX 3.2.1 Area Cost Factors section. PAX is the Programming Administration and Execution System, which is the DoD system for creating and tracking DD Form 1391s for MILCON projects.

NAVFAC Building Cost Index (BCI) adjustment for inflation/escalation was applied detailed in

b. NAVFAC BCI Index (Base & Option 1) section.
c. PAX Size Normalization adjustment for size of facility as detailed in UFC 3-730-01 Facility Size Adjustments section.
    i. Dorms were normalized by the number of rooms, with the PAX Size Normalization table initially accommodating up to 300 rooms. The table was extended in 100-room increments, with a 2% adjustment per increment, up to a maximum of 2,000 rooms. Only a small sample size met this extreme criterion.
    ii. All other facilities were adjusted by the size ratio according to sample average of 172,700 SF.
d. Private dorms were normalized to exclude structures that are not included in MILCON analogues such as pools, parking garages, commercial spaces, and other miscellaneous features. Those are discussed in detail in Appendix II – Private Dorm Normalization Tables.
e. Final normalized costs below were calculated:
    i. Final Normalized Adjusted Building Cost ($)
    ii. Final Normalized Adjusted Building Cost ($/SF)
    iii. Final Normalized Adjusted Building Cost ($/Space)

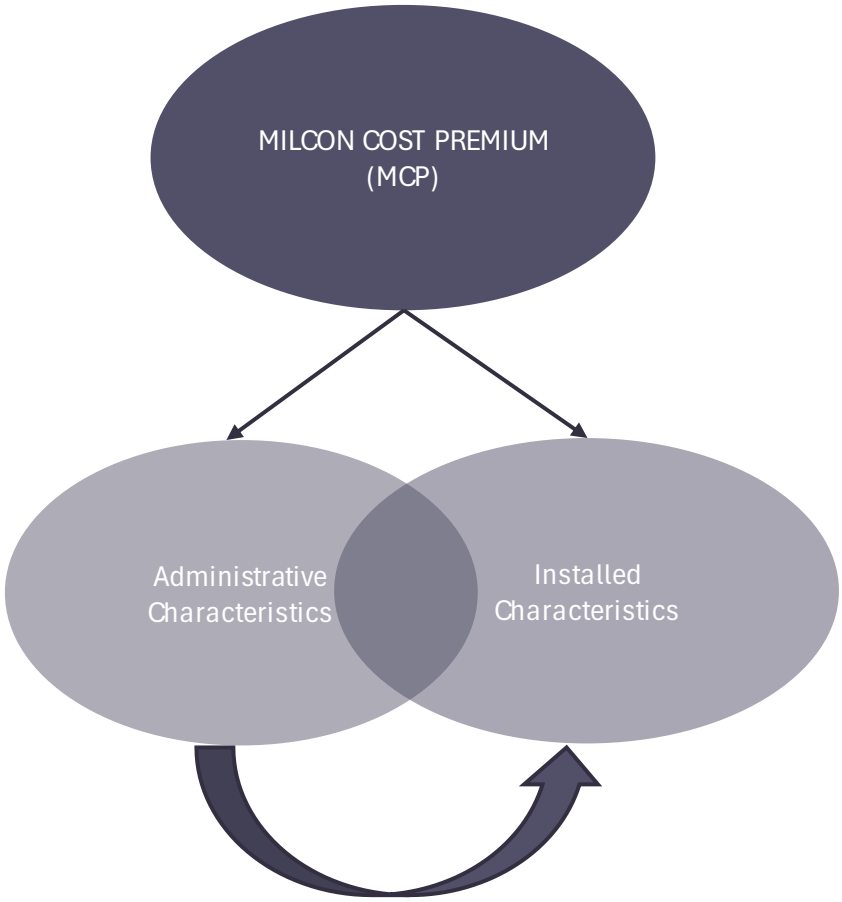
6. The Normalized Adjusted Building Cost in $/SF was compared between Private and MILCON as provided in Equation 2 MILCON Cost Premium (MCP) USD$/SF Calculation and Equation 3 MILCON Cost Premium (MCP) Percent % Calculation to quantify MCP. Equations are restated below for clarity.

Equation 4 MILCON Cost Premium (MCP) USD$/SF Calculation

$$\$/SF_{MILCON} - \$/SF_{Private} = MCP\ (\$/SF)$$

Equation 5 MILCON Cost Premium (MCP) Percent % Calculation

$$\frac{\frac{\$}{SF}_{MILCON}}{\frac{\$}{SF}_{Private}} - 1 = MCP\ (\%)$$



Note: Administrative Characteristics such as legal, regulatory, and guidance may influence physical outcomes. There also exists significant overlap between Administrative and Installed Characteristics. In this study we sought to limit overlap wherever possible.

Figure 4 MILCON Cost Premium (MCP) Component Subdivision

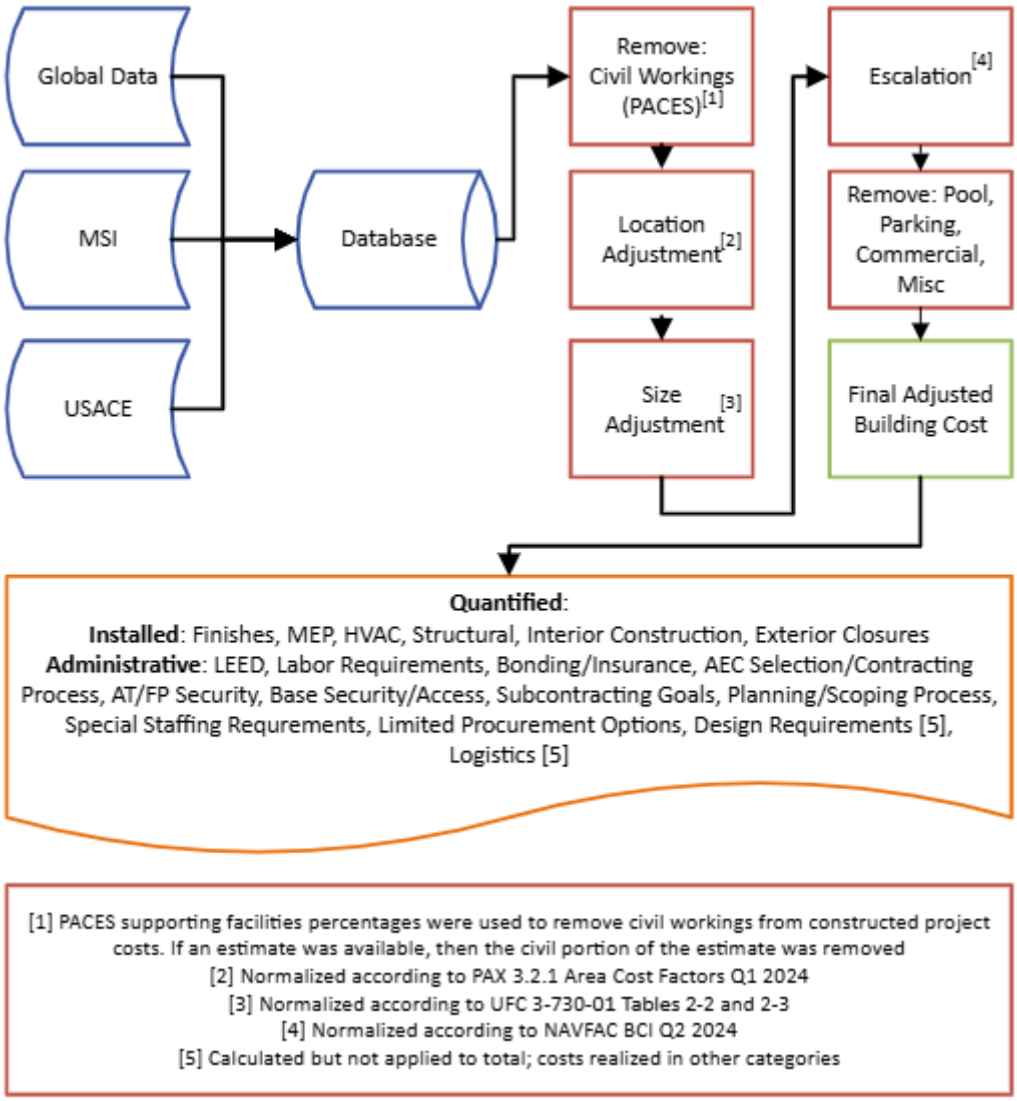


Figure 5 MILCON Cost Premium (MCP) Quantification Process

5.2.4.2 Administrative and Installed Characteristic Quantification

This study provides a detailed investigation, as granular as is possible, at individual components of MCP. To accomplish this a process was constructed to quantify how Administrative components impacted total construction cost and is highlighted in Figure 6: MCP Components Development Process. Physical components were assessed directly from estimates or approximated based on visual inspection from a combination of facility website data, Google Maps images, and scope statements from GlobalData.

MCP Component Process:

1. Subdivided MCP into Administrative and Installed components.
2. Administrative characteristics were assessed for dorms as a percentage of total construction cost.

    a. The percentage of total construction cost ranges for various features was calculated, justified values were applied as a percent of Normalized Adjusted Building Cost ($). The specific factors are detailed in Appendix I – Administrative Component Factor Tables.
3. Installed characteristics were assessed for Dorms as a percentage of the total construction cost:
    a. MILCON UHPP values were extracted from MII estimate files or pdf estimates.
    b. Private Dorm values were quantified by visual inspection via Google Earth, Google Maps, facility websites, and online articles.
4. Quantification of Administrative and Installed characteristics were aggregated and compared across both the private and MILCON dorms.
5. Data for MCP, Administrative, and Installed components was organized for the presentation to the DoD stakeholders and to provide recommendations.
6. Data checks, methodology checkpoints, and quality controls were integral throughout this process.

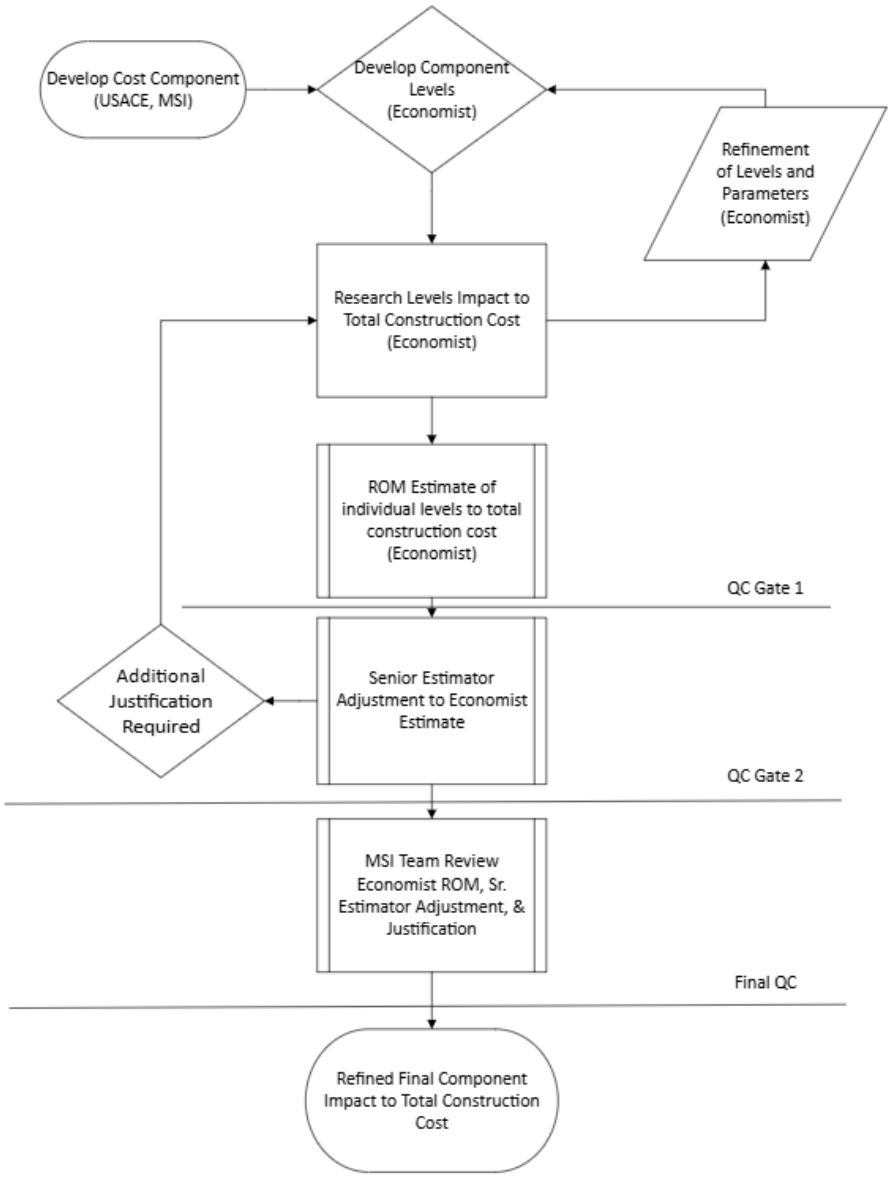


Figure 6: MCP Components Development Process

5.2.5 Data Characterization

Charts and tables below reflect the data sampling and characteristics of the total sample. In total 399 facilities were investigated with a majority of those facilities originating from MSI's database as shown in Table 1 MILCON Cost Premium (MCP) Investigation Sample by Source. While some in MSI's database may

also be bucketed into NAVFAC, USACE, or USAF; however, this chart focuses on the source of the data rather than the owner of the facility.

Table 1 MILCON Cost Premium (MCP) Investigation Sample by Source

Source	Count
GlobalData	157
MSI	208
NAVFAC	6
USACE	15
USAF	13
Total	399

Table 2 MCP Investigation Sample by Source and Facility Type (Count) shows the source and facility type count used in this study. Of the 399 facilities, just under half of them were classified as administrative (Admin). 253 were identified as MILCON and 146 were identified as private. While there was some numerical bias toward MILCON (253 vs 146), this was not identified as a source of error in subsequent analysis. The dorm sample contained 28 MILCON and 30 private facilities, with all private facilities being sourced from GlobalData. The high number of parking facilities in private construction compared to the low number in MILCON may reduce the accuracy of this sample category and in subsequent analysis a greater number of MILCON samples would be needed.

Table 2 MCP Investigation Sample by Source and Facility Type (Count)

	Admin	Dorm	Hangar	Medical	Misc	Parking	Physical Fitness	Grand Total
MILCON	105	28	68	37	9	3	3	253
GlobalData	10		2	4		1		17
MSI	89	12	63	33		2	3	202
NAVFAC		6						6
USACE	5	5			5			15
USAF	1	5	3		4			13
Private	35	30	3	12	12	37	17	146
GlobalData	31	30	3	11	12	36	17	140
MSI	4			1		1		6
Grand Total	140	58	71	49	21	40	20	399

The total square footage of facilities as shown in Table 3 MCP Investigation Sample by Source and Facility Type (Square Foot, SF) provides clarity on the overall size in SF of the total sample by facility type. While it is interesting to view these statistics across sources, they are of little value across facility types. Physical fitness facilities were the most disparate in SF terms. New private physical fitness facilities exceeding GlobalData's $25M threshold tend to be oriented toward career athletes and large community athletic facilities. These facilities may not have the same use case as a smaller physical fitness facility such as a

local gym on a smaller renovated scale. Total square footage is much larger in MILCON hangars than private.

Table 3 MCP Investigation Sample by Source and Facility Type (Square Foot, SF)

SF	Admin	Dorm	Hangar	Medical	Misc	Physical Fitness	Grand Total
MILCON	13,069,560	3,247,603	9,368,549	5,844,551	293,597	108,625	33,015,446
GlobalData	3,737,441		258,474	494,045			4,489,960
MSI	9,050,778	1,498,992	9,048,634	5,350,506		108,625	26,140,496
NAVFAC		583,907					583,907
USACE	239,249	571,528			226,622		1,037,399
USAF	42,092	593,176	61,441		66,975		763,684
Private	9,361,840	9,423,704	526,979	1,926,994	1,434,240	7,448,888	32,674,914
GlobalData	7,709,500	9,423,704	526,979	1,859,095	1,434,240	7,448,888	30,405,975
MSI	1,652,340			67,899			2,268,939
Grand Total	22,431,401	12,671,307	9,895,528	7,771,545	1,727,837	7,557,513	65,690,360

In Table 4 MCP Investigation Sample by Source and Facility Type (Square Foot/Count, SF/Count) we parsed the total SF/Count of facility by source and by type. The differences in facility sizes between MILCON and private sources can be attributed to the varying needs, standards, and amenities required by military versus private sector operations. In the admin category, MILCON facilities are smaller (124,472 sq ft) due to more standardized and functional administrative spaces required for military operations, whereas private facilities are larger (267,481 sq ft) to accommodate more comprehensive administrative needs and additional amenities. For dorm facilities, MILCON's average size (115,986 sq ft) reflects efficient, standardized living quarters for military personnel, while private facilities are significantly larger (314,123 sq ft) due to more spacious accommodations and higher living standards. In the hangar category, MILCON's average size (137,773 sq ft) is driven by specific requirements for military aircraft storage and maintenance, while private hangars (175,660 sq ft) need to accommodate a variety of private aircraft and related activities. Medical facilities show similar sizes, with MILCON at 157,961 sq ft and private at 160,583 sq ft, suggesting comparable space requirements with additional amenities in the private sector. The misc category has smaller MILCON facilities (32,622 sq ft) versus larger private facilities (119,520 sq ft). Lastly, physical fitness facilities are much smaller in MILCON (36,208 sq ft) reflecting functional, standardized spaces, whereas private facilities (438,170 sq ft) are significantly larger, providing extensive fitness and recreational amenities occasionally catering to professional athletes. Overall, private facilities tend to be larger across most categories, particularly in dorm and physical fitness, due to higher standards of living and additional services provided.

Table 4 MCP Investigation Sample by Source and Facility Type (Square Foot/Count, SF/Count)

	Admin	Dorm	Hangar	Medical	Misc	Physical Fitness
MILCON	124,472	115,986	137,773	157,961	32,622	36,208
Private	267,481	314,123	175,660	160,583	119,520	438,170

Table 5 MCP Investigation Sample by Source (Parking Spaces)

Spaces	Parking
MILCON	3,270
GlobalData	1,420
MSI	1,850
Private	76,586
GlobalData	75,386
MSI	1,200
Grand Total	79,856

Table 6 MCP Investigation Sample by Source and Facility Type ($Millions, USD)

Final Normalized Adjusted Building Cost ($Millions)	Admin	Dorm	Hangar	Medical	Misc	Parking	Physical Fitness	Grand Total
MILCON	$ 8,630	$1,534	$6,276	$3,965	$ 144	$ 174	$ 94	$20,817
GlobalData	$ 2,118	$ -	$ 149	$ 251	$ -	$ 108	$ -	$ 2,626
MSI	$ 6,376	$ 680	$6,064	$3,713	$ -	$ 66	$ 94	$16,994
NAVFAC	$ -	$ 232	$ -	$ -	$ -	$ -	$ -	$ 232
USACE	$ 102	$ 266	$ -	$ -	$ 94	$ -	$ -	$ 462
USAF	$ 34	$ 356	$ 63	$ -	$ 50	$ -	$ -	$ 503
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Private	$ 4,086	$2,331	$ 231	$ 980	$ 909	$3,727	$ 1,885	$14,148
GlobalData	$ 3,584	$2,331	$ 231	$ 939	$ 909	$3,689	$ 1,885	$13,567
MSI	$ 502	$ -	$ -	$ 40	$ -	$ 39	$ -	$ 581
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Grand Total	$12,716	$3,865	$6,507	$4,944	$1,053	$3,901	$ 1,979	$34,965

In Table 7 MCP Investigation Sample by Source and Facility Type ($/Square Foot, $/SF we take a first look at the MCP ($/SF) as per Equation 2 MILCON Cost Premium (MCP) USD$/SF Calculation. When focusing on dorms, the data reveals that MILCON facilities have a higher average normalized cost per square foot ($474.39) compared to private facilities ($281.86). This quantitative difference and the qualitative research on the MILCON process confirms that MILCON dorms are more expensive and involve more specialized construction standards and materials, reflecting the specific needs of military personnel.

Beyond dorms, MILCON facilities generally have higher simple average costs per square foot in categories such as admin, hangar, and medical, indicating the specialized infrastructure and operational requirements of military facilities. In contrast, private facilities tend to have lower simple average costs per square foot across most categories except misc which is a loosely defined category. Physical fitness facilities are significantly more expensive which could be an indication of a need for larger sampling. Overall, the differences in simple average costs per square foot highlight the varying priorities and construction standards of MILCON versus private sector operations. Simple average takes the average $/SF of each category and is not weighted by size.

Table 7 MCP Investigation Sample by Source and Facility Type ($/Square Foot, $/SF, simple average)

Average Final Normalized Adjusted Building Cost ($/SF)	Admin	Dorm	Hangar	Medical	Misc	Physical Fitness	Grand Total
MILCON	$ 748.70	$ 474.39	$ 846.41	$ 934.20	$ 610.78	$ 1,124.75	$ 771.55
GlobalData	$ 633.08		$ 547.44	$ 840.71			$ 674.28
MSI	$ 778.54	$ 436.74	$ 847.60	$ 945.54		$ 1,124.75	$ 812.53
NAVFAC		$ 493.79					$ 493.79
USACE	$ 438.21	$ 498.57			$ 517.14		$ 484.64
USAF	$ 801.19	$ 517.26	$ 1,020.70		$ 727.83		$ 720.07
Private	$ 531.52	$ 281.86	$ 445.40	$ 708.46	$ 775.47	$ 496.46	$ 501.30
GlobalData	$ 528.04	$ 281.86	$ 445.40	$ 718.76	$ 775.47	$ 496.46	$ 498.20
MSI	$ 558.49			$ 595.18			$ 565.83
Grand Total	$ 694.40	$ 374.81	$ 829.46	$ 878.92	$ 704.89	$ 590.70	$ 689.50

The total sample represented very few outliers when measured in $/SF with only a single outlier in dorms at $798/SF and misc at $1,702/SF indicating most samples followed a normal distribution and shown in Figure 7 Total Sample Distribution (Private and MILCON, Normalized Adjusted $/SF).

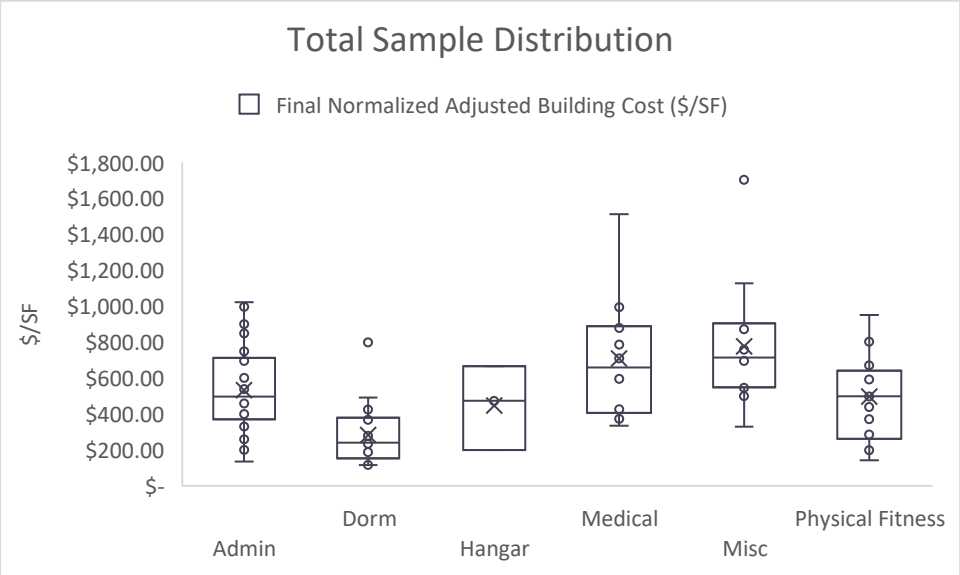


Figure 7 Total Sample Distribution (Private and MILCON, Normalized Adjusted $/SF)

Similarly, MILCON facilities were evenly distributed with some exception for admin facilities shown in Figure 8 Final Normalized Adjusted Building Cost Sample Distribution (MILCON, $/SF).

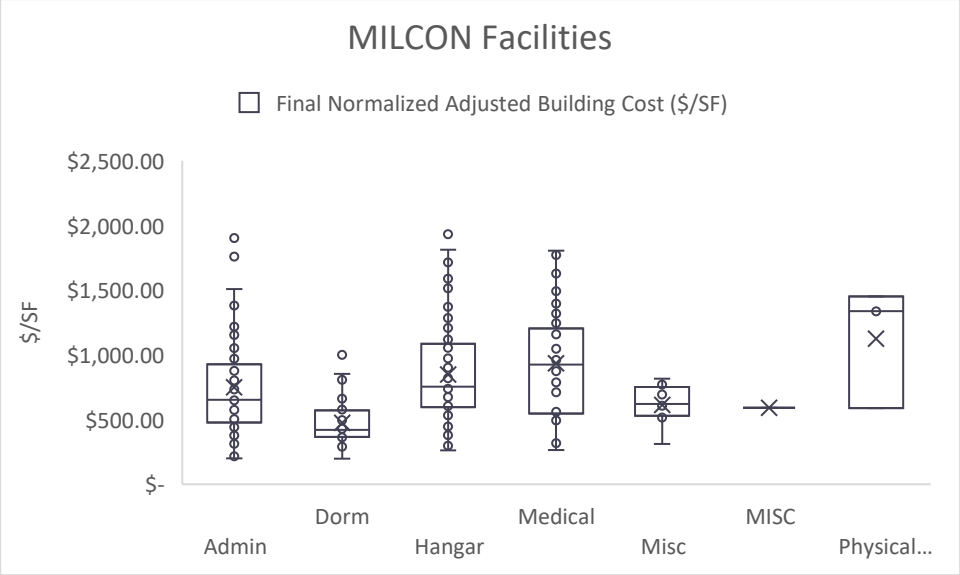


Figure 8 Final Normalized Adjusted Building Cost Sample Distribution (MILCON, $/SF)

Private facilities were normally distributed with two outliers: one in dorms and the other in misc as shown in Figure 9 Final Normalized Adjusted Building Cost Sample Distribution (Private, $/SF).

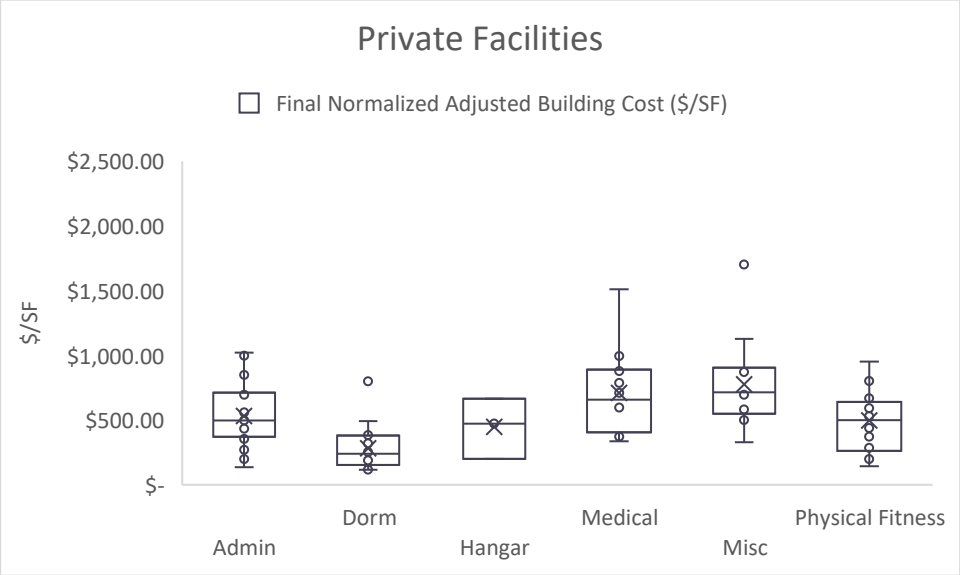


Figure 9 Final Normalized Adjusted Building Cost Sample Distribution (Private, $/SF)

When assessing the sample for final normalized adjusted building cost the MILCON samples were skewed higher than the normal distribution indicating some facilities fell outside the normal distribution in total cost as shown in Figure 10 Final Normalized Adjusted Building Cost Sample Distribution (MILCON,

$), though the values fell into a normal distribution in $/SF terms shown in Figure 8 Final Normalized Adjusted Building Cost Sample Distribution (MILCON, $/SF).

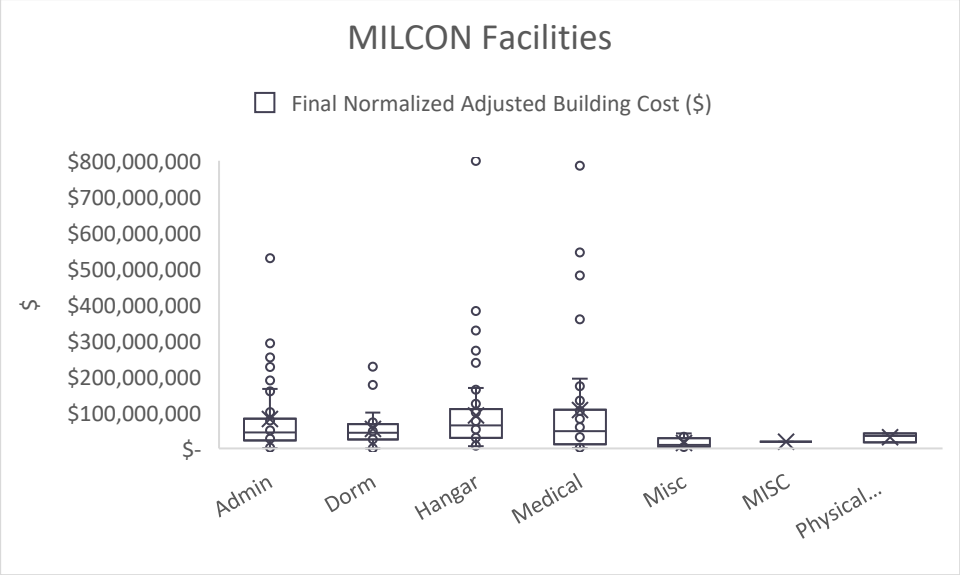


Figure 10 Final Normalized Adjusted Building Cost Sample Distribution (MILCON, $)

Similarly for private facilities there were some outliers toward the top of the distribution shown in Figure 11 Final Normalized Adjusted Building Cost Sample Distribution (Private, $), though not to the extent of MILCON.

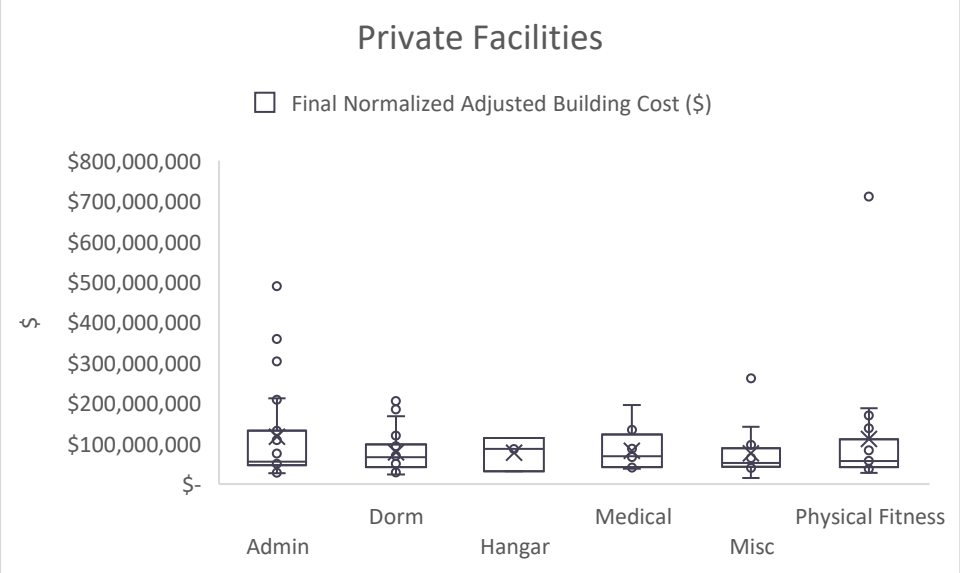


Figure 11 Final Normalized Adjusted Building Cost Sample Distribution (Private, $)

Overall, the data indicates that the total building cost tends to fall outside of a normal distribution, but when we investigate the values on a $/SF basis shown in Figure 7 Total Sample Distribution (Private and

MILCON, Normalized Adjusted $/SF), values fall within a normal distribution indicating a valid sample set for analysis.

Additional analysis carried out on the dorm sample indicated that there was a positive relationship in total construction cost to square footage in both the MILCON and private dorm categories shown in Figure 12 MILCON Dorms Building Cost to SF and Figure 13 Private Dorms Building Cost to SF which was anticipated. The R^2 values of 0.6238 in MILCON and 0.4755 in Private suggest a better fit to MILCON when assessing the relationship between size and cost. However, the slope of the MILCON line indicates that prices increase faster with larger size when compared to Private construction. When comparing Dorms on a $/SF basis there was little inference in a larger MILCON facility, whereas in the Private sector the economy of scale value was apparent as shown in Figure 14 MILCON Dorms $/SF to SF, Figure 15 Private Dorms $/SF to SF, Figure 16 Private Dorms Building Cost to SF (Outliers Removed), and Figure 17: Private Dorms $/SF to SF (Outliers Removed).

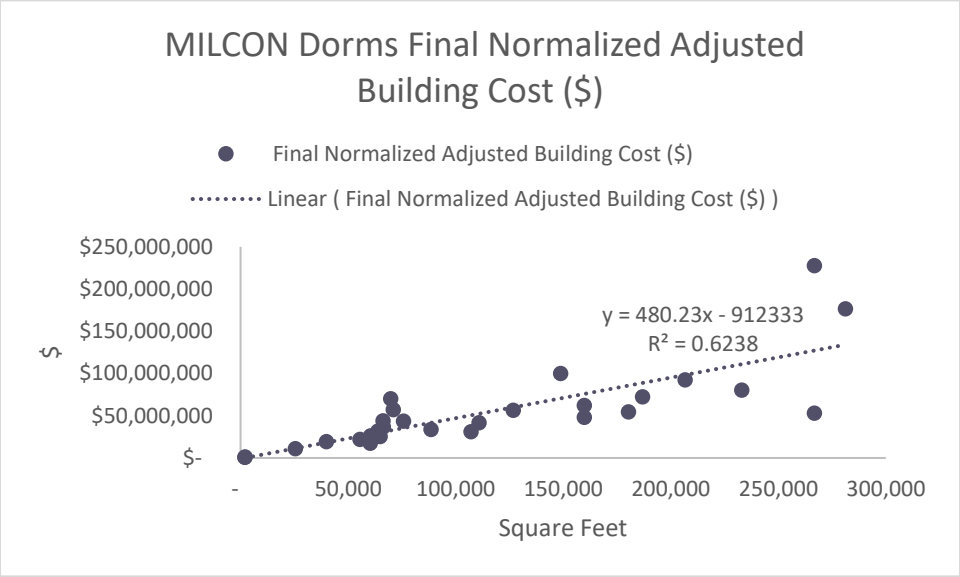


Figure 12 MILCON Dorms Building Cost to SF

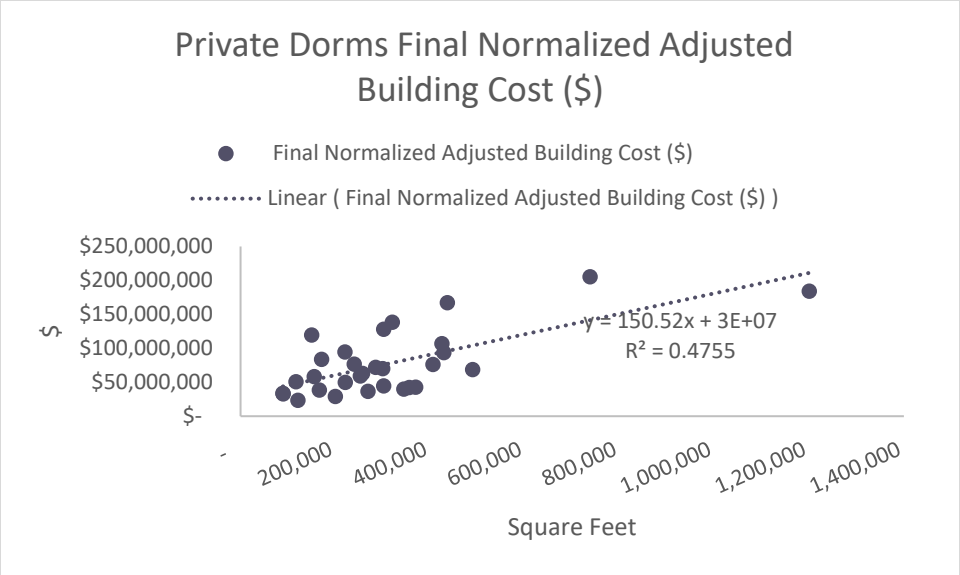


Figure 13 Private Dorms Building Cost to SF

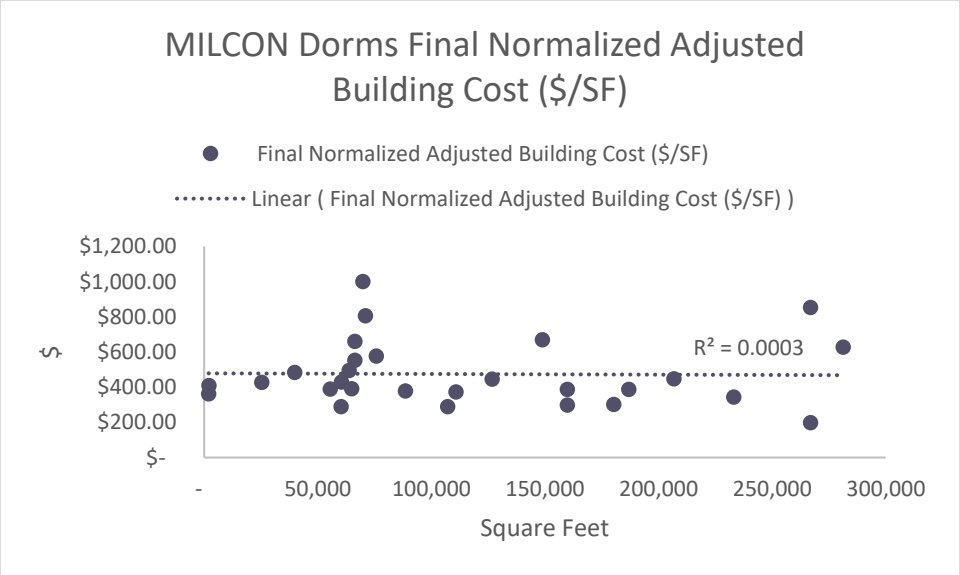


Figure 14 MILCON Dorms $/SF to SF

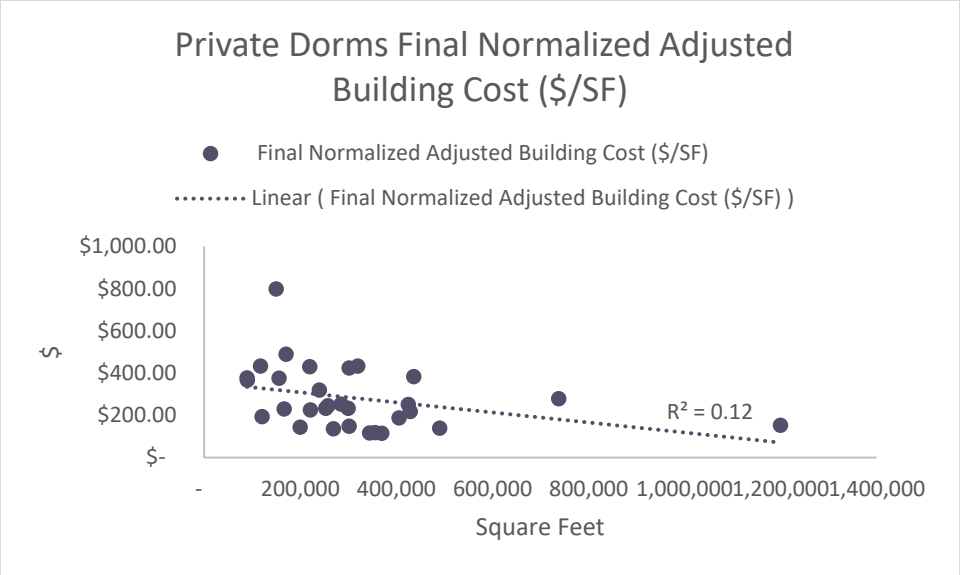


Figure 15 Private Dorms $/SF to SF

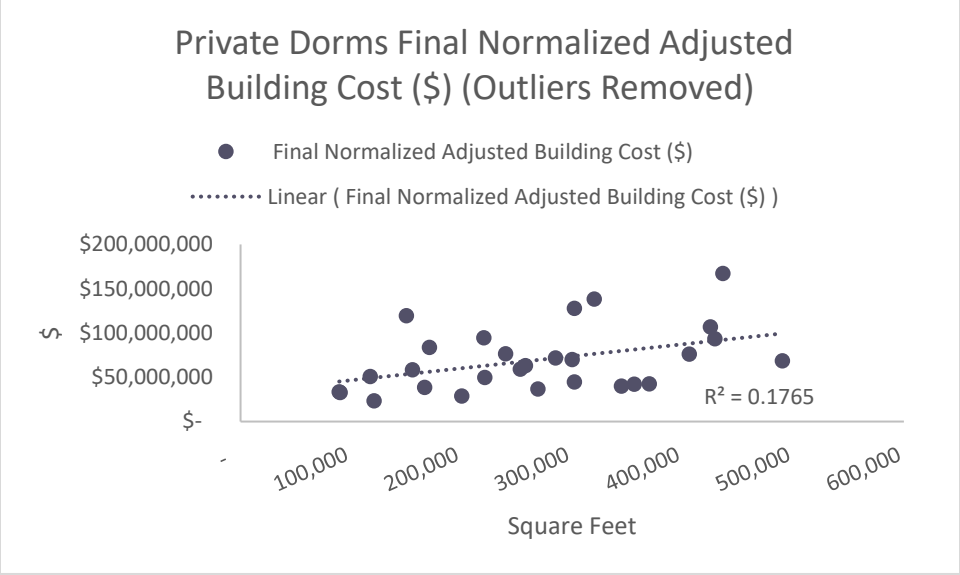


Figure 16 Private Dorms Building Cost to SF (Outliers Removed)

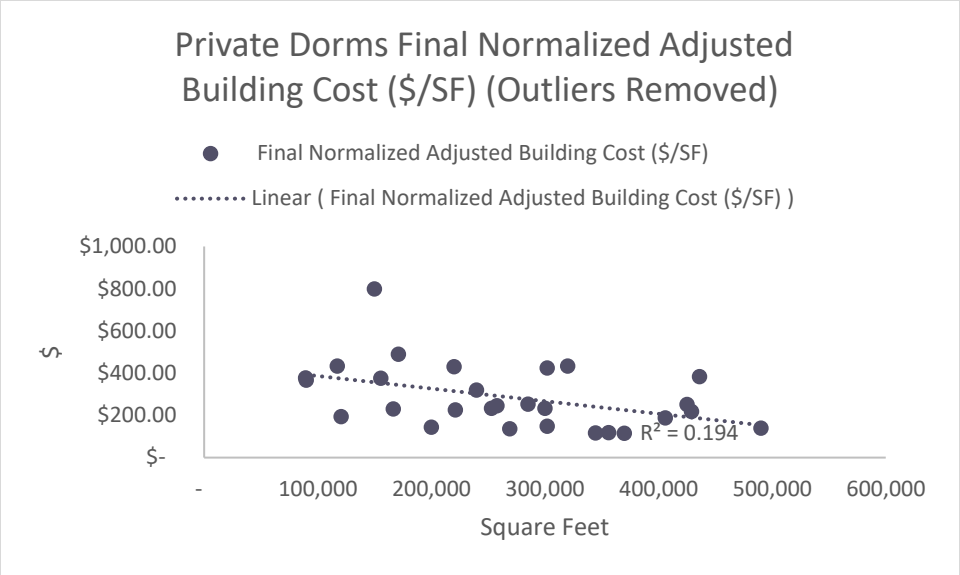


Figure 17: Private Dorms $/SF to SF (Outliers Removed)

Table 8 MCP Investigation Sample by Source (Parking, $/Space, simple average) characterized the parking facility data which showed there was a general increase in private versus MILCON construction. GlobalData projects indicated a higher overall $/Space, further investigation is warranted.

Table 8 MCP Investigation Sample by Source (Parking, $/Space, simple average)

Average Final Normalized Adjusted Building Cost ($/Space)		Parking
MILCON	$	48,398
GlobalData	$	76,015
MSI	$	34,589
Private	$	57,036
GlobalData	$	57,726
MSI	$	32,199
Grand Total	$	56,388

5.2.6 Base Contract: Dorms MCP

Both Figure 18 UHPP/Dorms/Barracks Average Final Normalized Adjusted Building Cost ($/SF) and Table 9 UHPP/Dorms/Barracks Average Final Normalized Adjusted Building Cost ($/SF, MCP$, MCP%) show the final calculated MCP for dorms. Costs have been adjusted for location and inflation and normalized for non-MILCON features as discussed in Administrative and Installed Characteristic Quantification. The MCP as deduced in this analysis is $192.53/SF or a premium of 68.31%. Table 11 MCP Components and Comparative Statistics (Dorms) highlights the specific Administrative and Installed components that have contributed to the sample MCP as well as ranges characteristic of facilities in this analysis.

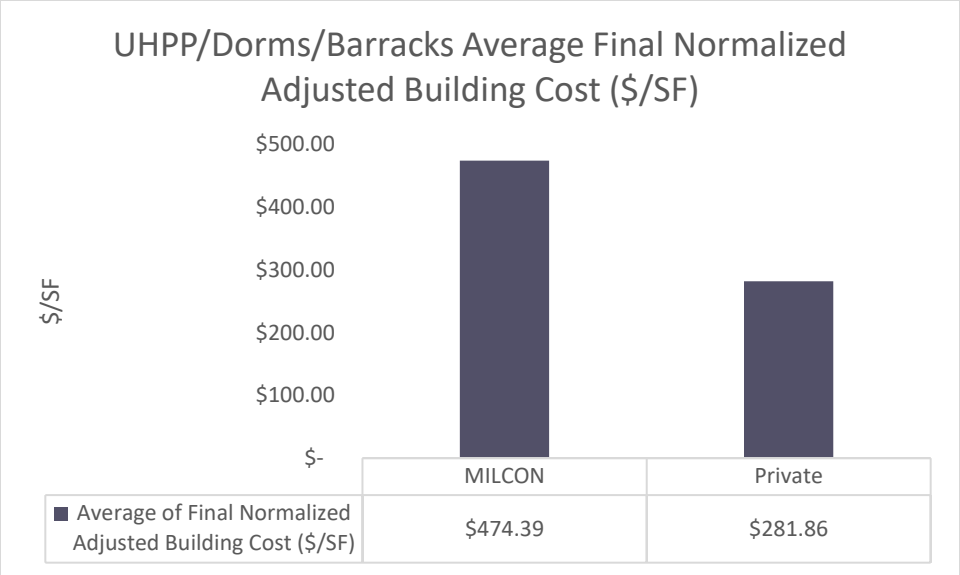


Figure 18 UHPP/Dorms/Barracks Average Final Normalized Adjusted Building Cost ($/SF)

Table 9 UHPP/Dorms/Barracks Average Final Normalized Adjusted Building Cost ($/SF, MCP$, MCP%)

Average of Final Normalized Adjusted Building Cost ($/SF)	MILCON	Private	Calculated Sample MCP ($/SF):	Calculated Sample MCP (%):
Dorm	$ 474.39	$ 281.86	$ 192.53	68.31%

Table 10: UHPP/Dorms/Barracks Average Final Normalized Adjusted Building Cost ($/SF, Mean & Median)

	Unweighted $/SF	
	Mean	Median
MILCON	$ 474.39	$ 418.93
Private	$ 281.86	$ 239.20
Total	$ 374.81	$ 374.51

The distribution of dorm facilities as shown in Figure 19 MCP Investigation Dorm Location Map indicates that for the majority of the continental US MILCON and private construction are well represented. However, MILCON facilities in Alaska and Hawaii pose challenges to analysis. This was mitigated by applying PAX 3.2.1 Area Cost Factors and characterized in the PAX 3.2.1 Area Cost Factors section.

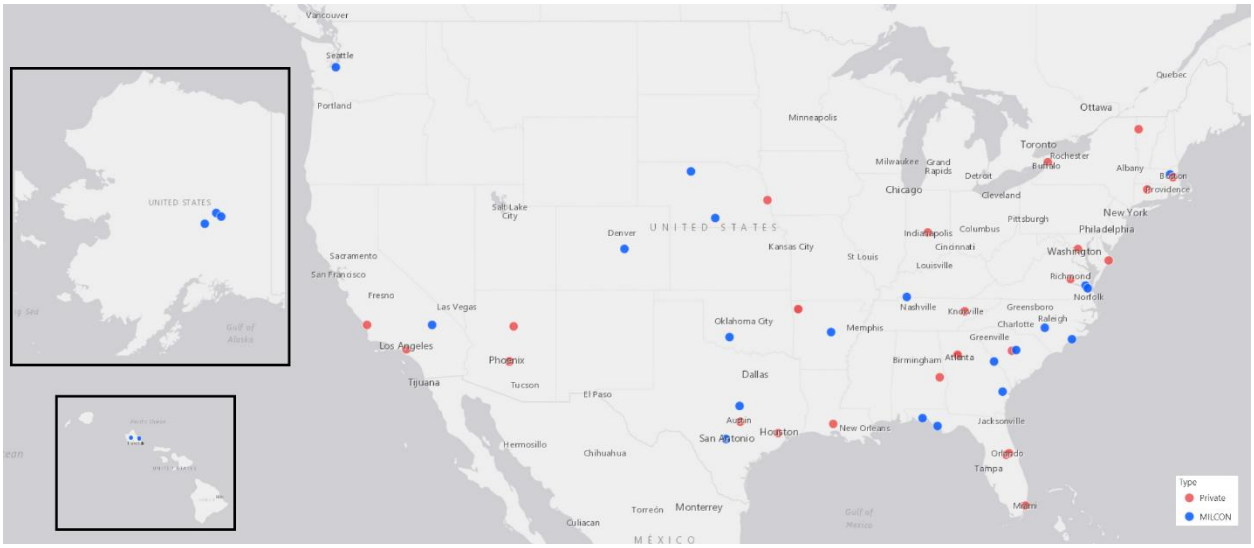


Figure 19 MCP Investigation Dorm Location Map

5.2.6.1 *Dorm MCP Components Analysis*

For ease of reading, analysis discussion follows Table 11 MCP Components and Comparative Statistics (Dorms).

Table 11 MCP Components and Comparative Statistics (Dorms)

MILCON Cost Premium (MCP) Components as Percent of Total Construction Cost (Dorms)

	MCP Administrative Components	Private			MILCON			Component
		Minimum	Average	Maximum	Minimum	Average	Maximum	MCP
Legal	Federal Contracting Requirements	-	-	-	-	-	-	-
	Sustainability/Energy Standards	0.0%	1.5%	9.2%	2.2%	2.2%	2.2%	0.7%
	Labor Requirements	0.0%	0.0%	0.0%	5.0%	22.0%	30.0%	22.0%
	Bonding/Insurance Requirements	1.4%	3.5%	6.6%	2.0%	2.0%	2.0%	-1.5%
	Approvals/Funding/Authorizations	-	-	-	-	-	-	-
	A/E/C Selection/Contracting Process	-	-	-	-	-	-	-
Regulatory	AT/FP/Security Factor	3.0%	3.3%	3.7%	5.0%	5.0%	5.0%	1.7%
	Design Requirements*	2.0%	4.0%	4.9%	5.0%	5.0%	5.0%	1.0%
	Base Security/Access Requirements	0.0%	0.0%	0.0%	5.0%	5.0%	5.0%	5.0%
	Subcontracting Goals	0.0%	0.5%	7.1%	10.0%	10.0%	10.0%	9.5%
	Planning/Scoping Process	0.2%	0.2%	0.4%	1.0%	1.0%	1.0%	0.8%
Guidance & Other	Special Staffing Requirements	0.0%	0.0%	0.1%	0.5%	0.5%	0.5%	0.5%
	Multiple Decision Makers/Stakeholders	-	-	-	-	-	-	-
	Limited Procurement Options	0.0%	0.0%	0.0%	3.0%	3.0%	3.0%	3.0%
	Dynamic Requirements	-	-	-	-	-	-	-
	Logistics	-	-	-	-	-	-	-

Approximate Total Administrative MCP Contribution: 41.6% [1]

	MCP Installed Components	Private			MILCON			Component
		Minimum	Average	Maximum	Minimum	Average	Maximum	MCP
Installed Components	Finishes %	11.9%	12.9%	15.4%	4.0%	7.5%	16.5%	-5.4%
	MEP %	29.4%	33.0%	38.9%	21.8%	38.8%	52.0%	5.8%
	HVAC %	6.7%	9.9%	14.7%	6.1%	14.3%	20.8%	4.4%
	Structural %	7.7%	14.4%	24.8%	8.5%	16.7%	35.4%	2.2%
	Interior Construction %	8.2%	8.7%	13.9%	4.8%	11.9%	22.2%	3.3%
	Exterior Closures %	9.5%	12.2%	18.5%	5.2%	10.5%	17.1%	-1.8%

Approximate Total Installed Component Dorm MCP Contribution: 8.6% [2]

Combined Administrative and Installed Total Explained Dorm Component Sample MCP: **50.3%** [3]

Dorm MCP: **68.3%** [4]

Remaining Unexplained MCP: 18.1% [5]

Notes: 1 - Administrative Component of MCP, 2 - Installed Component of MCP, 3 - Combined Administrative and Installed Components of MCP, 4 - Calculated MCP ($/SF), 5 - Remaining uncalculated MCP, may be explained through unknowns
*Not included in total MCP Component calculation due to significant overlap
Indicates controllable Administrative Component

Table 11 MCP Components and Comparative Statistics (Dorms) characterizes the overall analysis of MCP by both Administrative components and Installed components as a total percent of Final Normalized Adjusted construction cost. For some Administrative categories there was not a quantifiable value and those have been left blank. Additionally, to mitigate redundancy Design Requirements have been assessed but not accounted for in the Administrative MCP Contribution or combined calculations.

5.2.6.1.1 Variation

While there was significant variation in Administrative components in private construction, the team did not find significant variation in MILCON. Specifically, sustainability standards, and those within the Regulatory category. In these categories there were no identified outliers that exceeded the ranges described in Appendix I – Administrative Component Factor Tables. Additional data from the MILCON data set may have increased this range, but the consistency of approach in these categories is reflected in the null variation. Outliers for MILCON such as those with historical presentation requirements were not identified. Specifically, when the sample for MILCON barracks was carried out the function and form were consistent, and the team did not identify any outliers with significant AT/FP, PLA, or historical preservation features. If those items were within the sample, they would likely have increased the MCP and in future research normalizing for those factors out with create a consistent sample.

5.2.6.1.2 Observations

As a result of our analysis we have deduced that on average 41.6% of the cumulative MCP discussed in Table 9 UHPP/Dorms/Barracks Average Final Normalized Adjusted Building Cost ($/SF, MCP$, MCP%) can be attributed to Administrative components from legal, regulatory, or guidance, while 8.6% of the overall MCP can be attributed to the Installed characteristics of facilities. Ranges have been provided from the sample and highlight that both private and MILCON have to contend with varying degrees of administrative burden.

Observations recorded in Administrative Components in Table 11 MCP Components and Comparative Statistics (Dorms) indicate that sustainability standards minimally impact MCP. Despite the Army's Climate strategy[49] (referenced in the Purpose Summary section), current sustainability standards (LEED Silver) are not major MCP factors. Bonding requirements, which can exceed MILCON standards in some jurisdictions showed a negative contribution to MCP. The largest contribution to MCP is labor, constrained by federal labor laws and regulations, as detailed in the Project Labor Agreements (PLAs)/Wage Determination section, detailed further in the Labor Requirements (Davis-Bacon Act, Legal Status, etc.) section, and characterized quantitatively in the Labor Requirements section in Appendix I – Administrative Component Factor Tables. Labor markets for construction are already significantly constrained[50,51] and various laws and regulations have compounded that issue for the MILCON process.

Further analysis of Installed Components in Table 11 MCP Components and Comparative Statistics (Dorms), indicates that mechanical, electrical, and plumbing (MEP) components contribute the most to MCP. As detailed in the Life-Cycle Analysis and Quality-of-Life Risks Assessment sections there are

[49] https://www.army.mil/e2/downloads/rv7/about/2022_army_climate_strategy.pdf
[50] Addressing the US construction labor shortage | McKinsey
[51] Labor Report Shows Dire Need for New Construction Workers | NAHB

differing selection criteria for these components that are derived from the life cycle cost. Private industry prioritizes a shorter time horizon for facilities, while MILCON targets a longer life with marginally lower maintenance costs. The difference in heating, ventilation, and air-conditioning (HVAC) is also a large contributor to MCP. An interesting characteristic of this contribution is that private industry has been assessed by the team to prefer individual HVAC units in each dwelling unit, wherein MILCON typically utilizes a centralized heating and cooling generation system for the entire facility, which adds to up-front cost per unit. Finishes in private construction provided a discount to MCP as private construction markets value finishes more than MILCON to entice students. Similarly, discounts were provided to MCP from exterior finishes which came as a surprise given the specific MILCON requirements of exterior finishing. Ultimately, we concluded that a larger window area in private construction, especially with curtain wall systems in high rise structures (20 floors or more), was the single largest contributor to that factor.

5.2.6.1.3 Balancing Components

Balancing accuracy and detail is crucial in complex analyses. MSI provided detailed MCP information while ensuring overall accuracy. Administrative and Installed components overlap, as shown in Figure 4 MILCON Cost Premium (MCP) Component Subdivision. To reduce this, we excluded Design Requirements. Summing the average categories in Table 11 MCP Components and Comparative Statistics (Dorms), resulted in total construction costs exceeding 100% (104.1% for private and 155.3% for MILCON). Despite no standard convention, MSI showed the full accounting for the 68.3% dorm MCP in the data sample to account for the full gross up from Administrative and Installed components.

To break down the MCP components, we combined Administrative (41.6%) and Installed (8.6%) components, totaling 50.3%, and leaving 18.1% unexplained. Figure 20 Explained vs Unexplained Dorm MCP shows this breakdown. The unexplained portion likely comes from unquantifiable Administrative Components like Federal Contracting Requirements and Approvals/Funding/Authorizations. With more data, we could reduce the overlap and account for 100% of the building cost. MSI has provided the most detailed analysis possible with the available data.

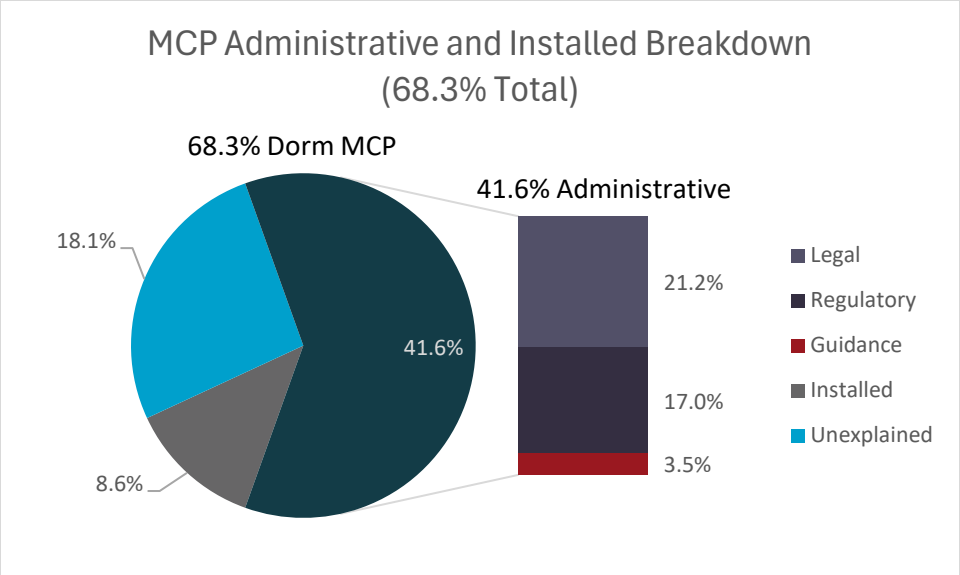


Figure 20 Explained vs Unexplained Dorm MCP

5.2.6.1.4 Additional Considerations

While the scope of analysis was thoroughly investigated for dorms, the additional facilities included in the wider study presented complexities to deeper analysis shown in Table 11 MCP Components and Comparative Statistics (Dorms). Size and cost variation as well as significant functional differences were For these reasons, a deeper investigation was limited to dorms.

5.2.7 Option 1 Contract: Other Facilities MCP

As shown in Figure 21 Average Final Normalized Adjusted Building Cost by Facility Type ($/SF), all facility categories except for misc showed that private was cheaper to construct than MILCON. As noted in the Data Characterization section, the physical fitness facilities are likely skewed by quantity of facilities and some differing use characteristics. Similarly, private hangar quantity limited analysis in addition to differing use characteristics. Administrative facilities show the highest MCP at 126.6% though this may be erroneous. Similarly, misc structures indicate a negative MCP, though again this category is somewhat nebulous and may be weighted toward one specific type of facility versus another. For the rest of the categories (admin, dorm, and medical) results met expectations and reflected a range of premiums with the lowest in medical at 31.9% and the highest in hangars at 90.0% (again, the use case is skewed by quantity of data and function). These values are further detailed in Table 12 Average Final Normalized Adjusted Building Cost by Facility Type ($/SF, MCP$, MCP%) and summarized in Figure 21 Average Final Normalized Adjusted Building Cost by Facility Type ($/SF).

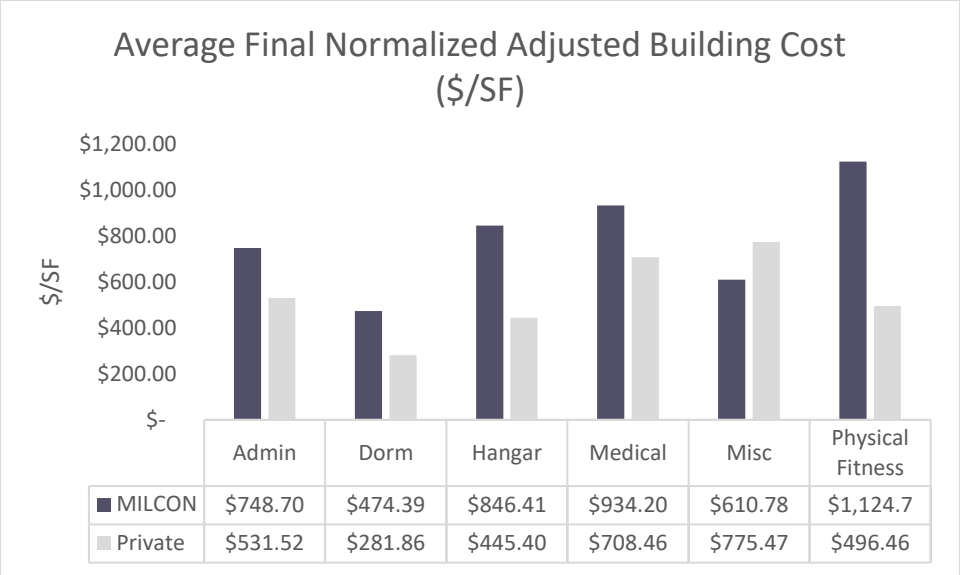


Figure 21 Average Final Normalized Adjusted Building Cost by Facility Type ($/SF)

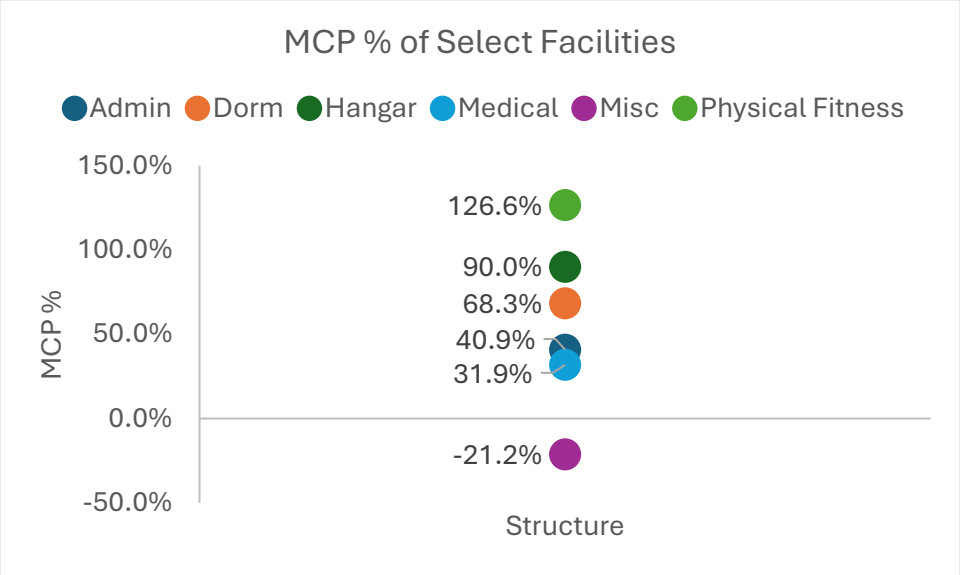


Figure 22 Average Final Normalized Adjusted Building Cost by Facility Type (MCP %)

Table 12 Average Final Normalized Adjusted Building Cost by Facility Type ($/SF, MCP$, MCP%)

Average of Final Normalized Adjusted Building Cost ($/SF)	MILCON	Private	Average	MCP ($/SF)	MCP (%)
Admin	$ 748.70	$ 531.52	$ 694.40	$ 217.17	40.86%
Dorm	$ 474.39	$ 281.86	$ 374.81	$ 192.53	68.31%
Hangar	$ 846.41	$ 445.40	$ 829.46	$ 401.01	90.03%
Medical	$ 934.20	$ 708.46	$ 878.92	$ 225.75	31.86%
Misc	$ 610.78	$ 775.47	$ 704.89	$ (164.69)	-21.24%
Physical Fitness	$ 1,124.75	$ 496.46	$ 590.70	$ 628.30	126.56%

Detailed in Figure 23 MCP Investigation Option 1 Facilities Location Map, facilities within the continental US were mainly able to offset regional biases. There are some differences in the Midwest and similar to dorms, there may be some biases for Alaska and Hawaii, but the location normalization was applied to mitigate these effects.

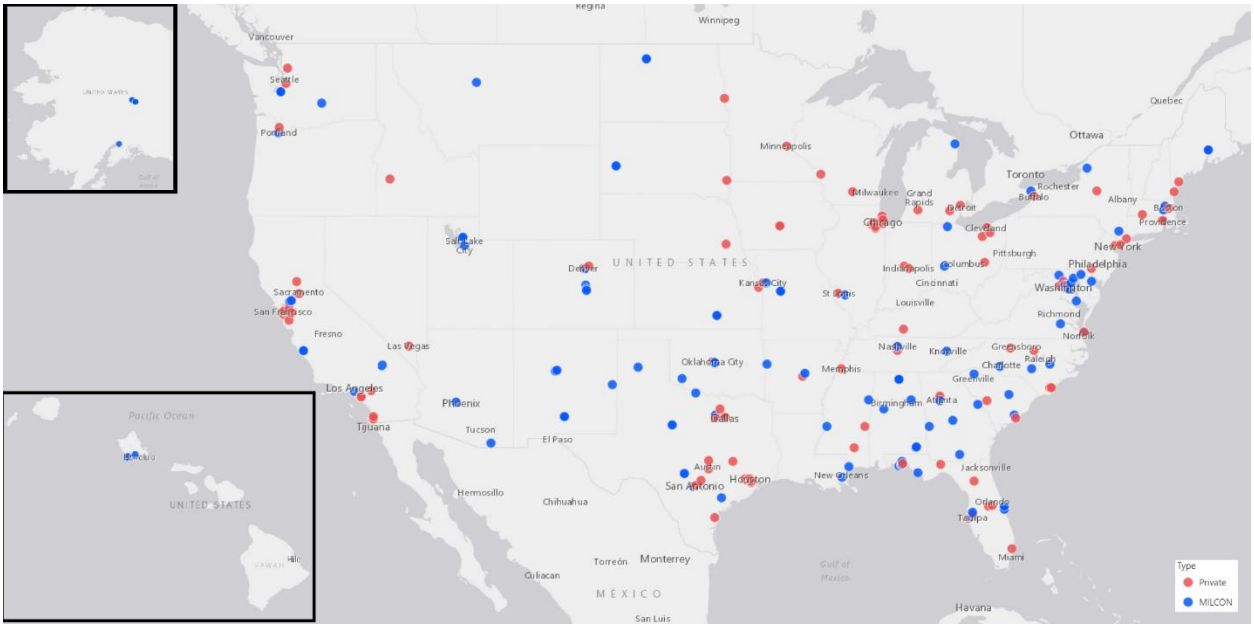


Figure 23 MCP Investigation Option 1 Facilities Location Map

Shown in Figure 24 Average Final Normalized Adjusted Building Cost (Parking, $/Space), private parking facilities had a higher overall cost than MILCON. There are a few reasons for this outside of the quantity of facilities assessed as discussed in the Data Sourcing and Criteria, wherein it was stated that there were fewer MILCON facilities assessed versus private. One potential explanation for this difference is that in private construction these are often built in dense urban areas with limited access for concrete trucks, labor parking, and functioning buildings in closer proximity that must be accommodated. MILCON facilities planning and land availability are often more easily mitigated in this space.

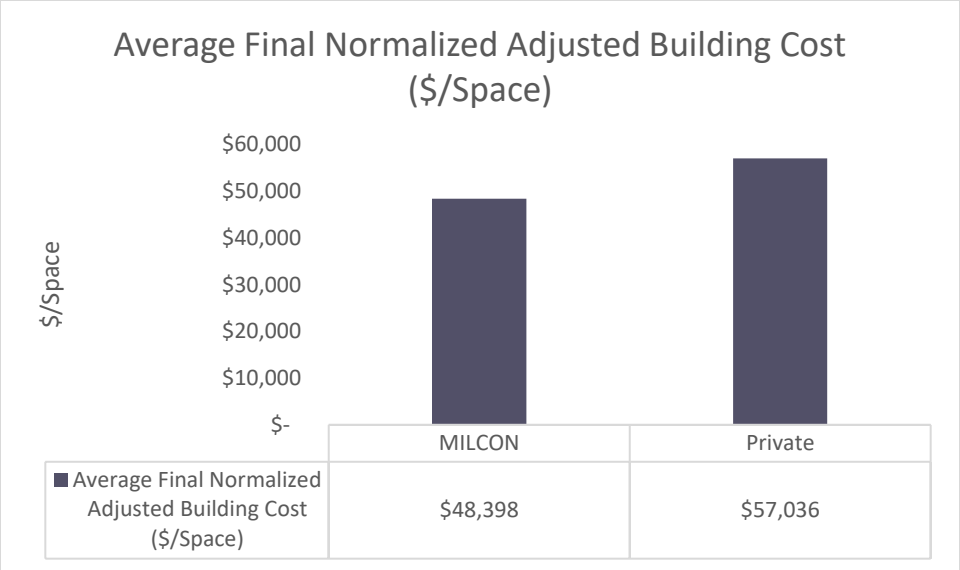


Figure 24 Average Final Normalized Adjusted Building Cost (Parking, $/Space)

5.3 MCP Data Analysis Conclusions

As a result of this investigation, MSI was able to conclude the following:

- MILCON UHPP/barracks were constructed at a premium to their private counterpart, dormitories on average by 68.3%
    - MILCON barracks were smaller and more expensive to construct
    - Both MILCON and Private dorms suffered from cumulative statistics which led to outliers. MSI expects this to be the case for any construction as specific location requirements dictate construction (historical preservation, robust HVAC requirements, additional security, etc.)
- Of the 68.3% MCP in Dorms, 50.2% was able to be quantified into Administrative and Installed components
    - 41.6% was attributable to Administrative components (legal, regulatory, guidance)
    - 8.6% was attributable to Installed components
    - The remaining 18% can be reasonably attributed to factors such as Federal Contracting requirements, Approvals/Funding/Authorizations, AEC Selection/Contracting process, Multiple Decision Makers/Stakeholders, Dynamic Requirements, and Logistics, but were unable to be quantified in this study
- MILCON facilities were generally more expensive
    - Research concluded a high degree of confidence of MCP in robust data categories (admin, dorms & medical); between 30-68%
    - There was a weak correlation between other categories (hangar, medical, misc, physical fitness); additional data and studies would further refine MCP in these categories.
    - Parking facilities were shown to be at a discount, but factors such as civil workings, location, and type of construction compounded with a constrained sample size limited conclusive analysis
- Additional investigation would be expected to positively conclude that although MCP was generally higher; the total life-cycle cost would be lower due to specific focus in MILCON portfolio
- MCP increased from 2013 L3 study from ~35% to 68% for Dorms/barracks due to market factors and revised methodology

6 Areas for Further Study

To build upon the findings of this study, several avenues for further research and analysis may shed more light on MCP:

1. Sustainability Features Extension

Given the existing focus on sustainability features, this topic can be explored in greater depth. This would involve:

- Detailed analysis of the cost implications of incorporating advanced sustainability features in barracks construction.
- Comparison of long-term operational savings versus initial investment costs.
- Evaluation of the impact of sustainability features on the overall life-cycle costs and environmental benefits.

2. Impact of Technological Advancements

Investigate the role of emerging technologies in reducing construction costs and improving efficiency. This could include:

- Use of modular construction techniques.
- Implementation of Building Information Modeling (BIM) for better project planning and execution.
- Adoption of smart building technologies to enhance operational efficiency and reduce maintenance costs.

3. Longitudinal Study on Cost Trends

A longitudinal study to track cost trends over time, considering factors such as inflation, changes in material costs, and evolving construction practices. This would help in:

- Understanding long-term cost trends and their drivers.
- Predicting future cost trajectories for better budgeting and planning.
- Evaluating the effectiveness of cost-saving measures implemented over time.

By pursuing these continuation options, the study can provide a more comprehensive understanding of the factors influencing construction costs and offer actionable insights for optimizing Federal construction projects.

4. Specific Labor Requirements

Additional labor requirements are likely to factor into MCP such as the requirements for extensive background checks, drug-free workplace, etc. A limited worker pool for DoD projects would be expected to increase the cost of construction. Determining the impacts would further enhance the understanding of MCP.

7 Recommendations

Based on investigations of controlled, uncontrolled, and real-world case studies this report provides the following recommendations. These suggestions may be currently in practice but expanding them with the aim to streamline the MILCON process and reduce the MILCON Cost Premium (MCP) is advisable.

- **Focus on Controllable Factors**:
    - Prioritize managing factors within control while understanding the limits of uncontrollable factors. Working within the immediate DoD confines while challenging status quo is critical to driving change within any organization.
- **Enhance Planning and Cost Estimation**:
    - Reference qualified cost estimators to better handle Project Labor Agreements (PLAs) and wage determinations.

    - Follow-up on estimations once construction is completed to improve the accuracy of qualified estimators. Developing a process that allows a vetted look-back once work is completed.
- **Streamline Procurement Processes**:
    - Reduce costs and improve efficiency by:
        - Expanding procurement options both within the Buy America(n) and international vetted partners.
        - Ensuring compliance with federal regulations as a baseline to supply while supporting smaller suppliers.
- **Apply Private Sector Practices and Review Past Projects**:
    - Mitigate risks and improve outcomes by:
        - Adopting best practices from the private sector such as effective progress meetings, Gantt and baseline planning software, design-build and integrated project delivery, and post-project reviews.
        - Analyzing lessons learned from previous projects and be flexible with workforce and practices where possible. Examples include public-private partnerships and pilot projects to engage additional contractors.
- **Conduct Thorough Post-Project Reviews**:
    - Use reviews to:
        - Identify areas for improvement.
        - Train project managers based on past experiences.
- **Develop Training Programs for Project Managers**:
    - Training for DoD MILCON staff and contractors should focus on:
        - Federal requirements.
        - Cost-saving opportunities.
        - Enhancing overall efficiency and effectiveness.
- **Use Innovative Construction Methods and Materials**:
    - Offset some long-term project costs by:
        - Implementing proven contemporary construction techniques.
        - Utilizing advanced materials to improve life-cycle costs.
- **Quality Management Requirements**:
    - Develop a comprehensive quality management plan that includes clear quality standards, inspection protocols, and continuous improvement processes.
    - Implement a robust training program for all project personnel to ensure adherence to quality standards.
    - Utilize technology, such as quality management software and real-time monitoring tools, to enhance oversight and ensure consistent quality across all projects.
- **Federal Design Requirements – All (including AT/FP)**:
    - Conduct a comprehensive review of current scoping differences due to differing design standards and identify areas where cost-effective alternatives can be implemented without compromising safety or compliance.
    - Develop a set of best practices and guidelines for design optimization that can be applied across projects.
    - Engage with industry experts to explore innovative materials and construction methods that meet federal requirements at a lower cost.
- **Planning and Scoping Process**:

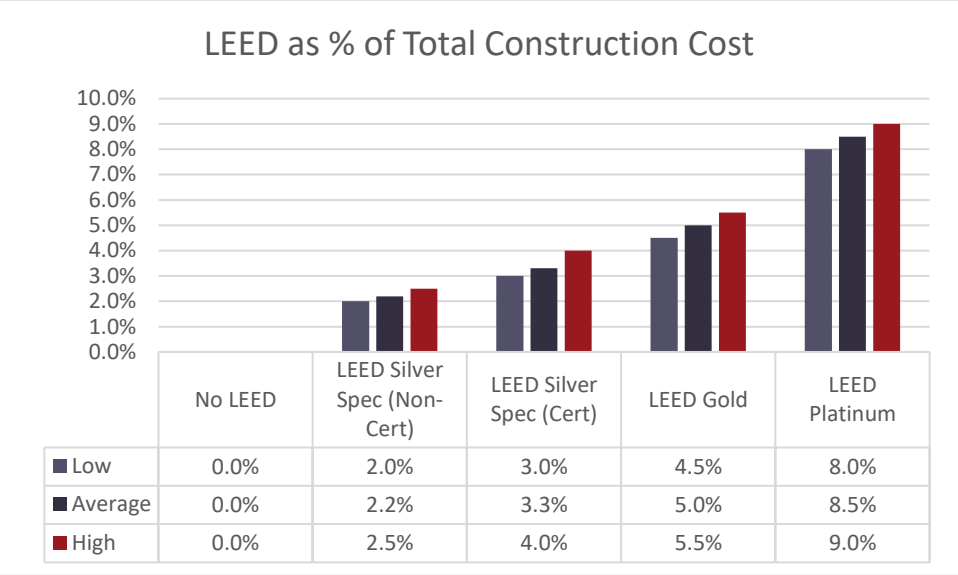
- Define concisely and specifically what is required from each project. Establish clear expectations and assign a dedicated project lead to oversee the planning and scoping process.
- Implement a standardized project management framework that includes detailed planning and scoping templates, regular progress reviews, and stakeholder engagement to ensure alignment and accountability.

By implementing these proposed actions, the DoD can improve the efficiency and cost-effectiveness of its construction projects while maintaining high standards of quality and compliance.

8 Appendix I – Administrative Component Factor Tables

Administrative groups were researched to determine average and range of costs of each component as a percentage of total construction cost. Levels and justification are provided in this appendix though there may be some differences in opinion on exact percentages which is why ranges are provided.

8.1 Leadership in Energy and Environmental Design (LEED)[52,53]



	No LEED	LEED Silver Spec (Non-Cert)	LEED Silver Spec (Cert)	LEED Gold	LEED Platinum
Low	0.0%	2.0%	3.0%	4.5%	8.0%
Average	0.0%	2.2%	3.3%	5.0%	8.5%
High	0.0%	2.5%	4.0%	5.5%	9.0%

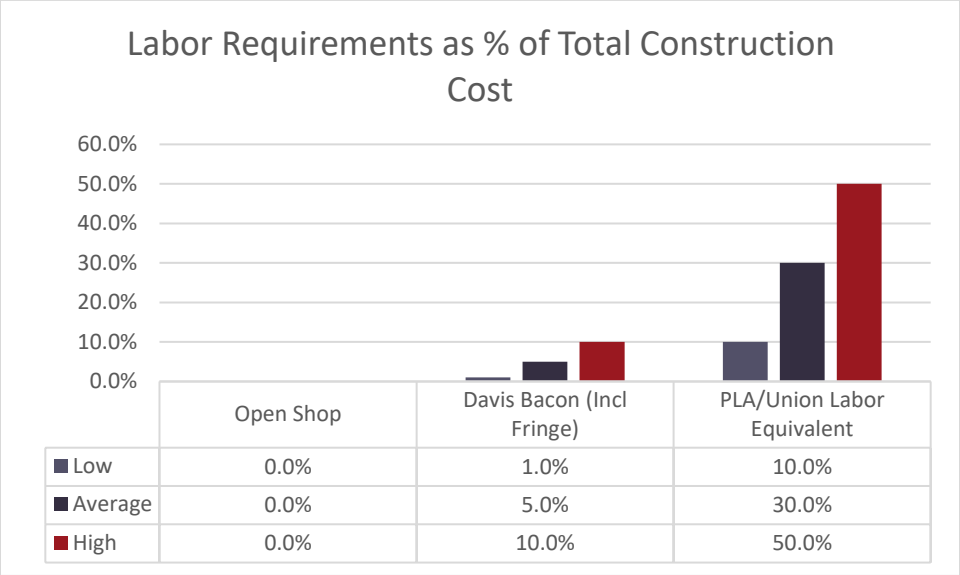
1. **No LEED**: Buildings in this category do not follow any LEED guidelines or sustainable building practices.
2. **LEED Silver Spec (Non-Cert)**: These buildings are designed to meet LEED Silver standards but have not undergone the certification process, incorporating basic sustainable features. Low administrative burden.
3. **LEED Silver Spec (Cert)**: Certified LEED Silver buildings include enhanced energy efficiency, water conservation, and improved indoor environmental quality. Moderate administrative burden.
4. **LEED Gold**: Buildings with LEED Gold certification feature advanced energy and water efficiency, use of sustainable materials, and superior indoor environmental quality. Significant administrative burden.
5. **LEED Platinum**: The highest level of LEED certification, these buildings exemplify the best in sustainable design, including cutting-edge energy and water efficiency, extensive use of renewable

[52] Measuring The Cost To Become LEED Certified - Facilities Management Insights

[53] LEED costs are associated with administrative burden; material and equipment costs are captured in Installed Characteristics

resources, and exceptional indoor environmental quality. Thorough administrative coordination and highest level of burden to cost.

8.2 Labor Requirements[54]



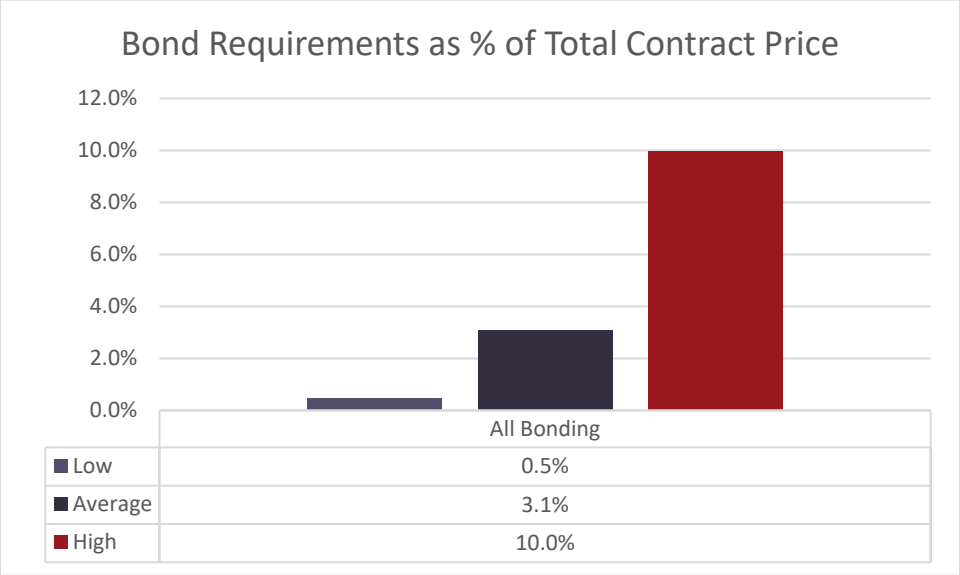
	Open Shop	Davis Bacon (Incl Fringe)	PLA/Union Labor Equivalent
Low	0.0%	1.0%	10.0%
Average	0.0%	5.0%	30.0%
High	0.0%	10.0%	50.0%

1. **Open Shop**: This category includes projects that do not require union labor or specific labor agreements, allowing for more flexible labor practices.
2. **Davis-Bacon (Incl Fringe)**: Projects under this category adhere to the Davis-Bacon Act, ensuring that workers are paid prevailing wages, including fringe benefits, as determined by the Department of Labor.
3. **PLA/Union Labor Equivalent**: These projects operate under Project Labor Agreements (PLAs) or equivalent union labor agreements, ensuring union-scale wages, benefits, and working conditions.

Note: Labor component was "zeroed out" to reduce double counting as much of the labor costs are captured in other components in the study. This differs from other factors where they represent the cost over the entire construction cost. This is in line with MSI's efforts to eliminate double counting of factors.

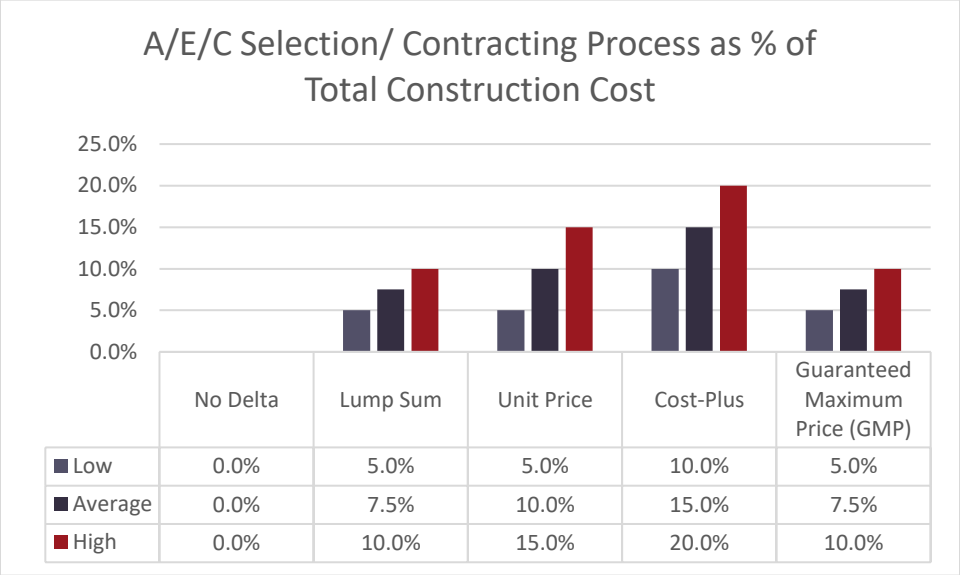
[54] Labor vs material cost in construction: Overview - Bridgit

8.3 Bonding/Insurance



State	Low (%)	Average (%)	High (%)	Reference/ Statute	Notes
MA	1.00%	2.00%	3.00%	Massachusetts General Laws, Chapter 149, Section 29	Performance and payment bonds required for public construction contracts.
AL	1.00%	5.50%	10.00%	Alabama Code Title 39, Chapter 1	Performance and payment bonds required for public works contracts over $50,000.
CA	0.50%	2.75%	5.00%	California Civil Code Section 9550	Required for public works contracts over $25,000.
MD	1.00%	5.50%	10.00%	Maryland Code, State Finance and Procurement, Section 13-216	Required for contracts over $100,000.
VT	1.00%	3.00%	5.00%	Vermont Statutes, Title 19, Chapter 1	
TN	1.00%	2.00%	3.00%	Tennessee Code Annotated, Title 12, Chapter 4	
CT	1.00%	2.00%	3.00%	Connecticut General Statutes, Section 49-41	Required for public works contracts over $100,000.
TX	1.00%	5.50%	10.00%	Texas Government Code, Title 10, Chapter 2253	Required for public works contracts over $100,000.
GA	1.00%	2.00%	3.00%	Georgia Code, Title 13, Chapter 10	
FL	1.00%	1.40%	1.80%	Florida Statutes, Section 255.05	Required for public works contracts over $200,000.
NY	1.00%	2.00%	3.00%	New York State Finance Law, Article 9	
VA	1.00%	5.50%	10.00%	Virginia Code, Title 2.2, Chapter 43	
AZ	0.50%	2.50%	5.00%	Arizona Revised Statutes, Title 34, Chapter 2	
AR	1.00%	5.50%	10.00%	Arkansas Code, Title 22, Chapter 9	
SC	0.50%	2.50%	5.00%	South Carolina Code, Title 11, Chapter 35	
MN	1.00%	5.50%	10.00%	Minnesota Statutes, Section 574.26	
LA	1.00%	5.50%	10.00%	Louisiana Revised Statutes, Title 38, Chapter 10	
IN	0.50%	2.50%	5.00%	Indiana Code, Title 5, Article 16	
WA	1.00%	2.00%	3.00%	Revised Code of Washington, Title 39, Chapter 08	Required for public works contracts over $150,000
AK	1.00%	2.00%	3.00%	Alaska Statutes, Title 36, Chapter 25	Required for public works contracts over $100,000
NC	1.00%	2.00%	3.00%	North Carolina General Statutes, Chapter 44A	Required for public works contracts over $300,000
HI	1.00%	2.00%	3.00%	Hawaii Revised Statutes, Title 9, Chapter 103D	Required for public works contracts over $250,000
KY	1.00%	2.00%	3.00%	Kentucky Revised Statutes, Title 45, Chapter 45A	Required for public works contracts over $100,000
CO	1.00%	2.00%	3.00%	Colorado Revised Statutes, Title 24, Article 105	Required for public works contracts over $150,000
NE	1.00%	2.00%	3.00%	Nebraska Revised Statutes, Chapter 52	Required for public works contracts over $100,000
OK	1.00%	2.00%	3.00%	Oklahoma Statutes, Title 61, Section 1	Required for public works contracts over $50,000
MILCON	1.00%	2.00%	3.00%	Miller Act	

8.4 A/E/C Selection/Contracting Process[55,56,57,58,59]



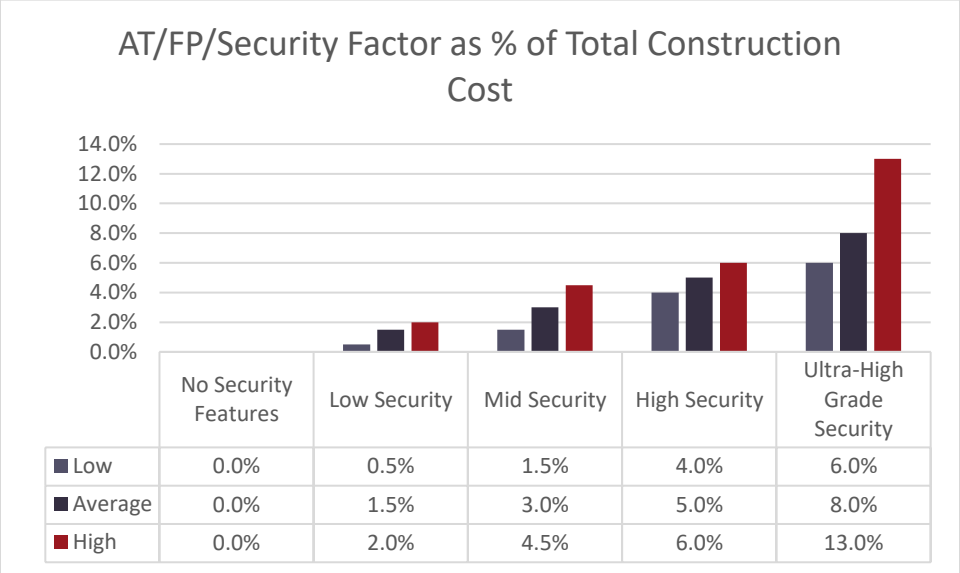
	No Delta	Lump Sum	Unit Price	Cost-Plus	Guaranteed Maximum Price (GMP)
Low	0.0%	5.0%	5.0%	10.0%	5.0%
Average	0.0%	7.5%	10.0%	15.0%	7.5%
High	0.0%	10.0%	15.0%	20.0%	10.0%

1. **No Delta**: This category indicates no change or additional cost associated with the selection or contracting process.
2. **Lump Sum**: Projects under this category have a fixed total price agreed upon for the entire project scope, providing cost certainty.
3. **Unit Price**: This method involves pricing based on individual units of work, allowing for flexibility in quantities while maintaining cost control.
4. **Cost-Plus**: Projects using this method reimburse the contractor for actual costs incurred plus an additional fee, offering transparency but with less cost certainty.
5. **Guaranteed Maximum Price (GMP)**: This approach sets a maximum price that the contractor cannot exceed, combining cost control with flexibility for changes within the project scope.

Note: Although these values were calculated, they were not applied as no information on contract-type was provided for either MILCON or Private.

[55] The 5 Key Types of Construction Contracts | Procore
[56] Project Management for Construction: Construction Pricing and Contracting
[57] (PDF) Correlating Bid Price with the Number of Bidders and Final Construction Cost of Public Street Projects
[58] A Guide to 8 Types of Construction Contracts
[59] Values were approximated, but not applied as no contract terms were identified

8.5 AT/FP/Security Factor[60,61]

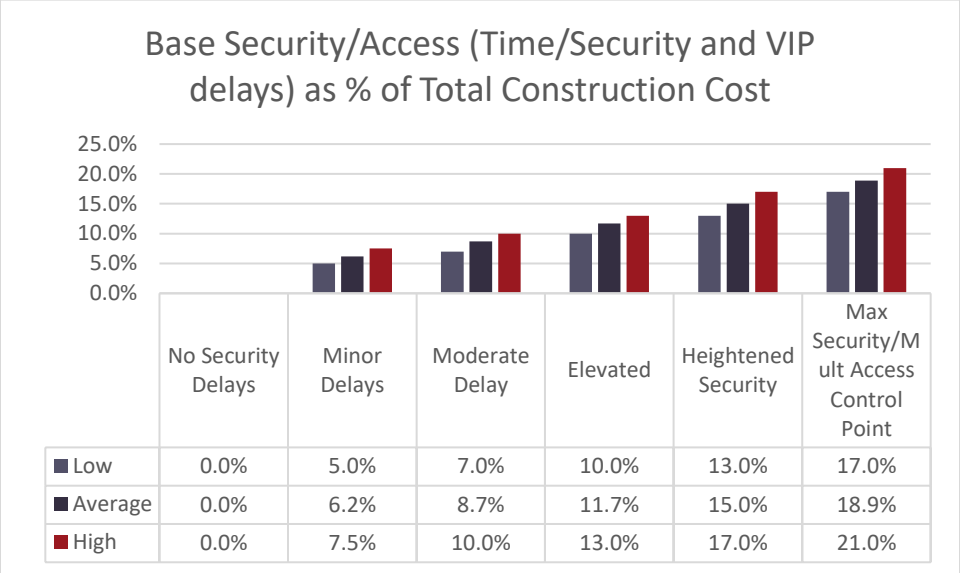


	No Security Features	Low Security	Mid Security	High Security	Ultra-High Grade Security
Low	0.0%	0.5%	1.5%	4.0%	6.0%
Average	0.0%	1.5%	3.0%	5.0%	8.0%
High	0.0%	2.0%	4.5%	6.0%	13.0%

1. **No Security Features:** Basic level with minimal or no security measures. Standard locks on doors and windows; No surveillance cameras; No access control systems
2. **Low Security:** Basic security measures to deter casual intruders. Keycard or key fob access for main entrances; Basic surveillance cameras at entry points; Intercom system for visitor access; Basic lighting around the perimeter
3. **Mid Security:** Enhanced security measures for increased protection. Keycard access for all entry points and common areas; Surveillance cameras covering all entry points and common areas; Manned security checkpoints at main entrances during peak hours; Motion sensor lighting around the perimeter; Secure mail and package delivery areas
4. **High Security:** Advanced security measures for high-risk environments. Biometric access control (fingerprint or facial recognition) for main entrances and sensitive areas; 24/7 manned security checkpoints; Comprehensive surveillance system with real-time monitoring; Anti-tamper and anti-intrusion alarms; Secure fencing and controlled access gates; Emergency response systems and panic buttons
5. **Ultra-High Grade Security:** Highest level of security for critical or high-risk facilities. Multi-factor authentication (biometric, keycard, and PIN) for all access points; 24/7 manned security with armed personnel; Anti-terrorism setbacks and barriers; Advanced surveillance with facial recognition and license plate readers; Secure perimeters with reinforced fencing and vehicle barriers; Regular security drills and emergency response plans; Secure communication systems and encrypted data networks

[60] How Much Does It Cost To Build a SCIF or SAPF? - Adamo
[61] 2024 Home Security System Costs by Type – Forbes Home

8.6 Base Security/Access (Time/Security and VIP delays)[62]

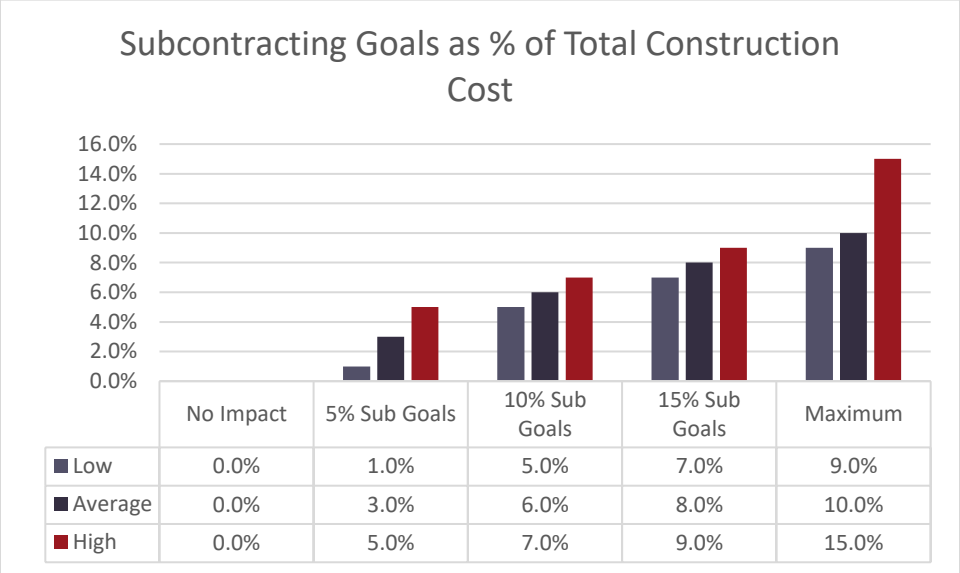


	No Security Delays	Minor Delays	Moderate Delay	Elevated	Heightened Security	Max Security/Mult Access Control Point
Low	0.0%	5.0%	7.0%	10.0%	13.0%	17.0%
Average	0.0%	6.2%	8.7%	11.7%	15.0%	18.9%
High	0.0%	7.5%	10.0%	13.0%	17.0%	21.0%

1. **No Security Delays**: Projects in this category experience no delays due to security measures.
2. **Minor Delays**: These projects face minimal delays caused by basic security checks and occasional VIP access requirements.
3. **Moderate Delay**: Projects encounter moderate delays due to more frequent security checks and VIP access interruptions.
4. **Elevated**: This category involves significant delays due to heightened security measures and regular VIP access requirements.
5. **Heightened Security**: Projects experience substantial delays from stringent security protocols and frequent VIP access.
6. **Max Security/Multiple Access Control Points**: These projects face the highest level of delays due to maximum security measures and multiple access control points.

[62] Derived from MII software package; productivity scaling to determine impact to total estimated construction price.

8.7 Subcontracting Goals



	No Impact	5% Sub Goals	10% Sub Goals	15% Sub Goals	Maximum
Low	0.0%	1.0%	5.0%	7.0%	9.0%
Average	0.0%	3.0%	6.0%	8.0%	10.0%
High	0.0%	5.0%	7.0%	9.0%	15.0%

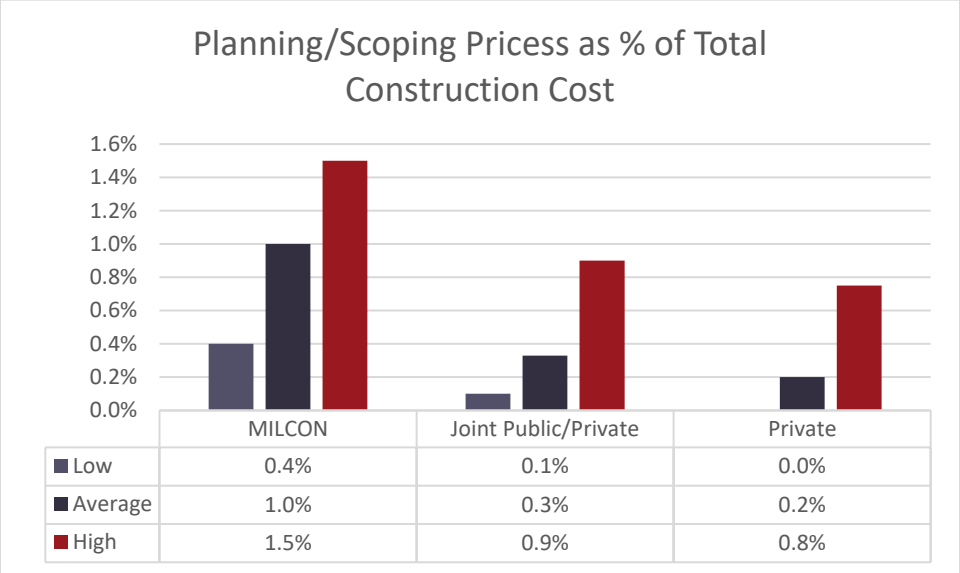
1. **No Impact**: Projects in this category do not have any specific subcontracting goals, resulting in no additional costs.
2. **5% Sub Goals**: These projects aim to have 5% of subcontracting work performed by minority-owned, disadvantaged, or small businesses, which can increase costs due to the need for outreach and compliance with specific requirements
3. **10% Sub Goals**: With a goal of 10% subcontracting to minority-owned, disadvantaged, or small businesses, costs may rise further due to the increased effort in sourcing and managing these subcontractors
4. **15% Sub Goals**: Projects targeting 15% subcontracting to these businesses face higher costs due to the significant administrative and compliance efforts required to meet these goals
5. **Maximum**: The highest level of subcontracting goals, aiming for up to 15%, incurs the most substantial costs due to extensive outreach, compliance, and potential premium pricing from specialized subcontractors

These costs are influenced by factors such as the need for additional administrative oversight[63] (exemplified by the Maryland example), compliance with federal and state regulations,[64] and the potential premium pricing from subcontractors who meet these specific criteria.

[63] Subcontracting in the Minority Business Enterprise (MBE) Program

[64] eCFR :: 2 CFR 200.321 -- Contracting with small businesses, minority businesses, women's business enterprises, veteran-owned businesses, and labor surplus area firms.

8.8 Planning/Scoping Process

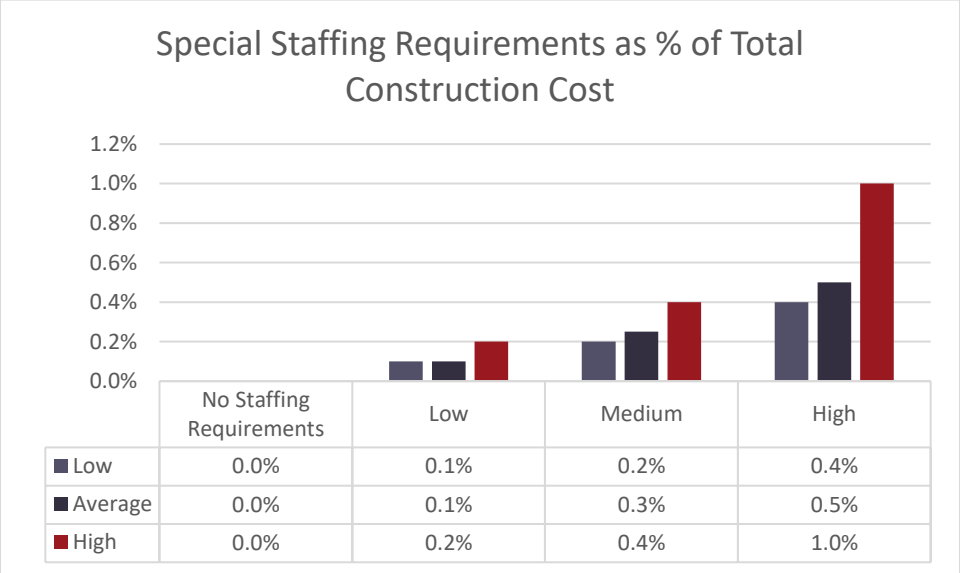


	MILCON	Joint Public/Private	Private
Low	0.4%	0.1%	0.0%
Average	1.0%	0.3%	0.2%
High	1.5%	0.9%	0.8%

1. **MILCON**:[65, 66] Military Construction (MILCON) projects involve a comprehensive and structured process that includes planning, programming, budgeting, and execution. The complexity and length of this process, often spanning five to seven years, contribute to higher costs due to extensive regulatory compliance, detailed planning, and coordination between the Department of Defense and Congress.
2. **Joint Public/Private**:[67, 68] These projects involve collaboration between public entities and private sector partners. The costs can be influenced by the need for coordination between different stakeholders, regulatory compliance, and the negotiation of agreements that balance public and private interests.
3. **Private**: Privately funded projects typically have lower costs due to streamlined processes and fewer regulatory requirements. However, costs can still vary based on the complexity of the project and market conditions.

[65] https://crsreports.congress.gov/product/pdf/download/r/r44710/r44710.pdf/
[66] Bulletin 12-05 - Construction Projects, Planning, Programming, and Approval Process.pdf
[67] On Public–Private Partnership Performance: A Contemporary Review - Graeme A. Hodge, Carsten Greve, 2017
[68] A review of studies on Public–Private Partnership projects in the construction industry - ScienceDirect

8.9 Special Staffing Requirements[69, 70, 71, 72, 73]



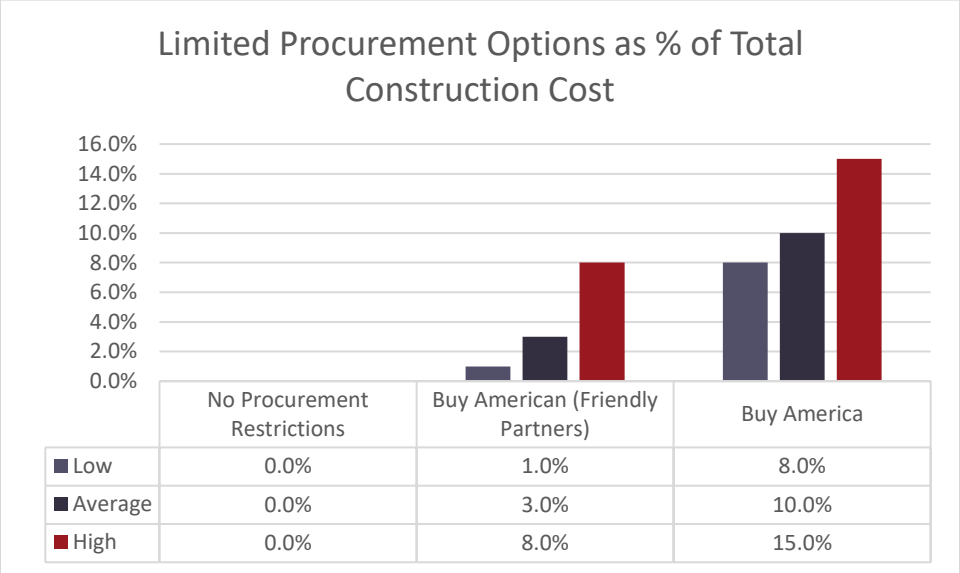
	No Staffing Requirements	Low	Medium	High
Low	0.0%	0.1%	0.2%	0.4%
Average	0.0%	0.1%	0.3%	0.5%
High	0.0%	0.2%	0.4%	1.0%

1. **No Staffing Requirements**: Projects in this category do not have any special staffing needs, such as PLA administrators, safety personnel, QA/QC staff, or E-Verify system requirements.
2. **Low**: These projects have minimal special staffing needs, possibly including a small number of safety personnel or basic E-Verify system checks.
3. **Medium**: Projects in this category require a moderate level of special staffing, including dedicated safety personnel, QA/QC staff, and more comprehensive E-Verify system implementation.
4. **High**: These projects have extensive special staffing needs, involving multiple PLA administrators, a full team of safety personnel, detailed QA/QC processes, and rigorous E-Verify system usage.

Note: Although E-Verify or E-Verify+ are free services[74], there is an administrative cost to documentation and retaining qualified personnel. Further study is needed to refine the exact cost of these factors and the limited labor pool for MILCON.

[69] Project Labor Agreement Resource Guide | U.S. Department of Labor
[70] Budgeting for Safety: Incorporating Safety Costs into Construction Projects | SALUS Safety
[71] Calculating the True Cost of Underinvesting in Construction Health and Safety
[72] Quality Assurance/Quality Control: Worth the Cost (or Investment) - Terracon
[73] QA and QC in construction: What's the difference and how to improve your processes | Fieldwire by Hilti
[74] Is there a cost to use E-Verify+? | E-Verify

8.10 Limited Procurement Options[75]

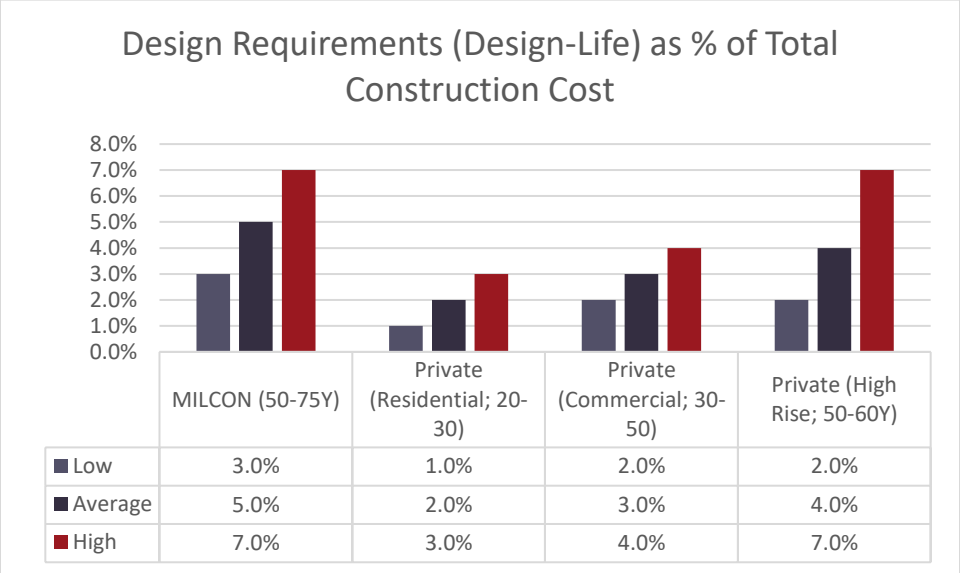


	No Procurement Restrictions	Buy American (Friendly Partners)	Buy America
Low	0.0%	1.0%	8.0%
Average	0.0%	3.0%	10.0%
High	0.0%	8.0%	15.0%

1. **No Procurement Restrictions**: Projects in this category do not face any procurement restrictions, allowing for the free selection of materials and suppliers without additional costs.
2. **Buy American (Friendly Partners)**: These projects require the use of materials and products from American manufacturers or friendly partner countries. The costs can increase due to the limited pool of suppliers and potentially higher prices for domestically produced goods.
3. **Buy America**: This category mandates the use of American-made materials and products, significantly restricting procurement options. The higher costs are attributed to the limited availability of certain materials, higher production costs in the U.S., and compliance with stringent regulations.

[75] There is a wide range of variability to procurement options; by limiting suppliers there is an inherent premium to the market-determined rate for materials. MSI has sought to provide a knowledge-based estimation for this value.

8.11 Design Requirements (Approximated, but not applied)[76]

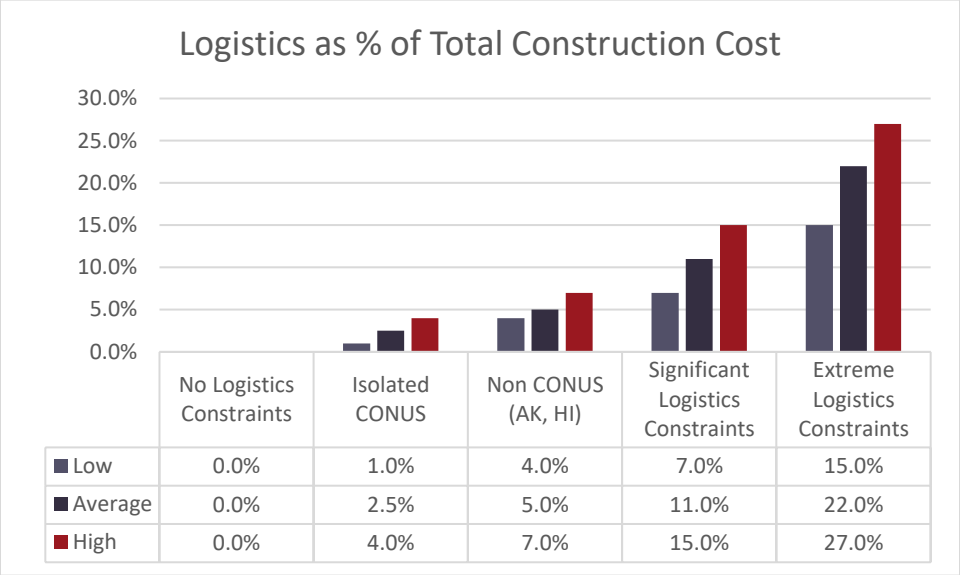


	MILCON (50-75Y)	Private (Residential; 20-30)	Private (Commercial; 30-50)	Private (High Rise; 50-60Y)
Low	3.0%	1.0%	2.0%	2.0%
Average	5.0%	2.0%	3.0%	4.0%
High	7.0%	3.0%	4.0%	7.0%

1. **MILCON (50-75Y)**: Military Construction (MILCON) projects are designed for a lifespan of 50 to 75 years, incorporating stringent sustainability standards, federal design regulations, and anti-terrorism/force protection measures, which contribute to higher costs.
2. **Private (Residential; 20-30)**: Private residential projects are typically designed for a lifespan of 20 to 30 years, focusing on cost-effective materials and construction methods, resulting in lower costs compared to MILCON.
3. **Private (Commercial; 30-50)**: Commercial projects in the private sector are designed for a lifespan of 30 to 50 years, balancing durability and cost-efficiency, leading to moderate costs.
4. **Private (High Rise; 50-60Y)**: High-rise buildings in the private sector are designed for a lifespan of 50 to 60 years, requiring advanced engineering, high-quality materials, and compliance with safety standards, which increase costs.

[76] Approximated; not applied to overall Qualitative MCP; determined in Physical building characteristics

8.12 Logistics (Approximated, but not applied)



	No Logistics Constraints	Isolated CONUS	Non CONUS (AK, HI)	Significant Logistics Constraints	Extreme Logistics Constraints
Low	0.0%	1.0%	4.0%	7.0%	15.0%
Average	0.0%	2.5%	5.0%	11.0%	22.0%
High	0.0%	4.0%	7.0%	15.0%	27.0%

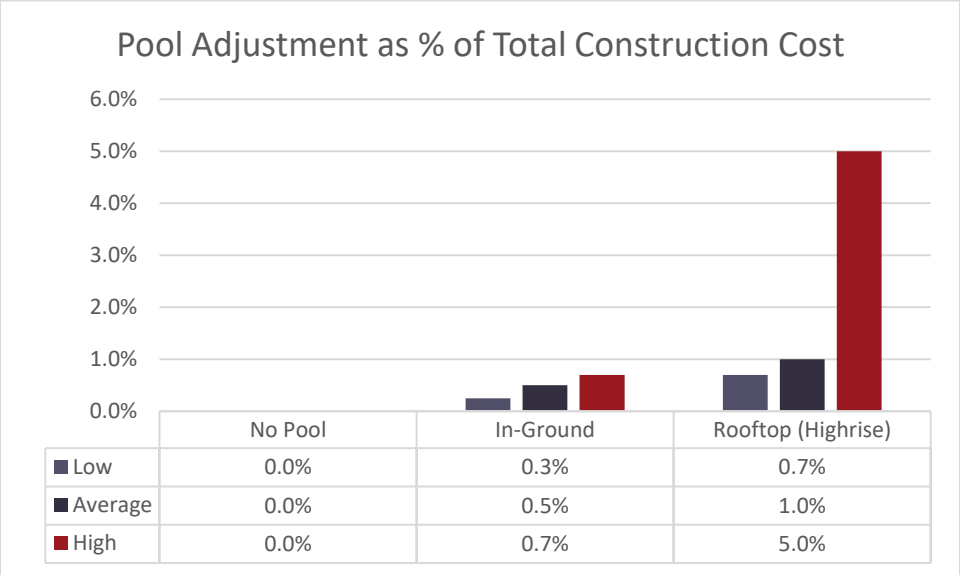
1. **No Logistics Constraints**: Projects in this category do not face any logistical challenges, allowing for smooth and cost-effective transportation and delivery of materials.
2. **Isolated CONUS**: These projects are located in isolated areas within the continental United States, leading to increased costs due to longer transportation distances and limited access to suppliers.
3. **Non-CONUS (AK, HI)**: Projects in Alaska and Hawaii face higher costs due to the need for shipping materials over long distances, which involves additional transportation and handling expenses.
4. **Significant Logistics Constraints**: Projects with significant logistical challenges encounter substantial costs due to difficult access, limited transportation infrastructure, and the need for specialized handling and storage.
5. **Extreme Logistics Constraints**: These projects face the highest costs due to extreme logistical challenges, such as remote locations, harsh environmental conditions, and the need for extensive planning and coordination to ensure timely delivery of materials.

Note: Research suggests that logistics costs for a given material account for 27% of the total purchase amount on a project. A 100% increase in logistics costs in an extreme case would thus be 27% as indicated at the high end of this range.[77,78]

[77] 4 Types of Logistics Costs: A Construction Budget Breakdown - Trangistics
[78] Performance measurement in construction logistics - ScienceDirect

9 Appendix II – Private Dorm Normalization Tables

9.1 Pool Adjustment[79]

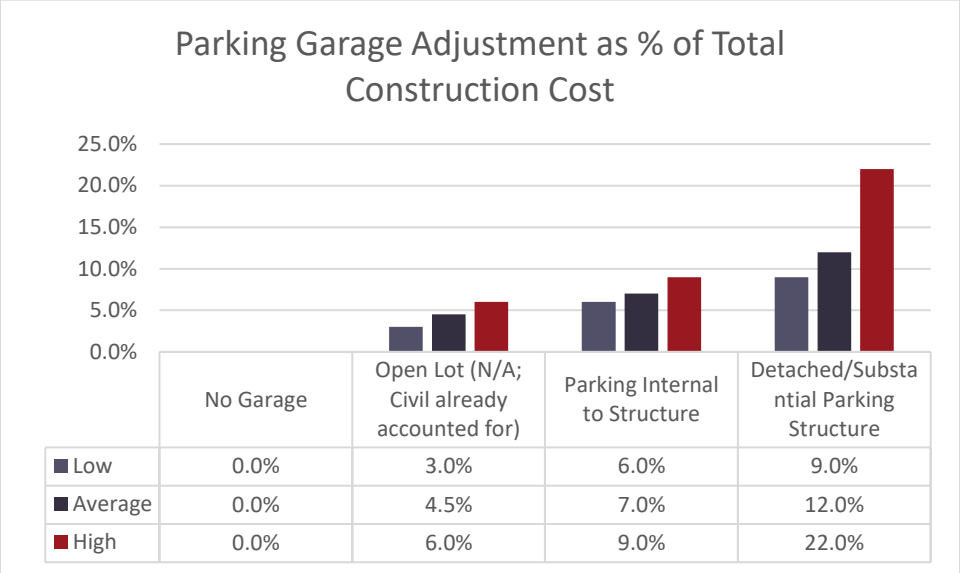


	No Pool	In-Ground	Rooftop (Highrise)
Low	0.0%	0.3%	0.7%
Average	0.0%	0.5%	1.0%
High	0.0%	0.7%	5.0%

1. **No Pool**: Projects in this category do not include a swimming pool, resulting in no additional costs.
2. **In-Ground**: These projects feature in-ground pools, which involve excavation, installation, and finishing. Costs are influenced by factors such as pool size, materials, labor, and site-specific conditions.
3. **Rooftop (Highrise)**:[80,81] High-rise buildings with rooftop pools face higher costs due to the need for structural reinforcement, specialized construction techniques, and additional safety measures.

[79] How Much Does A Pool Renovation Cost: Factors And Tips For Staying Within Your Budget - Love Gunite Pool
[80] Who Can Get a Rooftop Pool?
[81] Rooftop Pool Design Ideas, Pros/Cons & More - Pool Research

9.2 Parking Garage Adjustment[82, 83]

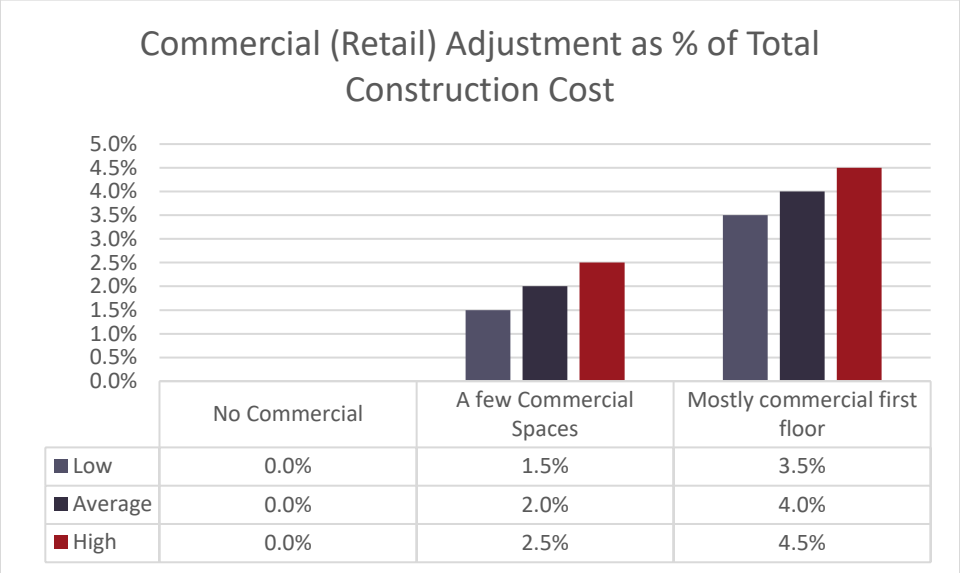


	No Garage	Open Lot (N/A; Civil already accounted for)	Parking Internal to Structure	Detached/Substantial Parking Structure
Low	0.0%	3.0%	6.0%	9.0%
Average	0.0%	4.5%	7.0%	12.0%
High	0.0%	6.0%	9.0%	22.0%

1. **No Garage**: Projects in this category do not include a parking garage, resulting in no additional costs.
2. **Open Lot (N/A; Civil already accounted for)**: These projects feature an open parking lot, with costs already accounted for in civil works, leading to moderate additional expenses. In this study this feature has been mostly accounted for when subtracting civil works. This is reserved for extensive surface lots.
3. **Parking Internal to Structure**: Projects with parking integrated within the building structure incur higher costs due to the need for structural support, ventilation, and access control systems.
4. **Detached/Substantial Parking Structure**: These projects involve a separate, substantial parking structure, resulting in the highest costs due to extensive construction, materials, and additional infrastructure requirements.

[82] How Much Does It Cost to Build a Parking Garage? (2024)
[83] Cost to Build a Parking Garage | Parking Lot Costs per Square Foot | Fixr

9.3 Commercial (Retail) Adjustment[84]

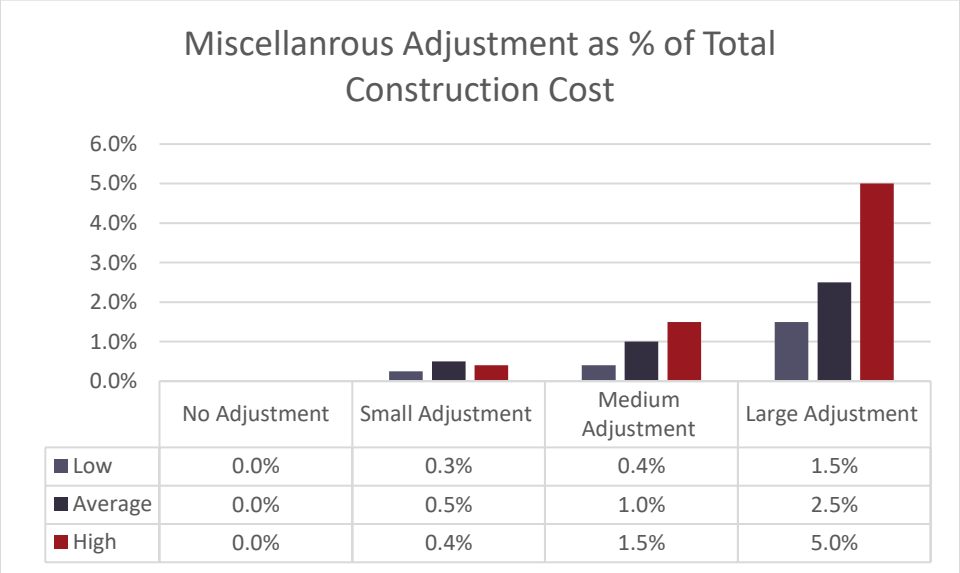


	No Commercial	A few Commercial Spaces	Mostly commercial first floor
Low	0.0%	1.5%	3.5%
Average	0.0%	2.0%	4.0%
High	0.0%	2.5%	4.5%

1. **No Commercial**: Projects in this category do not include any commercial spaces, resulting in no additional costs.
2. **A few Commercial Spaces**: These projects feature a small number of commercial spaces, leading to moderate additional costs due to the need for retail-specific infrastructure and finishes.
3. **Mostly Commercial First Floor**: Projects with a predominantly commercial first floor incur higher costs due to extensive retail space requirements, including specialized construction, utilities, and finishes.

[84] Approximated based on individual structure characteristics.

9.4 Miscellaneous Adjustment[85]



	No Adjustment	Small Adjustment	Medium Adjustment	Large Adjustment
Low	0.0%	0.3%	0.4%	1.5%
Average	0.0%	0.5%	1.0%	2.5%
High	0.0%	0.4%	1.5%	5.0%

1. **No Adjustment**: Projects in this category do not include any additional amenities, resulting in no extra costs.
2. **Small Adjustment**: These projects feature minor amenities such as a small dog park, a small gym, or a rooftop sitting area, leading to modest additional costs.
3. **Medium Adjustment**: Projects with medium adjustments include amenities like a large dog park, substantial gym facilities, a medium-sized office area, or a large outdoor patio, resulting in moderate additional costs.
4. **Large Adjustment**: These projects involve extensive amenities, such as a dedicated building for a gym, a leasing office, an athletic facility, or other specialized spaces, leading to the highest additional costs.

[85] Approximated based on individual structure.

10 Appendix III – PAX, NAVFAC, and PACES Adjustment References

10.1 PAX 3.2.1 Area Cost Factors (March 2024)

Published in March 2024. Applied to Base and Option 1 structures to normalize location.

PAX 3.2.1 Area Cost Factors 2024-03			
State	ACF	State	ACF
AK	2.28	NC	0.85
AL	0.86	ND	1.17
AR	0.86	NE	0.98
AZ	0.89	NH	1.06
CA	1.24	NJ	1.18
CO	1.06	NM	0.90
CT	1.10	NV	1.16
DE	1.09	NY	1.07
FL	0.96	OH	0.98
GA	0.88	OK	0.89
HI	2.15	OR	1.13
IA	0.98	PA	1.06
ID	1.04	RI	1.16
IL	1.01	SC	0.95
IN	0.92	SD	0.98
KS	0.92	TN	0.87
KY	0.87	TX	0.82
LA	0.93	UT	0.99
MA	1.18	VA	0.88
MD	1.01	Various	1.00
ME	1.11	VT	1.03
MI	1.03	WA	1.10
MN	1.11	D.C.	1.04
MO	0.96	WI	1.07
MS	0.83	WV	0.97
MT	1.04	WY	0.98

10.2 UFC 3-730-01 Facility Size Adjustments

Size Adjustment Factors for UHPP/Dorm/Barracks are based on UFC 3-730-01 in PAX Newsletter 3.2.2 (March 2024), Table I, Part II. Dorm sizes initially ranged to 300 (all inclusive of greater values); however, due to significant rooms sized above this value for private industry, the bounds were expanded to 2000 (inclusive). Though there were few facilities with rooms at this extreme value as shown below.

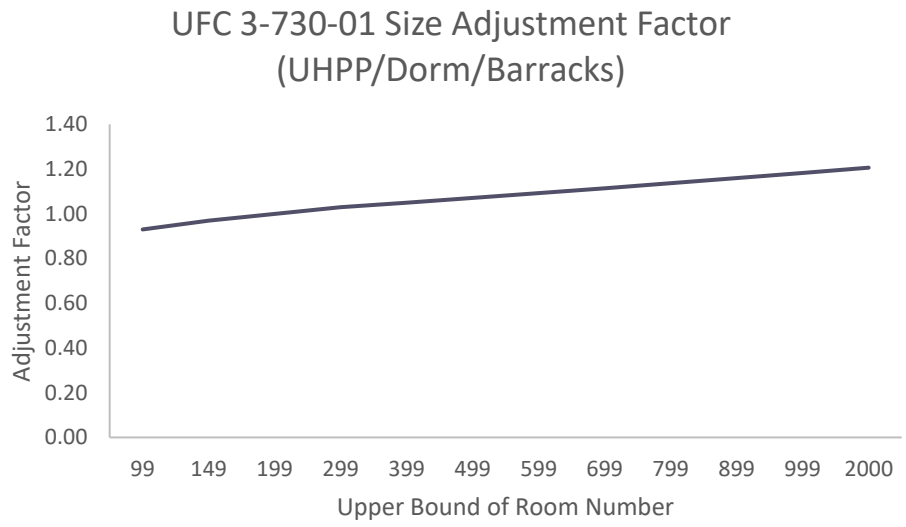


Figure 25 PAX Size Adjustment Factor (UHPP/Dorm/Barracks)

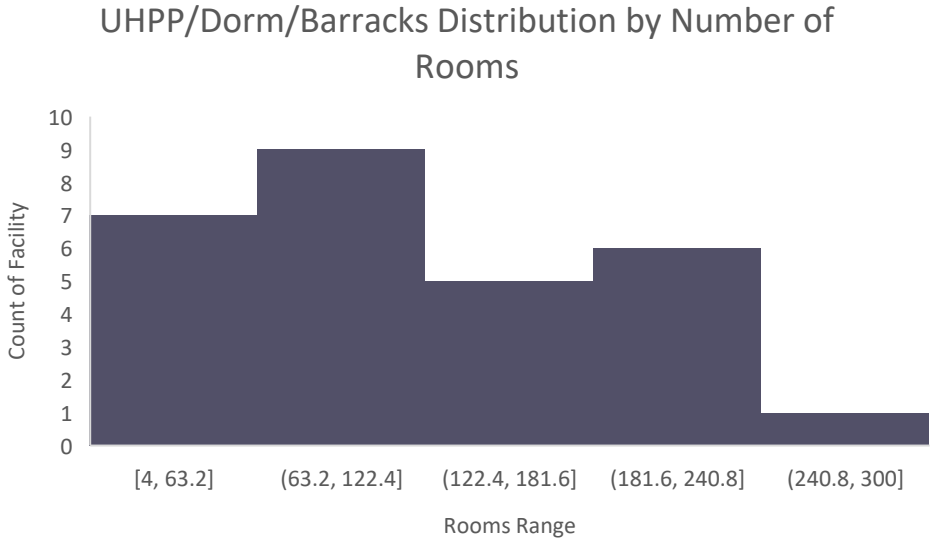


Figure 26 UHPP/Dorm/Barracks Distribution by Number of Rooms

10.3 UFC 3-730-01 Size Adjustment Factor

Size Adjustment Factors for Option 1 Facilities are based on UFC 3-730-01 in PAX Newsletter 3.2.2 (March 2024), Table I, Part I; Average sample size (SF) calculated 172,700 SF, all values were scaled off of this value.

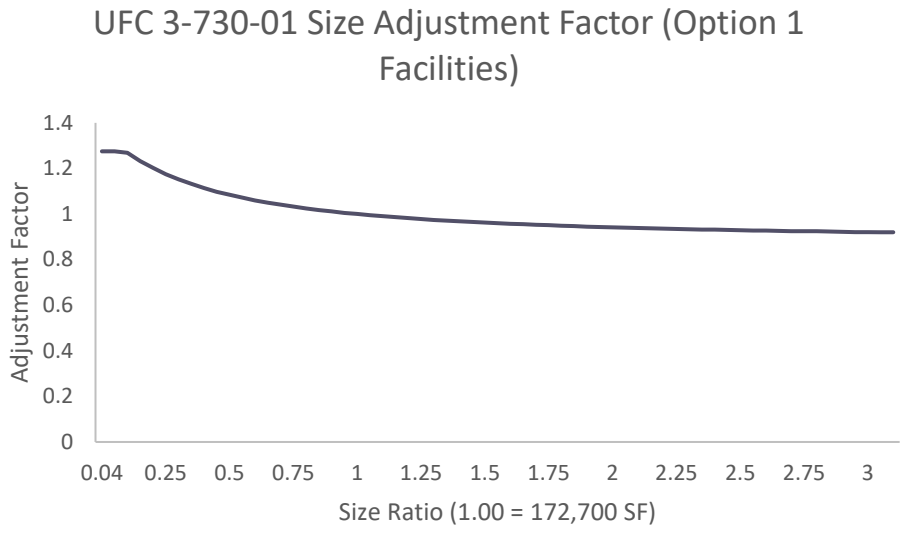


Figure 27 PAX Size Adjustment Factor (Option 1 Facilities)

10.4 NAVFAC BCI Index (Base & Option 1)

Values indexed to Jan 2025 = 1.00

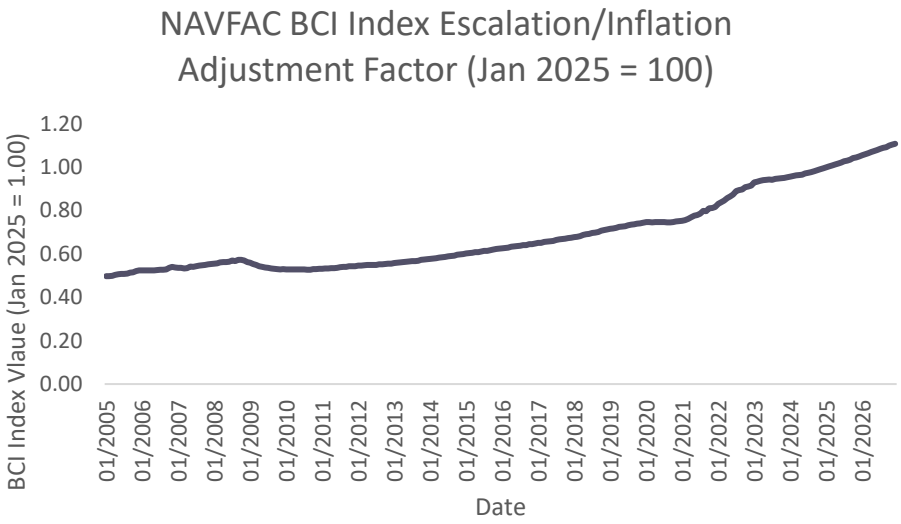


Figure 28 NAVFAC BCI Index Escalation/Inflation Adjustment Factor (Jan 2025 = 100)

10.5 PACES Civil Works Adjustments

Civil works were removed from all projects according to the PACES table shown in Table 13 PACES Civil Works Adjustments.

Table 13 PACES Civil Works Adjustments

PACES Civil Works Adjustments		
PACES Class	Tag Class	Civil Adjustments (PACES)
Administrative	Admin	22.0%
Medical Clinic	Medical	15.0%
Parking Garage	Parking	15.0%
Hangar	Hangar	26.2%
Fitness Center	Physical Fitness	18.7%
Miscellaneous	Misc	15.0%
Barracks	Dorm	20.0%

11 Appendix IV – Controllable vs Uncontrollable Factors Case Studies

These case studies provide practical examples of how the proposed improvements can be effectively implemented in DoD construction projects, leading to enhanced efficiency, cost savings, and quality outcomes.

11.1 Federal Design Requirements – General

11.1.1 *Case Study: GSA Portfolio of Grid-Interactive Efficient Buildings (GEB)*[86]

Overview

The 2021 General Services Administration (GSA) report examines Grid-Interactive Efficient Buildings (GEB) within the federal portfolio, highlighting the transition from traditional one-way electricity transmission to a multidirectional system involving distributed energy sources. GEBs aim to manage energy use efficiently, reduce peak demand, and enhance grid resiliency. This report was chosen as a case study to highlight a wide variety of controllable factors including sustainability, security, planning and scoping, and quality management. There are overlapping lessons learned for multiple controllable factors.

Practices and Technologies

The report analyzed various GEB practices and technologies implemented across Federal facilities:

1. **Edward J. Schwartz Federal Building and U.S. Courthouse**:
    a. **Technologies**: Solar photovoltaic systems, battery energy storage system (BESS).
    b. **Practices**: Peak demand reduction through battery discharge during peak times.
2. **Fort Carson**:
    a. **Technologies**: BESS, energy management control system (EMCS), lighting upgrades, HVAC control system.
    b. **Practices**: Peak load shifting, occupancy-based HVAC control, microgrid integration.
3. **Picatinny Arsenal**:
    a. **Technologies**: Automated demand response (ADR).
    b. **Practices**: Integration of market signals with ADR for energy consumption reduction.
4. **NIST Headquarters**:
    a. **Technologies**: Solar photovoltaic (PV), cogeneration, demand response programs.
    b. **Practices**: Direct load control, manual demand response, energy management through a central utility plant.
5. **Joint Base Cape Cod (JBCC)**:
    a. **Technologies**: Wind turbines, microgrid, energy demand response program.
    b. **Practices**: Renewable energy integration, energy curtailment for cost savings.
6. **Moorhead Federal Building**:
    a. **Technologies**: Thermal energy storage (TES).
    b. **Practices**: Dynamic electricity purchasing, day-ahead utility rate assessment.
7. **Marine Corps Air Station Miramar**:

[86] GSA GEB Case Study Report Mar 2021.pdf

    a. **Technologies**: Microgrid, solar, energy storage, landfill gas, diesel and natural gas plant, EV charging.
    b. **Practices**: Net zero energy installations (NZEIs), phased microgrid implementation.
8. **Philadelphia U.S. Custom House**:
    a. **Technologies**: Automated pre-cooling and demand limiting protocol.
    b. **Practices**: Pre-cooling during off-peak hours, demand reduction strategies.
9. **John F. Shea Federal Building**:
    a. **Technologies**: Pre-cooling with zonal temperature reset.
    b. **Practices**: Demand shifting, leveraging building thermal mass for energy savings.

Obstacles

The report identifies several challenges faced during the implementation of GEB technologies:

- **Security Concerns**: Cybersecurity requirements for automated systems, especially in DoD facilities.
- **Operational Knowledge Gaps**: Lack of specialized skills and training for managing GEB technologies.
- **Financial Constraints**: High upfront costs and budget limitations for GEB investments.
- **Technological Challenges**: Integration issues with existing systems, inoperable meters, and outdated infrastructure.
- **Permitting Delays**: Environmental permitting requirements causing project delays.
- **Leadership Approval**: Need for buy-in from agency leadership to support GEB projects.

Lessons Learned

Key lessons from the case studies include:

- **Early Planning for Cybersecurity**: Address cybersecurity needs early in project development to ensure smooth implementation.
- **Engagement with Facility Managers**: Continuous engagement with facility managers and tenants proved crucial for successful GEB projects.
- **Integrated Solutions**: Considered integrated solutions like PV and storage systems to reduce costs and increase performance to meet sustainability objectives.
- **Training and Knowledge Transfer**: Implement robust training programs and succession planning to address operational knowledge gaps.
- **Financial Incentives**: Highlight financial benefits and potential savings to gain support for GEB projects.
- **Phased Implementation**: Use a phased approach to manage funding challenges and adapt to changing conditions.

Additionally, MSI recommends forming specialized groups of leads or managers after guidelines are finalized and as the project is being built. Examples include a cybersecurity team or a life-cycle team. Individuals may join multiple groups to ensure adequate staffing and interoperability knowledge. Tracking Federal guidelines during the construction process will reduce delays and rework and ensure that the project is built to spec.

11.2 Staffing Requirements (Division 01 Specification)

11.2.1 Case Study: The Hudson Yards Project, New York City[87,88]

Project Overview: Hudson Yards is a large-scale real estate development in New York City, completed in phases starting in 2019. It includes residential, commercial, and public spaces, making it one of the most ambitious urban development projects in the U.S. In many ways complex projects like Hudson Yards face challenges similar to the MILCON process.

Challenges:

- Coordinating a vast number of subcontractors and suppliers.
- Ensuring compliance with stringent safety and environmental regulations.
- Maintaining high standards of quality and sustainability.

Improvements in Division 01 Specifications:

- **Enhanced Project Management:** [89]
  - Qualified Project Managers: The project employed experienced project managers with PMP certifications. This ensured meticulous planning, coordination, and execution, leading to fewer delays and better resource management.
  - Dedicated Roles: Clearly defined roles and responsibilities for each team member helped avoid overlaps and gaps in the project workflow.
- **Improved Quality Control:**
  - Quality Control Managers: Dedicated quality control managers were appointed to oversee all aspects of construction quality. Regular inspections and third-party testing ensured that all materials and workmanship met the highest standards.
  - Training Programs: Continuous training for staff on the latest construction techniques and materials improved the overall quality of the project.
- **Efficient Communication:** [90]
  - Communication Protocols: The project established clear communication protocols, including regular meetings and updates via project management software. This ensured that all stakeholders were informed and aligned, reducing misunderstandings and delays.
  - Submittal Procedures: Detailed guidelines for document submissions, including timelines and required formats, streamlined the approval process and ensured timely reviews.
- **Safety and Compliance:**
  - Safety Officers: Dedicated safety officers were on-site to ensure that all safety protocols were followed, reducing the risk of accidents and ensuring compliance with regulations.

[87] Hudson Yards | The Atlas of Urban Tech
[88] Cost_of_Hudson_Yards_WP_11.5.18.pdf
[89] Pulse of the Profession 2017 | PMI
[90] The Hudson Yards Project: A 21st Century Urban Experience and Challenges Faced|Project Management 360

    - Safety Training: Regular safety training for all staff members created a safer work environment and reduced the likelihood of incidents.
- **Resource Management:**
    - Skilled Labor: The project ensured access to skilled labor for specialized tasks, improving efficiency and quality.
    - Staffing Levels: Properly managing staffing levels to match the project's needs at different stages optimized productivity and avoided delays.
- **Sustainability and Environmental Impact:**
    - Environmental Specialists: Environmental specialists were included in the team to develop and implement sustainable practices, such as waste management and energy efficiency measures.
    - LEED Certification: Staff trained in LEED standards helped achieve green building certifications, enhancing the project's sustainability credentials.

Results:

- The Hudson Yards project was completed on time and within budget.
- Achieved multiple LEED certifications for various buildings within the development.
- Improved stakeholder satisfaction due to clear communication and high-quality standards.
- Enhanced reputation of the construction company as a leader in sustainable urban development.

This case study illustrates how improving staffing requirements can significantly enhance Division 01 specifications, leading to better project outcomes in terms of quality, safety, efficiency, and sustainability.

11.2.2 Case Study: Iskandar Muda Military Regional Finance Office[91]

- **Overview:** The study, "Optimizing Human Resource Allocation in Construction Projects: A Case Study," analyzes the feasibility of constructing the Iskandar Muda Military Regional Finance Office in Banda Aceh City. It focuses on determining the optimal number of skilled workers needed to enhance productivity and efficiency. While not specifically a Division 01 Specification there are applications to how project managers may effectively plan for crew flow dynamics to meet these specs.
- **Key Findings:** The study emphasizes the importance of having workers with the right skills and found that productivity decreases when the number of workers is not optimized. Efficient labor allocation and time utilization are essential for enhancing productivity. The study concludes that optimizing human resource allocation is feasible and effective for improving overall project outcomes. MSI similarly recognizes this impact to crew flow and is the premise for the application of the Touchplan® software platform.
- **Methods for Optimizing Labor Allocation:**

[91] https://everant.org/index.php/etj/article/download/1315/930

- **Skill Matching**: Ensure workers have the requisite skills for their specific tasks.
- **Dynamic Allocation**: Adjust labor requirements throughout the project duration to maintain optimal productivity levels.
- **Workforce Planning**: Prevent under or overstaffing by planning the workforce effectively. Examples include crew flow planning such as within the MSI Touchplan® platform.
- **Time Management**: Manage time better by ensuring each phase of the project is completed as scheduled through consistent checkpoints.

11.3 Planning and Scoping Process

11.3.1 *Case Study: NASA's Mars Rover Project*[92, 93]

Overview

- **Project**: Mars Exploration Rovers (MER) mission by NASA.
- **Rovers**: Spirit and Opportunity, equipped with various scientific instruments.
- **Objective**: Explore Mars' geology, especially for evidence of past water.
- **Planning System**: MAPGEN (Mixed-initiative Activity Plan GENerator) used for daily activity planning.[94]

Planning & Scoping Process

- **Challenges**: Time-pressured task with resource limitations, safety rules, and temporal constraints.
- **Solution**: MAPGEN, a mixed-initiative system combining automated planning with human expertise.
- **System Features**:
  - **Plan Editing**: Modify activities and constraints.
  - **Plan Completion**: Achieve subgoals and add necessary support activities.
  - **Active Constraints**: Enforce constraints during plan editing.
  - **Hopper**: Staging area for unplanned activities.
  - **Goal Rejection**: Reject lower-priority activities if necessary.
  - **Constrained Move**: Move activities within permitted ranges.
  - **Minimal Perturbation**: Minimize changes to maintain plan consistency.

Outcome

- **Success**: MAPGEN significantly improved the efficiency and quality of planning.
- **Impact**: Estimated 20-40% increase in science return compared to manual planning.
- **Lessons Learned**:
  - Mixed-initiative systems provide flexibility and adaptability.
  - Importance of features like unplanning, replanning, and active constraint enforcement.
  - Need for better explanations of automated reasoning and support for temporal preferences.

---

[92] 20050157091.pdf
[93] Effective Project Planning Case Studies: Overcome Challenges
[94] ntrs.nasa.gov/api/citations/20050184145/downloads/20050184145.pdf

    - Challenges in resource management and the need for heuristic techniques.
- **Future Directions**: Enhance user interaction, improve resource management, and develop better explanation facilities.

11.3.2 *Case Study: Heathrow Airport Terminal 5*[95]

Overview

- **Project**: Construction of Heathrow Terminal 5 (T5) by British Airports Authority (BAA).
- **Scale**: Largest construction project in Europe in the early 2000s.
- **Components**: Two terminal buildings, air traffic control tower, 14,000-space car park, airport hotel, road and railway links.
- **Size**: 260 Ha site, designed for 30 million passengers per year.
- **Workforce**: Approximately 50,000 people involved.

Planning Process

- **Research**: Extensive two-year study of major UK construction projects and international airports.
- **Challenges Identified**: Poor collaboration and reluctance to assume risk.
- **Solution**: Developed a bespoke relational contract (T5 agreement[96]) for tier 1 suppliers.
- **Integrated Team**: Co-located suppliers to foster collaboration and manage risk.
- **Contract Type**: Cost-plus contract with BAA retaining major risks and providing project-wide insurance.
- **Risk Management**: Pooled risk into a program-wide 'risk pot' for better financial control.
- **Open Book Pricing**: Detailed examination of suppliers' internal cost structures.
- **Incentives**: Target cost approach with shared savings between contractors, BAA, and a contingency fund.
- **Long Planning Period**: 15 years of planning and design, complying with 700 planning conditions.
- **Technology**: Favored established technologies, with 70% of components manufactured off-site.

Outcome

- **Completion**: Delivered on time and within the GBP4.3 billion (USD8.5 billion) budget.
- **Awards**: Multiple awards including StructE Supreme Award, British Construction Industry Awards, and RIBA National Award.
- **Key Lessons**:
    - Importance of new working methods and risk management.
    - Need for strong leadership and competent client.
    - Benefits of integrated project teams and open-book pricing.
    - Importance of organizational change programs and in-house project management capability.
    - Aligned commercial approach focusing on technical delivery aspects.

[95] Heathrow Terminal 5 - Improving Delivery Models
[96] 308-308-1

11.4 Quality Management Requirements

11.4.1 *Case Study: Kuala Lumpur International Airport (KLIA)*[97]

Overview

The Kuala Lumpur International Airport (KLIA) construction project focused on implementing a Quality Management System (QMS) to ensure the project's success.

Quality Management Improvements[98]

- **Human Resources**: Emphasized the importance of skilled labor, continuous training, and development programs to ensure workers were competent and motivated.
- **Planning and Documentation**: Developed detailed Project Quality Plans (PQP) for all parties involved, ensuring clear communication and adherence to quality standards.
- **Inspection and Testing**: Implemented rigorous inspection and testing procedures at various stages (receiving, in-process, final) to ensure materials and workmanship met quality standards.
- **Auditing**: Conducted internal and external audits to verify compliance with PQPs and identify areas for improvement.
- **Quality Recording**: Maintained comprehensive records of all quality-related activities, facilitating continuous assessment and improvement.
- **Data Analysis and Reporting**: Used data analysis techniques to assess QMS performance and make informed decisions for ongoing improvements.

Impact

- **Enhanced Quality**: Improved overall quality of construction through systematic planning, monitoring, and continuous improvement.
- **Cost Efficiency**: Reduced rework and defects, leading to cost savings.
- **Stakeholder Confidence**: Increased confidence among stakeholders due to adherence to high-quality standards and transparent processes.

[97] (99+) A case Study on Quality Management System in Construction Project | Wan Yusoff Wan Mahmood - Academia.edu

[98] Quality Management in Construction Projects