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Improving Stochastic Value and Cost Analysis of Tradeoffs in Lease Vs. Build Alternatives for the Department of Veterans Affairs

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Author Note: The authors of this report are completing an engineering capstone project, SE403, at the United States Military Academy at West Point. We appreciate the Department of Veterans Affairs (VA) presenting us with a complex, real-world problem that has allowed us to apply the engineering tools we have developed over the past three and a half years. The views expressed in this report are those of the authors and do not reflect the official position of the United States Military Academy, the Department of the Army, or the Department of Defense.

Abstract: The Department of Veterans Affairs (VA), specifically under the Office of Construction and Facilities Management (CFM), is designing a novel process to enable decision makers with value and life cycle cost insights to guide lease vs buy strategies, which then might inform OMB investment recommendations. This research presents a data-driven, stochastic, multi-criteria value model to help VA stakeholders evaluate Lease vs. Build alternatives. This research applies a Monte Carlo simulation to analyze the trade-offs between life cycle costs and value for Health Care Centers (HCC's). Using a case-study, the novel methodology and Shiny App model provides insights to guide VA leadership in making informed Build vs Lease decisions by allowing for direct pairwise comparisons, Pareto efficiency assessments, and represents an enhancement to existing VA strategic capital investments.

Keywords: Stochastic Value Modeling, Life Cycle Cost Engineering, Department of Veterans Affairs.

1. Introduction

1.1 Background

The Department of Veterans Affairs delivers primary and specialty care to over nine million former service members annually. This guiding principle underscores the need for continuous evaluation of how the VA provides services to this population, particularly through its healthcare division (U.S. Department of Veterans Affairs, 2022). The VA annually justifies its construction budget for new facilities to the Office of Management and Budget (OMB), prompting a reassessment of how it frames the decision justification on facility investments. When entering a new region, the VA might consider evaluating whether leasing or building offers the most practical alternative to meet veteran healthcare needs. This assessment might consider factors such as the veteran population, location cost factors, and specific facility requirements. Leaders at CFM establish the key criteria for deciding whether to develop a new facility or lease and change an existing building. This research focuses on the creation of a value-focused methodology through stochastic modeling. This methodology includes a life cycle cost analysis over a 60-year window resulting in data visualizations to aid senior leaders in understanding the trade space between complex alternatives. That understanding then arms VA leaders with strengthened justifications in their analysis of alternatives to OMB where approval and appropriation support helps to best pursue infrastructure capability for fulfillment toward the VA's mission.

The Veterans Health Administration (VHA) has traditionally used a heuristic, descriptive approach to evaluate life cycle cost and value, relying heavily on institutional knowledge and subjective judgment. The proposed model, shown in Figure 1, introduces a normative, data-driven framework that enables stochastic analysis of cost versus value, offering a more objective and transparent basis for decision-making. Transitioning to this integrated "TO-BE" model supports more consistent, analytically grounded evaluations, and the methodology's models presented in this paper outline their value proposition to the re-engineered process for improving decision quality on build versus lease decisions.

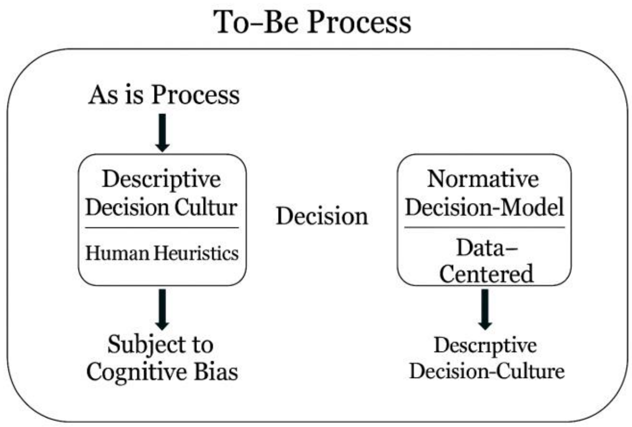

Figure 1: VA Decision Process 'As Is', and Recommended 'To Be

1.2 Literature Review

Healthcare facility decisions, such as building or leasing infrastructure, depend on long-term costs, demand forecasting, and risk management. Life Cycle Cost Analysis (LCCA) helps evaluate total ownership costs to ensure cost-effective, sustainable investments (Farr & Faber, 2018). This review explores LCCA, economic evaluation tools, and stochastic modeling in healthcare infrastructure planning.

LCCA provides a structured approach to assessing long-term costs, including replacement costs, discount rates, and residual values (DMA Engineering, 2024). These factors help planners select technologies and designs that maximize value. The Whole Building Design Guide (WBDG, 2024) stresses that early LCCA applications improve energy use, maintenance, and adaptability. However, rapid medical advancements and shifting healthcare needs make precise LCCA predictions challenging. Despite this, LCCA is still essential for balancing costs with high-quality patient care.

Cost-effectiveness analysis (CEA) and cost-benefit analysis (CBA) help assess healthcare infrastructure investments. CEA measures cost per health outcome (CDC, 2024), while CBA assigns monetary value to societal benefits, such as healthcare access (Lakdawalla et al., 2018). Cost-utility analysis (CUA), using Quality-Adjusted Life Years (QALYs) (Brent, 2023), further refines investment evaluations. These tools help the VA distribute resources efficiently while supporting long-term clinical goals.

The VA serves over nine million veterans, requiring correct demand forecasting to manage shifting demographics. Migration trends influence facility placement, preventing underutilization or overcrowding (VHA, 2024). The VA Mission Act of 2018 mandates modernization using migration data and market analysis (VA AIR Commission, 2019). Stochastic modeling helps assess uncertainties such as migration shifts, inflation, and healthcare costs, assigning probabilities to various outcomes (Pinsky & Karlin, 2011). These models support multi-criteria decision-making, balancing cost, time, and quality (Caddell et al., 2020). Stochastic modeling plays a key role in managing uncertainties in healthcare facility planning. These models assess risks related to migration trends, inflation, and healthcare costs by assigning probabilities to different outcomes (Pinsky & Karlin, 2011). In multi-criteria decision-making, stochastic models help the VA balance competing goals such as cost, time, and quality under uncertain conditions (Caddell et al., 2020). By simulating a range of outcomes, these models give decision-makers a clearer understanding of potential risks, enabling more informed, data-driven choices. LCCA enhances financial planning, while CEA and CBA evaluate economic and health impacts of infrastructure investments. Stochastic modeling mitigates uncertainties, providing a data-driven framework for sustainable, cost-effective decision-making. Together, these tools enable the VA to improve healthcare infrastructure, ensuring efficient resource allocation and high-quality care for veterans.

2. Methodology

2.1 Qualitative and Quantitative Stochastic Modeling

The Lease vs. Build evaluation methodology provides a systematic approach for comparing leasing and building alternatives. The process begins by scoring value alternatives using a multi-criteria value scoring tool in Excel. Next, a cost model extracts the Life Cycle Cost Analysis (LCCA) for each alternative. A trade space analysis follows, using a stochastic and predictive model to assess value and cost relationships. The research then presents dynamic results through an interactive application. These insights, supported by real data from counties in North Carolina, help inform lease vs. build decisions. The overall value measurements for all alternatives depend on value functions, as shown in Figure 2.

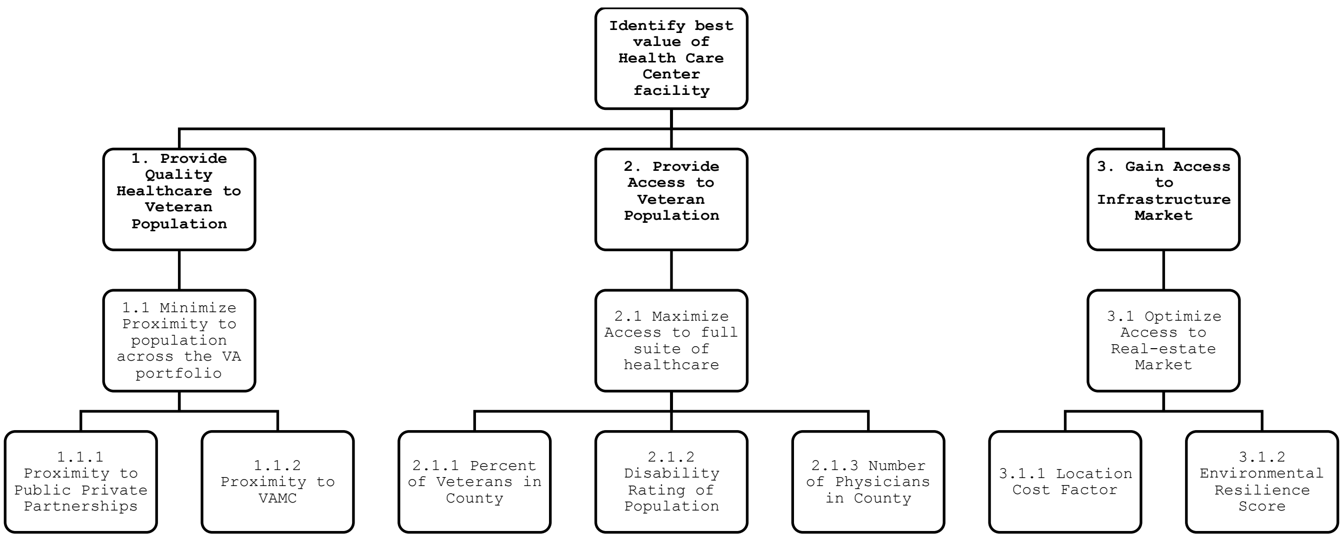

Figure 2: Qualitative Value Model

Figure 2 outlines a qualitative value model that breaks down different value criteria and explains their contributions to the overall quantitative total value score through their weights. The additive value model calculates the total value for each alternative by multiplying each alternative's value score for a given metric by its global weight. See Equation 1 below.

$$TV_n = 0.107 * VAMC + 0.143 * PDP + 0.250 * VetPct + 0.214 * Physicians + 0.179 * Disability + 0.036 * LCF + 0.071 * Resilience \quad (1)$$

The model sets up global weights based on inputs and rankings from VA executive leaders. The VA has confirmed this key assumption to ensure accurate value measurement and analysis. The model uses Rank Sum Weighting (RSW) to convert rankings into weights. RSW assigns weights to objectives according to their importance, giving higher-ranked objectives proportionally greater weights and lower-ranked one's smaller weights. For this model's use case, the research team collected data from all counties in North Carolina within Veterans Integrated Services Network seven (VISN-7), a VISN with a high veteran migratory pattern. After scoring each alternative, the team applied a Monte Carlo simulation that used a triangular distribution for the following variables: 1) Number of Physicians in a County, 2) Percentage of Veterans in a County, and 3) Location Cost Factor. Last year's study offered key insights into these parameters, helping refine distribution types and ensure the model accurately reflects real-world variations in healthcare access and regional costs. The team evaluated six build and lease alternatives across different counties in North Carolina, producing a stochastic total value score for each possibility. Figure 4 models the trade space between the value and cost of the six alternatives.

Several methodological enhancements improve the model's accuracy and robustness in evaluating financial implications. The refinements include updated cost estimation techniques, more representative financial assumptions, and an extended 60-year evaluation period—aligning with the VA's standard facility lifespan for healthcare infrastructure. A typical lease is 20 years, and OFM's executive team confirmed that three leases are equivalent to one sixty-year build. This extension enables more exact lifecycle cost comparisons between build and lease alternatives.

Parameters Table	
AVG Interest Rate	0.03
Min Interest Rate	0.02
Max Interest Rate	0.08
Current Interest Rate	**0.030042335**
Unserviced Rent Cost Per SQFT For Lease	**$48.07**
Unserviced Rent Cost Per SQFT For Lease MIN	$32.00
Unserviced Rent Cost Per SQFT For Lease Max	$85.00
Unserviced Rent Cost Per SQFT For Lease AVG	$61.00
Operating Expenses NUSF	**$8.33**
Operating Expenses NUSF Min	$5.00
Operating Expenses NUSF Max	$16.00
Operating Expenses NUSF AVG	$11.00

Figure 3: Finished Cost Parameters

The model estimates initial build costs using industry standards and historical VA data. The research team applies a triangular distribution method to operational cost projections, using VA estimates as a baseline to account for uncertainty with a range of plausible expenses as shown in the parameters in Figure 3. A similar approach applies to interest rates for build projects, using national averages to capture borrowing cost fluctuations. Lease cost estimates, based on cost-per-square-foot averages, also undergo triangular distribution analysis to reflect market variations, location-based differences, and inflationary effects. These refinements strengthen the model's ability to compare financial feasibility, providing a stronger foundation for VA infrastructure planning.

3. Findings

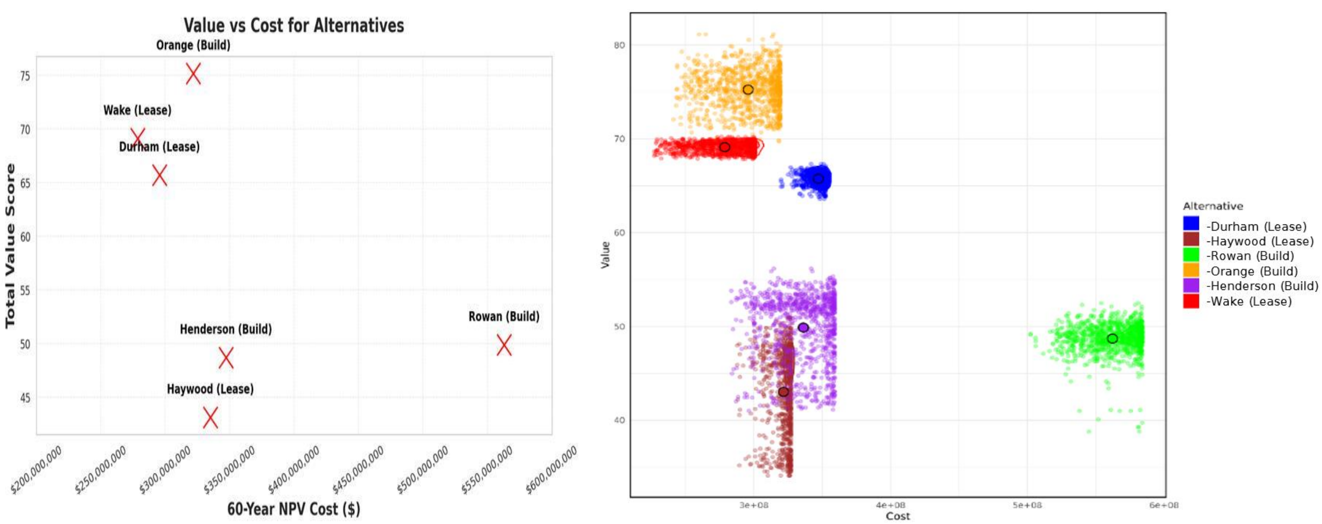

Figure 4: Deterministic (left plot) vs Stochastic (right plot) Analysis of Alternatives

Figure 4 compares deterministic and stochastic approaches in evaluating the trade space of cost and value for alternatives. Stochastic simulation populates the two-dimensional trade space with full distributions of potential realizations for each county, providing a more comprehensive analysis. In contrast, deterministic analysis relies on point estimates, which do not accurately stand for dominance relationships and alternative evaluations.

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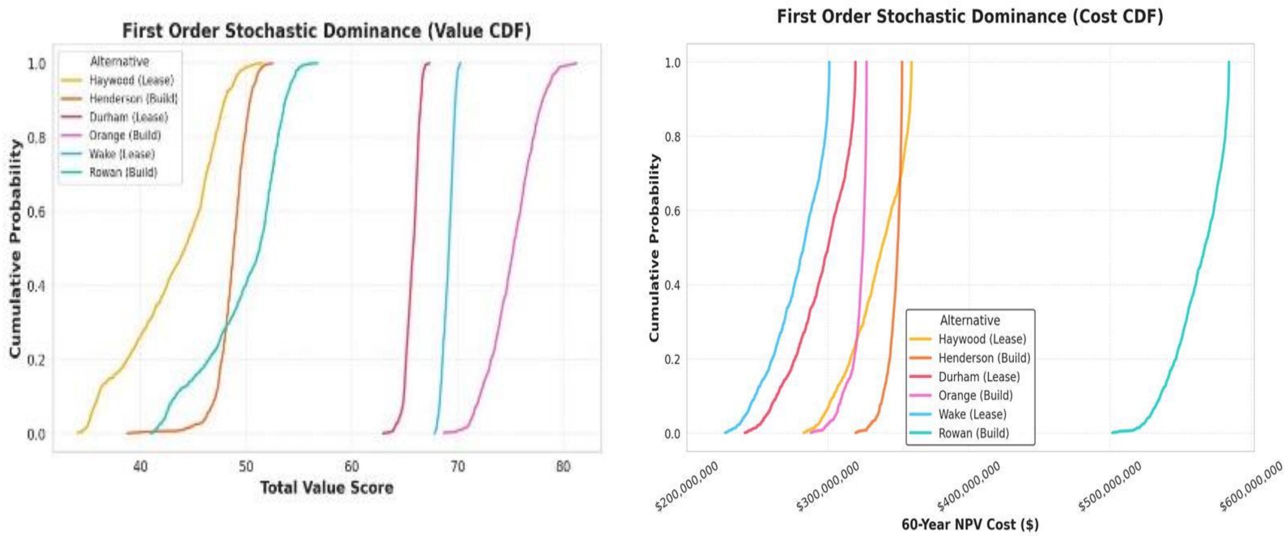

Figure 5: Cost and Value Cumulative Distribution Function (CDFs)

The Cost and Value CDFs illustrate that Orange County delivers the highest value compared to other alternatives in most cases. Wake County has the lowest cost among all alternatives, as shown in the First Order Stochastic Dominance in Figure 5. In this context, dominance refers to one alternative consistently outperforming others across a range of outcomes, making it a more favorable choice under uncertainty.

The model provides substantial value through its scalability, usability, and ability to offer critical decision-making insights for the VA's senior leadership as shown in the example of North Carolina. In the methodology example, the model evaluates six alternatives, comparing build-versus-lease options across North Carolina—one of the top regions for veteran migration in the U.S. However, it can scale to assess numerous alternatives across different states and counties.

A key strength of this model is its ability to capture uncertainty in cost and value assessments. Traditional deterministic methods do not account for inherent risks in infrastructure planning. The stochastic modeling approach used in this study allows decision-makers to better understand and evaluate risks, leading to more informed choices.

A key limitation of this study is its geographic scope, as the model only includes data for counties in North Carolina. This constraint limits its applicability to national-level VA infrastructure, and it prevents a comprehensive assessment of veteran demand across diverse regions. Scaling the model effectively would require collecting data from all U.S. counties to ensure broader relevance. Additionally, the model relies on several assumptions about project costs and sizes, including initial build costs, salvage value, an assumed national average of 225,000 SQFT for build and lease projects, and a triangular distribution of interest rates.

The findings highlight the importance of integrating advanced tools and methodologies to address these challenges. By incorporating stochastic life cycle cost estimation, decision-makers can enhance the accuracy and effectiveness of facility planning by showing a comprehensive risk analysis of alternatives. The model helps find high-demand areas, best facility placement, and mitigates risk related to overutilization, and underutilization. Acknowledging these limitations and planning for iterative improvements set the foundation for a more adaptive decision-making framework. Future iterations will focus on expanding the model's geographic scope and refining stochastic modeling techniques using artificial intelligence, ensuring a more precise and impactful approach to VA infrastructure planning. Based on the model's stochastic analysis, the VA should pursue a build alternative in Orange County, as it consistently demonstrates the highest value across scenarios and meets veteran demand in a high-migration region. While Wake County offers the lowest cost, Orange County provides a more favorable balance of cost and value, making it the best choice under uncertainty.

4. Conclusion and Future Work

This study presents a stochastic value model to help the Department of Veterans Affairs (VA) make informed Lease vs. Build decisions for healthcare infrastructure. By integrating stochastic modeling, life cycle cost estimation (LCCA), and multi-criteria decision analysis, the model quantifies financial and strategic trade-offs. It enables VA decision-makers to assess infrastructure options based on long-term costs, veteran demand, and regional factors, improving resource allocation.

A key strength of this model is its ability to incorporate uncertainty into planning. Traditional methods often overlook fluctuating costs, demographic shifts, and market changes. By using Monte Carlo simulations and probabilistic distributions, the model offers data-driven insights that improve healthcare accessibility, financial risks, and facility placement.

However, the model has limitations. It currently focuses only on North Carolina, limiting nationwide application. It also relies on assumptions about facility size, interest rates, and construction costs, which may not fully reflect local conditions. Additionally, it does not account for policy changes, medical advancements, or evolving VA priorities, which could affect long-term infrastructure needs.

Future work will address these challenges. Expanding the model nationwide will improve its relevance. Refining cost and risk parameters with real-time economic data will enhance accuracy. Integrating GIS tools will allow planners to visualize veteran migration trends and demand hotspots, improving facility placement. By addressing these gaps, this model can evolve into a scalable, data-driven decision-making tool that enhances VA infrastructure planning, cost efficiency, and healthcare accessibility for veterans nationwide. Our study demonstrated a method to stochastically model the trade space for a Lease vs. Build decision analysis.

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