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COST-BENEFIT ANALYSIS OF MARINE CORPS OPERATIONAL SUPPORT AIRLIFT: ALTERNATIVE ACQUISITION AND FORCE STRUCTURES FOR MARINE CORPS OPERATIONAL SUPPORT AIRLIFT

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THESIS

COST-BENEFIT ANALYSIS OF MARINE CORPS OPERATIONAL SUPPORT AIRLIFT: ALTERNATIVE ACQUISITION AND FORCE STRUCTURES FOR MARINE CORPS OPERATIONAL SUPPORT AIRLIFT

by

Jerett D. Fazendine

March 2022

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13. ABSTRACT (maximum 200 words)

The United States Marine Corps (USMC) currently operates 28 operational support airlift (OSA) aircraft. The USMC must maintain the requirements set forth by the Department of Defense in a cost-effective way to ensure the OSA aircraft and personnel accomplish the mission. In this thesis, I use a cost-benefit analysis to examine the current OSA fleet, specifically the UC-12W and UC-35D platforms and several feasible alternative courses of action (COAs). In my analysis, by estimating the costs associated with operations, support, and personnel, I find that there are cost-saving opportunities of approximately $2 million over the five-year cost projection by implementing an alternative COA that adds three additional UC-12W aircraft to the OSA fleet. The findings of the cost-benefit analysis provide evidence that the current structure of medium- and short-range aircraft is not the most cost-effective; therefore, a restructuring of the UC-12W and UC-35D must be undertaken to ensure the OSA program maximizes cost savings.

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The United States Marine Corps (USMC) currently operates 28 operational support airlift (OSA) aircraft. The USMC must maintain the requirements set forth by the Department of Defense in a cost-effective way to ensure the OSA aircraft and personnel accomplish the mission. In this thesis, I use a cost-benefit analysis to examine the current OSA fleet, specifically the UC-12W and UC-35D platforms and several feasible alternative courses of action (COAs). In my analysis, by estimating the costs associated with operations, support, and personnel, I find that there are cost-saving opportunities of approximately $2 million over the five-year cost projection by implementing an alternative COA that adds three additional UC-12W aircraft to the OSA fleet. The findings of the cost-benefit analysis provide evidence that the current structure of medium- and short-range aircraft is not the most cost-effective; therefore, a restructuring of the UC-12W and UC-35D must be undertaken to ensure the OSA program maximizes cost savings.

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LIST OF ACRONYMS AND ABBREVIATIONS

AFM	aviation fleet maintenance
AVDLR	aviation depot level repair
AVPLAN	Aviation Plan
CBA	Cost-Benefit Analysis
COA	course of action
CONUS	Continental United States
CPFH	cost per flying hour
DAU	Defense Acquisition University
DOD	Department of Defense
HQMC	Headquarters Marine Corps
IFF	identify friend or foe
JOSAC	Joint Operational Support Airlift Center
LCC	life-cycle costs
MAG	Marine Aircraft Group
MAGTF	Marine Air-Ground Task Force
MCAS	Marine Corps Air Station
MROC	Marine Requirements Oversight Council
NDS	National Defense Strategy
NPS	Naval Postgraduate School
NPV	Net Present Value
O&S	operation and support
OASD	Office of the Assistant Secretary of Defense
OCONUS	outside the Continental United States
OSA	Operational Support Airlift
PAI	Cost per Aircraft
RDT&E	research development test and evaluation
SAR	Search and Rescue
T/M/S	Type/Model/Series
USMC	United States Marine Corps
USTRANSCOM	United States Transportation Command

VAMOSC	Visibility and Management of Operations and Support Costs
WESTPAC	Western Pacific

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I. INTRODUCTION

The United States Marine Corps (UMSC) currently operates 28 Operational Support Airlift (OSA) aircraft located within the Continental United States (CONUS) and the Western Pacific (WESTPAC). These aircraft are divided into three type model series that include: UC-12 King Air, UC-35 Citation, and the C-20 Gulfstream. While not currently in wartime conditions, the USMC must maintain the requirements set forth by the Department of Defense (DOD) to ensure operational capability. With ever looming budget re-allocations, a new National Defense Strategy (NDS), updated USMC Aviation Plan (AVPLAN) along with an aging OSA fleet the USMC is looking to identify feasible cost-effective alternate ways to ensure the OSA aircraft and personnel accomplish the mission. The current structure of the short-range and medium range aircraft makeup two thirds of the OSA fleet and incur the most cost. The goal of this thesis is to provide a structure of medium and short-range aircraft that can support the OSA mission in the most cost-effective manner.

For this thesis, I examine the current OSA fleet, specifically the UC-12 and UC-35 platforms and the costs associated with operations, support, and personnel. The focus on the UC-12 and the UC-35 platforms is based on the versatility and capability they provide. My analysis operates under the assumption that operations will continue in CONUS and WESTPAC but also looking at future wartime requirements.

A. RESEARCH QUESTIONS

The thesis addresses the following research questions.

1. Primary Questions

What are the minimum requirements needed to sustain the USMC OSA capability?

What is the cost effectiveness of restructuring the current USMC OSA fixed wing assets consisting of UC-12 King Air and UC-35 Citation variants?

2. Secondary Question

What is the cost effectiveness of outsourcing USMC OSA missions to current USMC tactical aircraft?

B. APPROACH

The UC-12 King Air and UC-35 Citation aircraft provide different capabilities and limitations. For my analysis, I identify three courses of action (COA) that are differentiated from the status quo but align with my previous assumptions. Each COA is under the assumption that the OSA fleet inventory is 28 aircraft. The first COA examined was the addition of three new UC-12 variants along with modernizing the current aircraft and maintaining the current inventory of UC-35 variants. The second COA involves the addition of three UC-35 variants along with modernizing the current aircraft and maintaining the current inventory UC-12 variants. The third and final COA uses existing USMC tactical aircraft to facilitate he OSA mission. The current manpower model is that only the flight crews are military personnel in each COA, therefore the only COA that does not include contract maintenance is COA three.

To evaluate the best-value option, I use current and historical data provided from multiple sources to ensure the current capability and costs are well documented, then compare with the costs and capabilities of the three separate COAs. In this thesis I conduct a Cost-Benefit Analysis (CBA) on the UC-12 King Air, as well as the UC-35 Citation to provide the best possible recommendations for aircraft requirements, structure, and acquisitions.

Lastly, as part of conducting the CBA for this project, I account for the source and nature of risk and uncertainty related to maintaining the OSA capability through the different COAs considered and conduct a sensitivity analysis to better understand the relation between the risks and estimate net benefits for each COA. It is important to note that monetary values can be placed on certain factors such as aircraft, facilities and manpower but proves to be difficult in monetizing social benefit when analyzing a military platform. In my analysis, I identify relative strengths and drawbacks for each COA, to provide decision support even when all elements of relative costs and benefits are easily monetized.

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II. BACKGROUND

A. OSA AND MILITARY MANPOWER/PERSONNEL

The mission of OSA is to support movement of high-priority passengers and cargo with mission-sensitive requirements (Merritt, 2017). The DOD facilitates all OSA missions through the Joint Operational Support Airlift Center (JOSAC), which falls under the United States Transportation Command (USTRANSCOM). JOSAC in the single entity, regardless of service department that schedules and assigns fixed-winged aircraft to accomplish all OSA requirements. The DOD uses DOD Instruction 4500.43 (DoDI 4500.43) to establish policy and assign responsibilities for the use of OSA aircraft for all service branches. In the DoDI 4500.43 it specifically states, "Inventory levels of OSA aircraft shall be based solely on joint wartime readiness requirements. The DOD Components shall dispose of those aircraft in excess of joint readiness requirements" (Department of Defense [DOD], 2010, p. 21). The DoDI 4500.43 establishes that the "use of OSA aircraft is restricted to the transport of DOD personnel, government property, other official government passengers, and other passengers or cargo as authorized by DOD directives, regulations, and policies" (DOD, 2010). The DoDI 4500.43 requires that commanders and authorizing officials at all levels restrict OSA travel based of the purpose and the priority of the trip while using an aircraft with minimal cost and size that will satisfy the mission requirement (DOD, 2010).

In this thesis, I conduct a CBA of the USMC OSA aircraft inventory, specifically the UC-12 King Air and UC-35 Citation variants. My goal is to determine if the status quo is the more efficient while updating the current fleet, or to refine the requirements and restructure the current OSA fleet. Lastly, I determine if the outsourcing of OSA missions would yield cost savings for the Marine Corps and DOD.

While my focus is directed to the operation, sustainment, and maintenance costs of UC-12 and UC-35 platforms, manpower and personnel are factors when determining aircraft requirements or restructuring the fleet. OSA squadrons are located on MCAS and staffed by active-duty station personnel (Headquarters, Marine Corps [HQMC], 2019). In most cases aircrew will be able to make the transitions to multiple aircraft platforms without incurring any additional costs. With regards to maintenance personnel all OSA maintenance is contracted out therefore military manpower is unaffected. Also, the use of USMC tactical aircraft to facilitate the OSA mission requirements can be achieved with the current USMC aviation manpower model.

B. WHAT IS USMC OSA

> The mission of Marine Corps OSA is to provide Marine Corps forces and MAGTFs with time-sensitive air transport of high priority passengers and cargo and other critical air logistic support between and within a theater of war, and to otherwise support Marines as required. Marine Corps OSA units perform the same airlift missions whether deployed or at their home stations because the mission of providing time-sensitive air transport remains constant regardless of location. (Headquarters, Marine Corps [HQMC], 2020, p. 3)

1. Current OSA Inventory Requirements

As previously discussed, the DoDI 4500.43 specifically states, "Inventory levels of OSA aircraft shall be based solely on joint wartime readiness requirements. The DOD Components shall dispose of those aircraft in excess of joint readiness requirements" (DOD, 2010, p. 2). Currently the USMC does not have a model for the joint wartime readiness requirements and the last proposed requirement for a minimum of 27 USMC OSA aircraft came from the Marine Requirements Oversight Council (MROC) decision memorandum in 2010 (Amos, 2010). Figure 1 displays the current laydown of the Marine Corps OSA aircraft. Current funding allocates for the operation and support of 28 OSA aircraft.

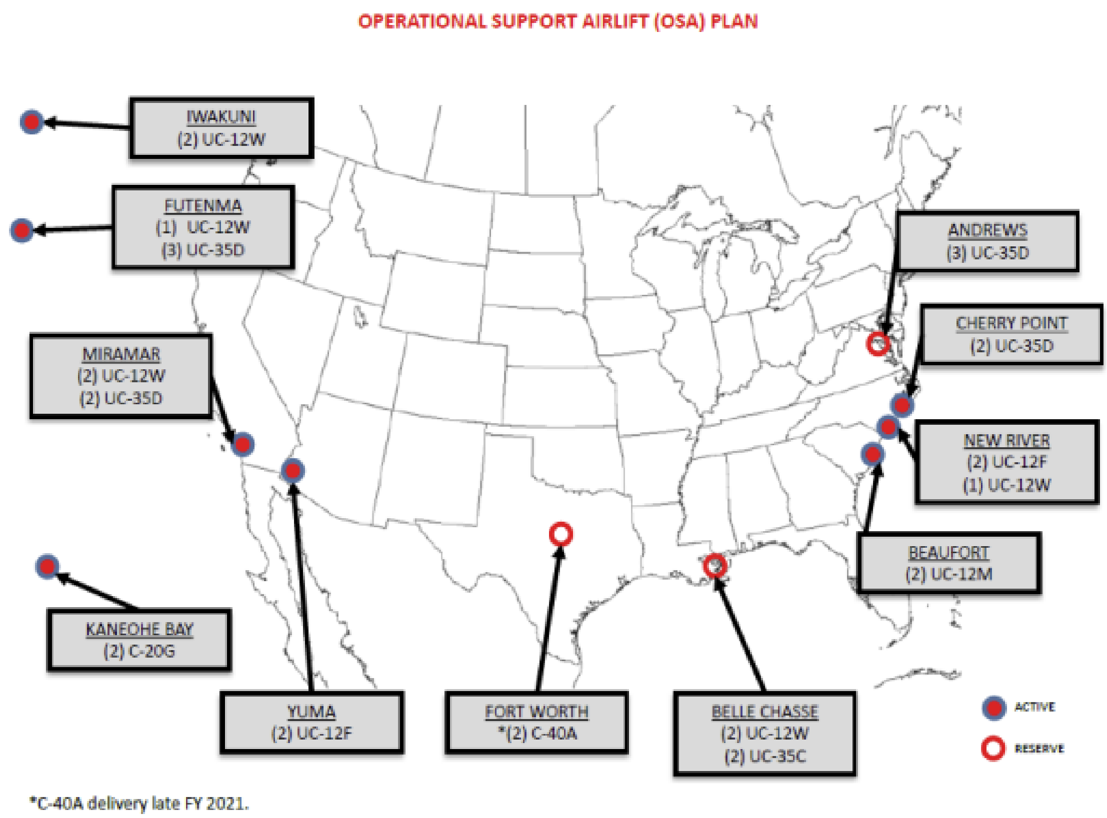


Figure 1. Marine Corps OSA Aircraft Laydown. Source: (HQMC, 2020).

2. Current OSA Aircraft

The USMC currently operates 28 OSA aircraft out a joint fleet of 287 OSA executive aircraft. The OSA role within USMC Aviation "falls under assault support, specifically, air logistic support and air evacuation" (HQMC, 2020, p. 10). For this reason, the USMC has selected aircraft that have unique attributes that support the USMC mission. The UC-12 King Air is the most utilized aircraft in the OSA fleet. Currently there are 15 UC-12's with three variants F, M, and W in the USMC OSA inventory.

The UC-12F/M (Figure 2) is a turboprop, twin-engine aircraft with a range of 1,100 nautical miles with a cruise speed of 270 knots. This aircraft can carry seven passengers with a cargo load cargo load of 400 pounds but are limited to CONUS operations. These limitations are due to the aircraft radios because they are unable to be encrypted as well as they are not equipped with an Identify Friend or Foe (IFF) transponder (HQMC, 2020).

Figure 2. UC-12 F/M King Air. Source: HQMC (2020).

The UC-12W (Figure 3) aircraft is the upgraded version of the UC-12F/M that provides greater capabilities with fewer limitations. The UC-12W is a turboprop, twin-engine aircraft with a range of 1,500 nautical miles and 2000 nautical miles when equipped with extended range fuel tanks. The cruise speed is 280 knots carrying 8 passengers with a cargo load cargo load of 500 pounds. Unlike the UC-12F/M the UC-12W can be deployed in support of Marine Air-Ground Task Force (MAGTF) operations worldwide (HQMC, 2020, p. 28).

Figure 3. UC-12W Super King Air. Source: HQMC (2020).

The next USMC OSA aircraft is the medium-range UC-35C/D (Figure 4), which is an off-the-shelf version of the Cessna Citation Encore. The UC-35C/D is a jet aircraft with dual Pratt & Whitney JT15-D engines. The aircraft has a range of 1,400 nautical miles and 2000 nautical miles and a cruise speed of 400 knots carrying 7 passengers with a cargo load cargo load of 300 pounds. Just as the UC-12W the UC-35C/D can be deployed in support of MAGTF operations worldwide (HQMC, 2020)

Figure 4. UC-35D/ Citation. Source: HQMC (2020).

The third and final aircraft of the OSA fleet is the C-20G (Figure 5), which is a Gulf Stream IV aircraft. This jet aircraft can carry 26 passengers or up to 6000 pounds of cargo and cruises at 460 knots with a range of 4,220 nautical miles. This aircraft serves the Commander of Marine Corps Forces Pacific (COMMARFORPAC), and Commander if Marine Forces Central Command (MARFORCENT). It has "intercontinental/ intertheater range and payload capabilities" (HQMC, 2020).

Figure 5. C-20G Gulf Stream IV. Source: HQMC (2020).

The mission of Marine Corps OSA is to provide Marine Corps forces and MAGTFs with time-sensitive air transport of high priority passengers and cargo and other critical air logistic support between and within a theater of war, and to otherwise support Marines as required (HQMC 2020, p. 3). The Marine Corps accomplishes this mission by using the 28 aircraft currently in active status with the possibility of adding additional aircraft. Currently these aircraft provide short, medium, and long-range capabilities while conducting training and combat mission in CONUS and OCONUS.

III. LITERATURE REVIEW

A. COST AND OPERATIONAL EFFECTIVENESS ANALYSIS OF ALTERNATIVE FORCE STRUCTURES FOR FULFILLMENT OF THE UNITED STATES MARINE CORPS OPERATIONAL SUPPORT AIRLIFT AND SEARCH AND RESCUE MISSIONS

In March 2000, Major Eric Chase completed a cost-effective analysis at the Naval Postgraduate School (NPS) covering USMC OSA and search and rescue (SAR). Chase tailored his preliminary research to find a cost-effective approach for restructuring the aircraft to facilitate OSA and SAR missions. This thesis came at a time when the USMC was poised to undertake significant modernization of its aviation assets (Chase, 2000). Chase points out that the modernization strategy of the aviation assets is mostly directed to the USMC tactical aircraft. Chase specifically conducted research on the comparative cost-effectiveness of four alternative force structures consisting of UC-12, UC-35, CH-46 and HV-609 for OSA and SAR mission requirements. Lastly, Chase's final recommendation is ultimately why I chose to conduct follow-on research and look for a cost effective approach to restructure the OSA fixed wing aircraft.

When Chase conducted his research, he focused on the maximizing the utility of the current Marine Corps OSA and SAR aircraft. At the time the of this research the United States was at a state of war, therefore OSA and SAR missions were mostly CONUS based. The OSA fleet is made up of off-the-shelf commercial aircraft for which procurement and life-cycle cost (LCC) are established. As pointed out in his research "traditional life-cycle cost categories are research, development, test, and evaluation (RDT&E), procurement, O&S and disposal" (Chase, 2000, p. 31). For the scope of his thesis Chase only included procurement and O&S costs. He chose to take four alternatives and analyze each of them to find the most cost-effective inventory for the OSA and SAR fleet.

The first alternative Chase aims to have 14 C-12's to facilitate the OSA mission while using 12 HH-46E to facilitate the SAR mission. The C-12 mission capability is mostly considered to be short range. What Chase failed to consider for the first alternative was that having only C-12's eliminates the ability to conduct medium and long-range missions. Therefore, the OSA structure for alternative one requires flexibility in fixed wing aircraft. His alternative of using 12 HH-46E for SAR would indeed facilitate the SAR mission and be cost-effective. Overall, his alternative one would benefit the Marine Corps SAR program but severely limit the OSA program.

The second alternative Chase proposes is the use of UC-35 for a one for one swap with the C-12 while keeping the same HH-46E structure as alternative one. The HH-46E structure in the first and second alternative provide the capabilities to accomplish the SAR mission. Like the first alternative the second concentrates on a single fixed wing capability but switched the capability from a short-range aircraft to a medium range aircraft. Although, this alternative could accomplish the short-range mission requirements it would come at the cost of decreased passengers or cargo weight. The third alternative, which Chase considers to be IIIa, is that the Marine Corps replaces the current C-12's with 14 HV-609 configured with an executive transport package to fulfill the OSA requirements (Chase, 2000). Additionally, alternative IIIa requires the Marine Corps procure 12 HV-609 configured with SAR capabilities. Lastly, alternative IIIb is structured like IIIa but instead of 12 HV-609 for SAR its decreased to 8 HV-609. Alternatives IIIa and IIIb provide the necessary requirements to complete the OSA and SAR missions but the Marine Corps chose to use the tilt rotor platform as a tactical aircraft.

As talked about before Chase chose the cost analysis approach in terms of LCC except he only used procurement and O&S costs. By not using disposal costs especially when his alternatives require one for one replacements of aircraft severely degrades the cost estimate. Chase converted all costs to FY98 value and 4.1% discount rate from the OMB Circular A-94 to calculate the Net Present Value (NPV) (Chase, 2000). Chase provides results through his research with specific conclusions for the most cost-effective alternative for each category. The alternative that is the most cost effective with regards to procurement and conversion cost is alternative one, alternatives IIIa and IIIb have the lowest O&S costs, and alternative II has the lowest overall LCC. He follows up his results with the recommendation that "further consideration should be given to examining alternative force structures that utilize multi-role aircraft to fulfill distinctly different tactical and non-tactical missions" (Chase, 2000, p. 81). Lastly, he concludes that additional research should be "conducted on specific force structure requirements" and "additional mixes of fixed wing OSA assets" (Chase, 2000, p. 81).

From his recommendations I chose to analyze the OSA force structure and requirements to provide a modernized structure that provides short and medium range capabilities in the most cost-efficient way. In order to frame his analysis Chase chose to use program office estimates, instead I use data from Visibility and Management of Operations and Support Costs (VAMOSC) and Headquarters Marine Corps. This data provides the most accurate costs to build three individual COA's that best support the OSA mission.

B. COST-BENEFIT ANALYSIS OF MARINE CORPS SEARCH AND RESCUE (SAR): A STUDY OF ALTERNATIVES FOR MARINE CORPS AIR STATIONS AT CHERRY POINT AND YUMA

Major's Clinton Collins and Robert Williamson completed a thesis that included a CBA on the USMC SAR which included alternatives for Marine Corps Air Station (MCAS) Yuma, and Cherry Point. They aimed to provide a more cost-effective approach to the SAR mission, more specifically they tailored their research to prove that a commercial contract alternative would be more cost-effective. This thesis provided insight into commercial outsourcing and showed it would be difficult to obtain the data needed to provide a thorough analysis. For that reason, I chose to provide an alternative in my thesis by using current Marine Corps tactical aircraft, instead of a commercial option to support the OSA mission. Their findings and recommendation ultimately concluded that "The Marine Corps could realize savings of approximately $14 million per year (FY2014) by utilizing a commercial contract for local base SAR at MCAS Cherry Point and MCAS Yuma" (Collins & Williamson, 2013, p. 69).

Collins and Williamson's CBA provided an analysis of the current SAR status quo as a benchmark to estimates costs, which included O&S costs over a one-year forecast based on 10 years of historical data. (Collins & Williamson, 2013). Their analysis provided a framework for which I applied to the OSA requirement. By using the status quo, I am able to examine current operating costs and compare them to new alternatives. Collins and Williamson also provided an option to upgrade all USMC SAR aircraft. This is a critical component of the OSA fleet due to LCC and the inventory needing several modifications. Like their alternative I chose to provide alternatives for upgrading the UC-12 and UC-35 aircraft. Lastly, their research was aimed at providing a commercial contract alternative. This approach for the OSA mission is not viable especially for the wartime requirements and for that reason I chose the use of USMC tactical aircraft. The use of tactical aircraft provides the capabilities needed for wartime requirements while limiting the bureaucratic approval process.

C. METRICS TO COMPARE AIRCRAFT OPERATING AND SUPPORT COSTS IN THE DEPARTMENT OF DEFENSE

In 2015, RAND Corporation produced a report by Michael Boito, Edward G. Keating, John Wallace, Bradley DeBois, and Ilana Blum titled "Metrics to Compare Aircraft Operating and Support Cost in the Department of Defense." Their research aimed to aid the Office of the Assistant Secretary of Defense (OASD) in developing a consistent definition of aircraft O&S cost per flying hour (CPFH) that can be used across different aircraft platforms in the DOD (Boito et al., 2015). A metric most referred to and used by decision makers is the CPFH. This metric can be used in a multitude of ways from tracking the success of an aircraft platform and comparing weapon systems. The problem with this metric is that it is difficult to normalize across aviation platforms. This research report recommends that instead of using the CPFH metric for O&S costs "that cost-per-aircraft metric as a useful alternative metric of aircraft O&S costs" (Boito et al., 2015, p. 35).

When they began their research for this report they started with the question "What are the most appropriate metrics that high-level DOD decisionmakers can use to compare the O&S costs of different aircraft" (Boito et al., 2015, p. 36)? This question is simple in nature but becomes much more difficult in its application. For the decision makers to compare O&S costs their needs to be a baseline of each element within the O&S costs. These elements include fixed costs such as personnel and variable costs like fuel and parts (Boito et al., 2015). Most importantly these costs need to be normalized across platforms in order to capture a complete comparison. Their research provides five metrics for normalizing O&S costs.

The first metric they address and one that is widely used is the CPFH. The formula for CPFH is

$$CPFH_{Cross\text{-}System} = \frac{Direct\ O\&S\ Costs}{Flying\ Hours}.$$

They conducted numerous interviews with subject matter experts all to which concluded that using the CPFH metric was "unsuitable as a measure of affordability" (Boito et al., 2015, p. 25). The report points out a particular issue with the CPFH metric because the flying hours are in the denominator of the equation. This causes the CPFH to increase when the O&S costs and flying hours decrease. For that reason, I chose in my analysis not to rely solely on the CPFH metric when providing my recommendations.

Cost per Aircraft (PAI) was the next metric looked at as an alternative. This metric takes the total O&S costs and divides it by the number of total aircraft

$$Cost\ per\ Aircraft = \frac{Total\ \ O\&S\ Costs}{Number\ of\ Aircraft}.$$

With PAI there is a more intuitive approach for the cost metric. The variability in PAI is less than the CPFH metric due to the fixed number of aircraft located in the denominator. The only variability in this equation comes from the changes in total O&S costs, not the number of aircraft. When looking at my alternative force structures PAI was the metric I chose because I am either adding or eliminating aircraft from the inventory. By using the total O&S costs and applying a different aircraft inventory I am able to show which alternatives are more cost effective. The RAND research report provides an illustration (Figure 5) of the "mirror-image relationship between the KC-135 CPFH and PAI" (Boito et al., 2015, p. 26).

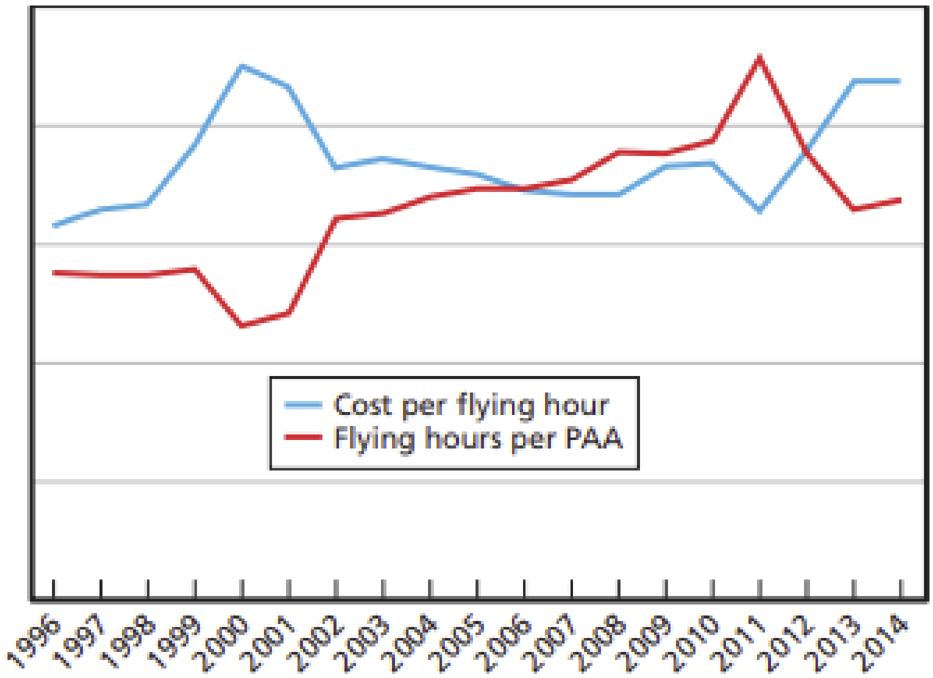


Figure 6. The Mirror-Image Relationship between KC-135 Cost per Flying Hour and Flying Hours per Aircraft. Source: Boito et al. (2015).

The Cost per Squadron metric is the third metric provided by the RAND research report. This metric uses the total O&S costs divided by the number of squadrons. This metric would suffice when comparing the same capabilities and platforms but due to the varying number of squadrons along with different inventory requirements this metric is not useful for comparing cross systems. Next, is Cost per Fleet metric, which is the total O&S cost associated with the weapon system. The following illustration (Figure 6) provided visual representation of a normalized "comparison of the KC-135 CPFH, PAI, and Cost per Fleet" (Boito et al., 2015, p. 26).

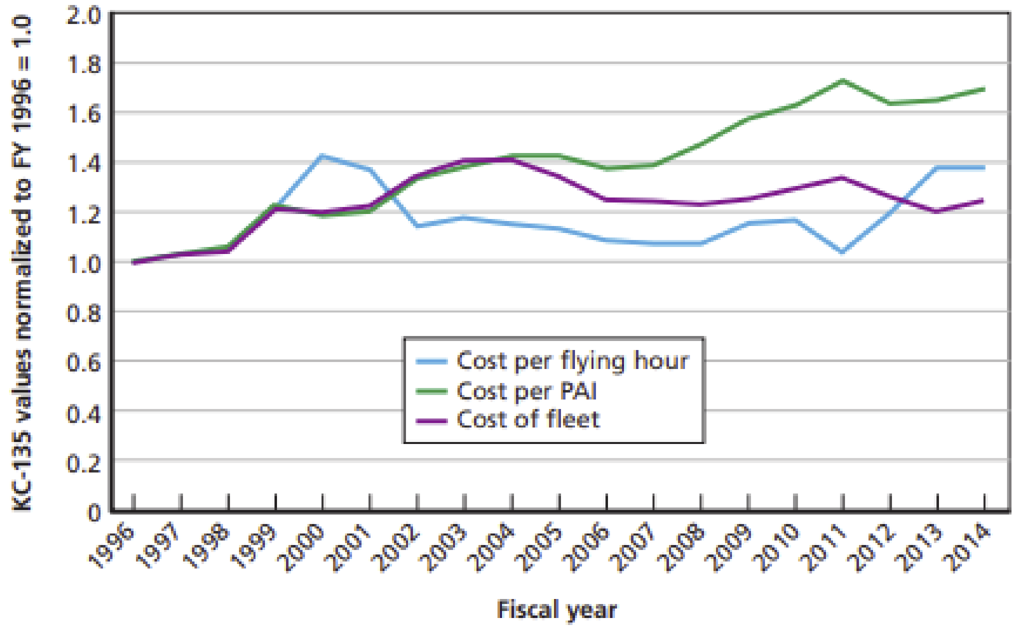


Figure 7. A Comparison of KC-135 Cost per Flying Hour, Cost per Aircraft, and Cost per Fleet since FY 1996 Normalized to FY 1996. Source: Boito et al. (2015).

Once again, this metric is suitable is looking into affordability of a platform but when comparing multiple platforms this metric would prove to be very difficult. Lastly, is the Cost per Capability, which is a metric that is very specific. The report states that "aircraft fleets in DOD fly a variety of missions with different purposes, many of which are complex and multidimensional" (Boito et al., 2015, p. 31). Therefore, to use this metric when comparing cost across platforms would require the same mission capability. For my analysis using this metric would not be practical because the UC-12 and UC-35 provide different capabilities to the OSA mission.

The RAND research report concludes by providing a recommendation on an aircraft O&S cost metric that best facilitates the DOD decision makers. They recommend the use of the PAI metric but provide an alternate name of Direct Cost per Aircraft. This metric has multiple advantages when comparing similar and different aircraft platforms. It is also pointed out that each metric is a viable solution when comparing O&S costs on aircraft and that it is "unrealistic" that one metric is the best for all solutions (Boito et al., 2015). When looking over the O&S costs for my analysis of the UC-12 and UC-35 aircraft, the metric that provides the best results for a CBA is the PAI metric.

The Chase thesis provided a path and direction for this thesis to conduct further research on fixed wing assets within the Marine Corps OSA program. The focus on medium and short-range assets are critical because they make up two thirds of the OSA asset. Next, the thesis by Major's Clinton Collins and Robert Williamson provided a cost benefit approach to SAR that is easily relatable to the Marine Corp OSA program. Finally, the RAND study provided the metric of PAI to be implemented while conducting the CBA. Each piece of literature provides an element that is displayed throughout this thesis.

IV. ANALYSIS

A. METHODOLOGY

The purpose of my thesis is to conduct a CBA to the Marine Corps OSA program with the intent of identifying feasible opportunities to improve efficiencies of maintaining the OSA capability. A CBA study approach, according to Boardman et al. (2011) is "a policy assessment method that quantifies in monetary terms the value of all consequences of a policy to all members of society" (Boardman et al., p. 2). Using this approach I provide decision makers, policy makers, and resource managers a "method for making direct comparisons among alternative policies" (Boardman et al., 2011, p. 27). My CBA highlights the pros and cons of each alternative in reference to the status quo. Like many CBA's my analysis aims to find the best feasible solution by allocating monetary values to each element within the program.

The four types of CBA's are as follows:

1. Ex ante CBA – conducted prior to the intervention. Useful to show whether resources should be used on a program or project.
2. Ex post CBA – conducted at the end of the intervention. Provides information about the particular class of intervention.
3. In medias res CBA- conducted during the intervention.
4. Comparative CBA – compares the ex-ante predictions to ex post results for the same project (very few of these comparisons have been conducted because the clients of ex post analyses are different from the clients of ex ante analyses). (Boardman et al., 2006)

For my analysis I chose the ex-ante CBA because it is being completed during the life cycle of the project. More specifically, this analysis provides validity to the program by demonstrating that one or more of the proposed alternatives is cost effective. Also, the information from this analysis could be used for future program decisions. CBAs are complex for many reasons such as it can be difficult to monetize all inputs, limited alternatives, and uncertainty. The reason a CBA is such a great analysis tool is that it provides a multitude of alternatives to a complex issue. When constructing a CBA, it is important that it has a structure that flows and provides decision makers multiple options.

Boardman breaks a CBA into nine steps to streamline the process and make the CBA more manageable.

There are nine steps to a CBA:

1. Decide whose benefits and costs count (standing)
2. Select the portfolio of alternative projects.
3. Catalogue potential (physical) impacts and select measured indicators.
4. Predict quantitative impacts over the life of the project.
5. Monetize (attach dollar values to) all inputs.
6. Discount for time and find present values.
7. Sum: Add up the benefits and costs.
8. Perform sensitivity Analysis.
9. Recommend the alternative with the largest net social benefit.
   (Boardman et al., 1996)

These nine steps provide a framework to the CBA process, for that reason I chose to use this framework for my analysis. I will explain in detail the CBA breakdown for USMC OSA.

1. CBA Breakdown of USMC OSA

Step 1: Who Has Standing?

For this analysis I assumed that the American taxpayer, DOD, and USMC are the entities that have standing. I took into consideration that the budget for the DOD more specifically, the OSA budget is funded by the American taxpayer.

Step 2: Portfolio and Alternatives

Status Quo – The Marine Corps currently operates eight UC-12W and ten UC-35D aircraft in support of the OSA mission. These aircraft are flown and operated by active-duty Marine pilots and enlisted aircrew. Maintenance and support personnel are contracted out specific to each MCAS.

Evaluation – I analyzed three COAs that provide different capabilities against the status quo:

a. COA 1 – The addition of three UC-12W Super King Air, upgrading existing UC-12 and maintaining current UC-35D Citation inventory.

b. COA 2 – The addition of three UC-35D Citation and maintaining current UC-12W Super King Air inventory.

c. COA 3 – Outsourcing the OSA mission to USMC tactical aircraft.

Project Life – I set the project timeline to five years, specifically FY2023 to FY2027. This project life-cycle lines up with the contracted maintenance costs provided from the program office.

Timing and Format – For my analysis I chose the ex-ante CBA because it is being completed during the life cycle of the project, as well as it reduces uncertainty. Currently the Marine Corps has not discussed OSA fleet modifications or policy changes therefore the in-media res CBA will provide decision makers the ability to shift resources. I provide the direct and indirect costs associated with each COA and analyze whether the benefits outweigh the costs.

Step 3: Identify Impact Categories

Direct Marginal Benefit – The additional aircraft will provide additional resources for the aircrew to complete training reducing training time.

Indirect Marginal Benefit – The Marine Corps could see retention rise and lower turnover due to the aircrew receiving more flight time.

Direct Marginal Cost – The DOD would incur a large procurement cost for initial purchase of new aircraft.

Indirect Marginal Cost – The additional aircraft could lead to different manpower structures and cost associated with training and relocating

Step 4: Predict Impacts

The impacts are presented in the analysis of the status quo and alternative COA portion of my thesis.

Step 5: Monetize Impacts

I procured cost data for each component of the alternative COA's from VAMOSC, HQMC, and the program office PMA-207. These elements include procurement costs, O&S costs, manpower costs and contracted labor costs. For the scope of this thesis, I assumed a five-year project timeline even though the life-cycle costs will exceed five years. The key impact of cost is the procurement cost of new aircraft. As discussed before using the PAI metric allows me to take the total cost of the program and apply it to the entire aircraft inventory because I am either adding or eliminating aircraft from the inventory. By using the total O&S costs and applying a different aircraft inventory I am able to show what the more cost-effective alternative is.

Step 6: Discount Rate

I normalized the cost data to FY2023 dollars and forecasted the cost for each alternative to five years. I chose to minimize the effect of inflation on this project and for that reason I used the real discount rate. According to the OMB Circular A-94 "a real discount rate that has been adjusted to eliminate the effect of expected inflation should be used to discount constant-dollar or real benefits and costs" (Department of Defense, 1992). The current real discount established by the OMB Circular A-94 is 7 percent (Department of Defense, 1992). The OMB Circular A-94 states "that a real interest rate has been adjusted to remove the effect of expected or actual inflation" (Department of Defense, 1992). This interest rate would align with the current discount rate and when adjusting for inflation. The current real interest rate for a five-year program is 1.6 percent (Department of Defense, 2020).

Step 7: Add Benefits and Costs

The benefits and costs are shown in the analysis portion for each COA. I also calculated the NPV with each alternative that provided a benefit.

Step 8: Sensitivity Analysis

Each COA presented has variability with respect to aircraft and manpower. The COA's I provide are structured from various assumptions. I will cover these assumptions in detail in the Sensitivity Analysis (H) of my thesis.

Step 9: Recommendation

My recommendation is provided in my conclusion (Chapter V) after the complete analysis.

2. Hypothesis and Initial Findings

Through my research I have found that each military service has OSA assets specifically structured to facilitate their mission set. I have identified the aircraft that I believe the Marine Corps needs to invest in because of an aging fleet and operational necessity. It is difficult to prove that restructuring the OSA fleet will be cost-effective without the data to prove it. With my research I found studies and cost data that suggest there could be cost savings for the DOD and Marine Corps by restructuring the OSA fleet. The key to providing an accurate analysis is taking the data and structuring it in the correct metric.

Hypothesis: In my initial outline of each COA I believe that there is cost savings for the DOD and Marine Corps. I emphasize that the initial procurement cost of new aircraft will be large but based off 30-year LCC of each platform and presented in the PAI metric there is potential for savings. From a cost savings and purely monetary view I believe that the first COA will be the most beneficial. The second COA provides an alternative, which provides a benefit of speed but monetarily its secondary to COA one. The third COA I believe is the easiest and most efficient, but it is very expensive to use tactical aircraft when applying the CPFH metric and severely degrades the aircrafts life cycle.

B. DATA

My research contains cost data for from VAMOSC, HQMC and PMA-207. VAMOSC is an information management system that "collects and reports U.S. Navy and Marine Corps historical operating and support (O&S) costs. VAMOSC provides the direct O&S costs of weapon systems, some linked indirect costs (e.g., ship depot overhead), and related non-cost information such as flying hour metrics, steaming hours, age of aircraft, etc." (Defense Acquisition University [DAU], 2011). I was provided data from HQMC Air Warfare Systems Director of Assault Support/OSA. The data included force structure and design along with cost estimations and procurement submissions. Lastly, I received cost data from PMA-207, which is the tactical airlift program office. The data included cost adjustments for contractual support and costs for program flying hours.

C. DESCRIPTION OF STATUS QUO AND ALTERNATIVE COAS

1. Status Quo

The status quo represents the baseline of cost estimates. With aircraft reaching their service life and structuring assets for wartime capabilities, the status quo is not a viable option moving forward. My analysis takes all O&S costs associated with the UC-12W and UC-35D over the last 10 years and normalizes all costs to provide a one-year total operating cost. This will serve as the benchmark while comparing all alternative COAs.

2. UC-12W Restructure (COA 1)

The Marine Corps currently operates a total of 14 UC-12's across three variants and of the 14 aircraft only 10 are deployable. Eight of the 14 UC-12's are the W variant, this platform provides extended range and the necessary wartime capabilities. This alternative considers the existing inventory and adds an additional three UC-12W aircraft bringing the total to 11 UC-12W. This provides the Marine Corps OSA mission with additional assets that are CONUS and OCONUS capable. The initial procurement cost is present within each alternative COA. I assume that the placement of these aircraft have minimal impact on costs associated with the facilities and active-duty personnel. The addition of newer aircraft will increase the total flying hours and incur additional costs but as discussed previously I use the PAI metric and not CPFH, which ties cost directly to the aircraft and not flying hours. My analysis uses the current operational and support structure and provides annual cost estimate over a 5-year period.

3. UC-35D Restructure (COA 2)

This alternative COA is much like the first alternative except the structure of UC-35D will increase. I chose to add an additional three UC-35's to the Marine Corps already functional ten aircraft. This COA not only provides more medium range assets but enhances the speed of OSA operational capability. Limitations within this COA are payload capability and passenger occupancy.

4. Tactical Aircraft Outsourcing (COA 3)

This alternative is to outsource OSA missions from the UC-12 and UC-35 to Marine Corps tactical aircraft. I chose this COA for my analysis because tactical aircraft are used on numerous occasions to accomplish OSA mission sets. Under this COA I assume that these OSA mission sets are time sensitive therefore the use of tactical aircraft provides a faster approval process. This analysis does not expound upon the policy regarding requesting OSA aircraft. For the sake of time and available data I chose to use the MV-22B Osprey as the tactical aircraft for this analysis. The other options available that maintain the capabilities required would be the C-130 and CH-53. I chose the MV-22B for my analysis to ensure that I limited uncertainty by using an aircraft that provided capabilities similar to the current aircraft. This alternative COA assumes that the costs associated with current MV-22B tactical operations and supporting OSA mission requirement remain similar. For my analysis I used current MV-22B O&S costs but I apply it to the PAI metric instead of the CPFH.

D. ANALYSIS OF STATUS QUO

1. Current Cost of UC-12W

For my analysis of the status quo, I create a baseline cost estimate. I used O&S costs from FY11 thru FY20 for the UC-12W aircraft provided by VAMOSC. The VAMOSC cost element structure is broken down into five primary cost elements, which are unit level manpower, unit operations, maintenance, sustaining support, and continuing system support. The five main cost elements do not vary but the sub-elements will vary based on aircraft platform. Table 1 illustrates the breakdown of the cost elements along with the sub-elements for the OSA aircraft. In my analysis I assume that the UC-12W fleet reach their intended service life and will not incur any additional aircraft costs.

Table 1. VAMOSC Cost Element Structure for OSA Aircraft

Element 1	Element 2	Element 3	Element 4	Element 5	Element 6	Element 7
Unit Level Manpower	Operations Unit Maint Other Maint	Marine Navy Other	Officer Enlisted	Regular FRS	Basic Pay Allowances Entitlements	
Unit Operations	Energy TAD	Marine Navy Other	Regular FRS			
Maintenance	Material Depot I-Level Contract	Gov. Labor Contract Consumables	Manpower	Marine Navy	Labor Material Other	
Sustaining Support	System Train Program Mgmt	Operator Train Maint Train Other	Marine Navy	Officer Enlisted		
Continuing System Support	Mods Updates	Kits Installs Spares				

The status quo analysis includes costs associated with eight UC-12W aircraft that are currently in operation for Marine Corps OSA. I started by taking the "then year" total costs associated with each cost element structure, which created a total cost for the entire UC-12W fleet. Table 2 shows the breakdown of the Type/Model/Series (T/M/S) aircraft inventory within the current fiscal year and total program costs converted to then year dollars. For the purpose of this analysis, I converted the PAI by taking the total program costs and dividing it by the current inventory. The upper bound on PAI in approximately

$3.7M per aircraft while the lower bound is approximately $2M, which equates to an average of $2.4M total cost per aircraft.

Table 2. Historical Cost of UC-12W without Fuel Costs

Aircraft Type/ Model/Series	Fiscal Year	Then Year Dollars	Count	Cost per Aircraft ($M)
UC-12W	2011	$10,496,710	6	$1,749,452
UC-12W	2012	$12,941,448	6	$2,156,908
UC-12W	2013	$17,780,557	6	$2,963,426
UC-12W	2014	$16,739,581	6	$2,789,930
UC-12W	2015	$16,708,866	6	$2,784,811
UC-12W	2016	$15,204,160	6	$2,534,027
UC-12W	2017	$14,143,872	7	$2,020,553
UC-12W	2018	$19,652,042	7	$2,807,435
UC-12W	2019	$16,354,436	8	$2,044,305
UC-12W	2020	$18,625,514	8	$2,328,189

The only additional costs I added to the status quo analysis of the UC-12W and UC-35D was fuel costs. I retrieved JP5 jet fuel prices per gallon from the United States Energy Information Administration. The calculated average price per gallon for JP5 from FY11 to FY20 was $2.01 (United States Energy Information Administration, 2020). To normalize the fuel costs to FY23 I calculated for inflation and set the baseline fuel costs per gallon to $2.58. Table 3 shows the complete breakdown of both platforms for the base year FY22. The current cost to operate one UC-12W in FY22 dollars is $3.1M totaling $24.7M for eight UC-12W aircraft. This table will be the baseline moving forward for the differentiation between the status quo and alternative COAs

Table 3. Status Quo Cost Estimate FY22

*Base year 2022	Status Quo		Costs (PAI)
Personnel	**Active Duty**	**$**	**1,583,365**
	(UC-12W)	$	687,367
	(UC-35D)	$	895,998
	Civilian	**$**	**957,150**
	(UC-12W)	$	396,980
	(UC-35D)	$	560,170
Aircraft (Procurement)	**UC12W/UC-35D**		
Fuel	**JP-5**	**$**	**617,636**
	(UC-12W)	$	242,460
	(UC-35D)	$	375,175
Operations/Training	**Unit**	**$**	**753,708**
	(UC-12W)	$	304,631
	(UC-35D)	$	449,077
Sustainment	**Program**	**$**	**87,568**
	(UC-12W)	$	85,498
	(UC-35D)	$	2,070
Maintenance	**AVDLR/AFM**	**$**	**3,353,810**
	(UC-12W)	$	1,118,991
	(UC-35D)	$	2,234,819
System Improvements	**Modifications/Updates**	**$**	**499,041**
	(UC-12W)	$	253,112
	(UC-35D)	$	245,929
Total		**$**	**7,852,278**
Difference from Status Quo		$	-

This data show the cost breakdown of O&S cost per aircraft including fuel for base year FY22.

2. Current Cost of UC-35D

The status quo analysis of the UC-35D includes 10 operational aircraft. Just like the analysis of the UC-12W I used O&S costs from FY11 thru FY20 for the UC-35D aircraft provided by VAMOSC. I also used the same approach for fuel costs to ensure the baselines matched. Table 4 shows the breakdown of the Type/Model/Series (T/M/S) aircraft inventory within the current fiscal year and total program costs converted to then year dollars. Same as before I converted the PAI by taking the total program costs and dividing it by the current inventory. The upper bound on PAI in approximately $3.9M per aircraft while the lower bound is approximately $2.7M, which equates to an average of $3.5M total cost per aircraft.

Table 4. Historical Cost of UC-35D without Fuel Costs

Aircraft Type/ Model/Series	Fiscal Year	Then Year Dollars	Count	Cost per Aircraft ($M)
UC-35D	2011	$38,859,292	10	$3,885,929
UC-35D	2012	$36,325,672	10	$3,632,567
UC-35D	2013	$36,130,428	10	$3,613,043
UC-35D	2014	$35,062,037	10	$3,506,204
UC-35D	2015	$38,446,272	10	$3,844,627
UC-35D	2016	$33,805,341	10	$3,380,534
UC-35D	2017	$31,070,969	9	$3,452,330
UC-35D	2018	$36,081,359	10	$3,608,136
UC-35D	2019	$26,877,370	10	$2,687,737
UC-35D	2020	$36,631,499	10	$3,663,150

Using the historical costs, I set the base year to FY22 for both platforms but to align the years of the maintenance contracts costs I chose to start the five-year analysis in FY23. I normalized the data and adjusted for inflation which provides the analysis program start date. My analysis estimates the costs to operate one UC-35D in FY22 dollars is $4.8M totaling $47.6M for 10 aircraft. The cost per aircraft total for the UC-35 and UC-12 is $7.9M, which sets the benchmark for my analysis. Table 5 illustrates a complete breakdown of both platforms based on the FY22 costs and inflated to FY23 then year costs.

Table 5. Status Quo Cost Estimate FY23

2023	Status Quo		Costs (PAI)
Personnel	Active Duty	$	1,622,949
	(UC-12W)	$	704,551
	(UC-35D)	$	918,398
	Civilian	$	981,079
	(UC-12W)	$	406,905
	(UC-35D)	$	574,174
Aircraft (Procurement)	UC12W/UC-35D		
Fuel	JP-5	$	620,456
	(UC-12W)	$	243,568
	(UC-35D)	$	376,888
Operations/Training	Unit	$	772,550
	(UC-12W)	$	312,246
	(UC-35D)	$	460,304
Sustainment	Program	$	89,758
	(UC-12W)	$	87,636
	(UC-35D)	$	2,122
Maintenance	AVDLR/AFM	$	3,437,656
	(UC-12W)	$	1,146,966
	(UC-35D)	$	2,290,689
System Improvements	Modifications/Updates	$	511,517
	(UC-12W)	$	259,440
	(UC-35D)	$	252,077
Total		$	8,035,964
Difference from Status Quo		$	-

This data shows the cost breakdown of O&S cost per aircraft including fuel for FY23.

Note the increase in total costs from total costs in Table 4.

E. ANALYSIS OF UC-12 RESTRUCTURE (COA 1)

1. UC-12W Acquisition Cost

This alternative considers the existing inventory and adds an additional three UC-12W aircraft bringing the total to 11 UC-12W. I obtained data from HQMC, which provided the procurement costs for three new UC-12W aircraft. The total acquisition cost for three new UC-12W extended range aircraft is $52.1M, which comes out to around $14.3M per aircraft. I chose to include the procurement cost in my analysis to differentiate the alternative COA's from the status quo. In order to normalize the large initial costs, I use the aircraft lifespan hours, cost per hour, and cost per year. I assumed that the total lifespan hours of a new UC-12W is 22,000 hours. Taking the assumed 22,000 hours and dividing it by the initial total costs, provided a cost of $650 per hour. I then took the cost per hour and multiplied by the average flying hours per aircraft, which I calculated to be 870 hours resulting in a total cost of $565,500 per aircraft for the fiscal year.

2. Operations and Support Cost (O&S)

The O&S costs associated with this alternative COA are compared to the status quo costs. My analysis uses PAI metric it, which considers all O&S costs as well as any variable costs then divides it by the total aircraft inventory. The manpower costs associated with this COA are broken down by active duty and civilian personnel used to operate and maintain 11 UC-12W. The current manpower structure will not change with the alternative COA due to the aircraft being spread across multiple MCAS's. The current structure will support one additional aircraft therefore I assume that based off future wartime needs and possible conflicts the new additional aircraft will be placed in the WESTPAC. My calculated personnel costs including inflation for COA 1 is $788,620. To account for the fuel costs, I used the historical data provided by VAMOSC, which provide total barrels of used fuel. As discussed, before I normalized a price per gallon to be $2.58 then multiplied by the amount on gallons per barrel, which is 42. The calculated fuel costs per UC-12W aircraft is $176,335. The additional aircraft provide more assets to facilitate OSA missions and training thus reducing costs for operations and training. The total cost for operations and training per aircraft are estimated to be $221,550. The one cost associated with each COA that has the most uncertainty is the maintenance costs. The maintenance cost estimate in my analysis provided maintenance manpower contract costs, aviation depot level repair (AVDLR) costs and aviation fleet maintenance (AFM) costs. The maintenance costs associated with the UC-12W in COA 1 total $688,610 per aircraft. The final O&S cost is system improvements, which broken down is the modifications and updates to the existing UC-12W fleet. The estimated cost per aircraft is $184,081.

Table 6 provides a complete breakdown of the costs associated with COA 1 from the base year of FY22. The cost per aircraft with regards to the UC-35D in this COA are the same as the status quo. The total O&S cost for the UC-12W is $2.8M per aircraft for COA 1. The total cost represented in the table represents the combination of total cost per UC-12W and UC-35D.

Table 6. UC-12W Restructure Cost Estimate FY22

*Base year 2022	COA 1		Costs (PAI)
Personnel	Active Duty	$	1,395,901
	(UC-12W)	$	499,903
	(UC-35D)	$	895,998
	Civilian	$	848,883
	(UC-12W)	$	288,713
	(UC-35D)	$	560,170
Aircraft (Procurement)	UC-12W	$	594,128
Fuel	JP-5	$	551,510
	(UC-12W)	$	176,335
	(UC-35D)	$	375,175
Operations/Training	Unit	$	670,627
	(UC-12W)	$	221,550
	(UC-35D)	$	449,077
Sustainment	Program	$	64,251
	(UC-12W)	$	62,180
	(UC-35D)	$	2,070
Maintenance	AVDLR/AFM	$	2,923,429
	(UC-12W)	$	688,610
	(UC-35D)	$	2,234,819
System Improvements	Modifications/Updates	$	430,011
	(UC-12W)	$	184,082
	(UC-35D)	$	245,929
Total		$	7,478,739
Difference from Status Quo		$	373,539

This data breaks down all O&S costs associated with COA 1and provides the difference from the status quo as cost savings.

COA 1 provides preliminary cost savings of $373,540 when compared to the status quo. Taking the preliminary cost savings and applying the current real discount established by the OMB Circular A-94 at seven percent I was able to establish the NPV (Department of Defense, 1992). FY22 is the base year therefore the NPV is the preliminary cost savings of $373,540. The total cost savings NPV from FY23 to FY27 is approximately $2M.

F. ANALYSIS OF UC-35 RESTRUCTURE (COA 2)

1. UC-35D Acquisition Costs

This alternative considers the existing inventory and adds an additional three UC-35D aircraft bringing the total to 13 UC-35D. The total acquisition cost for three new UC-35D aircraft is approximately $60M, which comes out to around $20M per aircraft. Like COA 1 I chose to include the procurement cost in my COA 2 analysis to differentiate the alternative COA's from each other as well as the status quo. I used the same process in this COA to ensure limited variability. I assumed that the total lifespan hours of a new UC-35D is 18,000 hours. Taking the assumed 18,000 hours and dividing it by the initial total costs, provided a cost of $1,111.11 per hour. I then took the cost per hour and multiplied by the average flying hours per aircraft, which I calculated to be 746 hours resulting in a total cost of $828,888 per aircraft for the fiscal year.

2. Operation and Support Costs (O&S)

The O&S cost estimate of the COA-2 analysis uses the same approach as COA 1. The O&S costs associated with this alternative COA are compared to the status quo costs. The manpower costs associated with this COA are broken down by active duty and civilian personnel used to operate and maintain 13 UC-35D. My calculated personnel costs including inflation for COA 2 is $1.12M. To account for the fuel costs, I used the historical data provided by VAMOSC, which provide total barrels of used fuel. As discussed, before I normalized a price per gallon to be $2.58 then multiplied by the amount on gallons per barrel, which is 42. The calculated fuel costs per UC-35D aircraft is $288,870. The total cost for operations and training per aircraft are estimated to be $345,445. The maintenance costs associated with the UC-35D in COA 2 total $1.72M per aircraft. The final O&S cost is system improvements, which broken down is the modifications and updates to the existing UC-35D fleet. The estimated cost per aircraft is $189,176.

Table 7 provides a complete breakdown of the costs associated with COA 2 from the base year of FY22. The cost per aircraft with regards to the UC-12W in this COA are the same as the status quo. The total O&S cost for the UC-35D is $4.55M per aircraft for COA 2. The total cost represented in the table represents the combination of total cost per UC-12W and UC-35D.

Table 7. UC-35D Restructure Cost Estimate FY22

*Base year 2022	COA 2		Costs (PAI)
Personnel	Active Duty	$	1,376,596
	(UC-12W)	$	687,367
	(UC-35D)	$	689,229
	Civilian	$	827,880
	(UC-12W)	$	396,980
	(UC-35D)	$	430,900
Aircraft (Procurement)	UC-35D	$	870,851
Fuel	JP-5	$	531,057
	(UC-12W)	$	242,460
	(UC-35D)	$	288,596
Operations/Training	Unit	$	650,075
	(UC-12W)	$	304,631
	(UC-35D)	$	345,444
Sustainment	Program	$	103,017
	(UC-12W)	$	85,498
	(UC-35D)	$	17,519
Maintenance	AVDLR/AFM	$	2,838,083
	(UC-12W)	$	1,118,991
	(UC-35D)	$	1,719,091
System Improvements	Modifications/Updates	$	442,288
	(UC-12W)	$	253,112
	(UC-35D)	$	189,176
Total		$	7,639,847
Difference from Status Quo		$	212,431

This data breaks down all O&S costs associated with COA 2 and provides the difference from the status quo as cost savings.

COA 2 provides preliminary cost savings of $212,431 when compared to the status quo. The total cost savings NPV from FY23 to FY27 is approximately $1.13M.

G. ANALYSIS OF TACTICAL AIRCRAFT OUTSOURCING (COA 3)

There is always a myriad of scenarios when selecting the correct tactical aircraft for an OSA mission but due to the limited time and data I chose to use the MV-22B. The MV-22B (Figure 8) maintains similar capabilities to the current OSA aircraft and for that reason I used it for my analysis. This COA is not absorbing the entire OSA mission but facilitating OSA missions when possible. To account for the additional costs of supporting OSA mission I increased the cost by 10% for each O&S cost. This COA takes the O&S costs associated with current MV-22B Osprey tactical operations and training missions then compares them against the status quo. When comparing this COA to the status quo it is important to note that the PAI metric normalizes the costs because there are currently 264 MV-22B's operational compared to eight UC-12W and 10 UC-35D. Using historical data from VAMOSC I calculated the O&S costs for this COA the same as the previous COA's. COA 3 manpower costs are strictly active-duty personnel assigned to MV-22B squadrons. The calculated manpower cost is approximately $1.4M per aircraft. This COA does not include procurement or acquisition costs because there are currently no plans to order any new MV-22B's.

Figure 8. MV-22B Osprey. Source: HQMC (2020).

The total fuel cost per aircraft for the MV-22B is $194,875.47. The cost elements that provide the most uncertainty for this COA is operations and training. My assumption is based on the variation of costs when conducting tactical operations and training while simultaneously supporting OSA mission. The total cost for operations and training is $322,383 per aircraft. The sustainment cost for the MV-22B is $801,611 per aircraft. Table 8 provides the complete breakdown of costs associated with COA 3. Maintenance costs for the MV-22B are almost double that of the UC-12W and UC-35D totaling $3.8M per aircraft.

Table 8. Tactical Outsourcing (MV-22B) Cost Estimates

*Base year 2022	COA 3		Costs (PAI)
Personnel	Active Duty	$	1,404,499
Aircraft (Procurement)	MV-22		
Fuel	JP-5	$	194,875
Operations/Training	Unit	$	322,384
Sustainment	Program	$	801,611
Maintenance	AVDLR/AFM	$	3,821,208
System Improvements	Modifications/Updates	$	1,884,005
Total		$	8,428,583
Difference from Status Quo		$	(576,305)

This data breaks down all O&S costs associated with COA 3 and provides the difference from the status quo.

Note the difference from the status quo equals additional costs to the Marine Corps.

The total O&S costs including fuel for the MV-22B for COA 3 is $8.42M per aircraft. COA 3 does not provide cost savings and costs $576,305 per aircraft more when compared to the status quo. This COA would cost the Marine Corps an additional $3.2M over the five-year analysis for FY23 thru FY27.

H. SENSITIVITY ANALYSIS

Step 8 in conducting a CBA is the sensitivity analysis, which is used to account for elements within the analysis that produce the most uncertainty. In my analysis I understand there are assumptions made that have some level of uncertainty, therefore I took actions to minimize their impact. I started the CBA with monetizing all O&S associated with each aircraft over a 10-year period to create a status quo that served as the baseline. Those baseline costs serve as the measuring stick when comparing the total costs of each alternative COA. The comparison of costs was illustrated as cost difference from the status quo, which provided either cost savings or additional cost. To account for the uncertainty in costs I applied NPV to the costs difference for each COA. In Step 3 of the CBA, I identified direct and indirect marginal benefits that were considered for my analysis but for the COA development I did not assign monetary values to those benefits. Lastly, and most importantly the PAI metric I used throughout my analysis limits variability. Currently all costs refer the CPFH metric produce large amounts of variability. This is because the variability comes from flight hours, which vary dramatically when comparing aviation platforms. The variability in PAI is less than the CPFH metric due to the fixed number of aircraft located in the denominator. The only variability in this equation comes from the changes in total O&S costs, not the number of aircraft.

I. COA TRADEOFFS

As discussed earlier, COA 1 provides cost savings of approximately $373,539, which is best amongst alternatives. COA 1 also provides the largest benefit to the Marine Corps for example, one benefit COA 1 provides is additional aircraft for training missions. This will ultimately reduce training time and increase qualifications. The reliability of the UC-12W aircraft equates to more available aircraft and flying hours. The increased flight time along with additional aircrew qualifications will entice pilots and aircrew to continue active-duty service limiting turn-over issues. COA 1 provides more passenger and cargo payload than COA 2 while providing the same range. The only trade off with using the UC-12W is eliminating the element of speed, which relates to the primary mission of OSA that is "to provide time-sensitive air transport" (HQMC, 2020, p. 3).

Like COA 1, COA 2 also provides a benefit of additional aircraft for training missions that will reduce training time and increase qualifications. The unreliability of the UC-35 limits flight hours therefore decreasing the aircrews flight time. For that reason, this COA is likely to have higher turnover thus creating a manpower issue. COA 2 provides the capability of speed with the tradeoffs being smaller passenger and cargo payload. Lastly, COA 3 was the least cost effective while providing minimal benefits. The additional flying hours for the MV-22 aircrews would increase qualifications and create greater opportunities for training. Those additional hours flown supporting the OSA missions would create longer working hours for MV-22 aircrews and eventually create fatigue or burnout. COA 3 provides the capabilities necessary to facilitate the OSA mission but would ultimately create a higher turnover in the MV-22 community.

V. CONCLUSION

A. SUMMARY AND RECOMMENDATION

The Marine Corps currently operates 28 Operational Support Aircraft located within the Continental United States and the Western Pacific. While not currently in wartime conditions, the USMC must maintain the requirements set forth by the DOD to ensure operational capability. The Marine Corps is looking for cost-effective ways to ensure the OSA aircraft and personnel accomplish the mission. For this reason, I chose to examine the current OSA fleet, specifically the UC-12W and UC-35D platforms and the costs associated with operations, support, and personnel. The focus on the UC-12 and the UC-35 platforms is based on the versatility and capability they provide. The current structure of the short-range and medium range aircraft makeup two thirds of the OSA fleet and ingenerate the most cost. The goal of this thesis is to examine whether a structure of medium and short-range aircraft could support the OSA mission in the most cost-effective manner.

To complete the objective of my thesis, I address three research questions, as follows.

(1) What are the minimum requirements needed to sustain the USMC OSA capability?

The DoDI 4500.43 specifically states, "Inventory levels of OSA aircraft shall be based solely on joint wartime readiness requirements. The DOD Components shall dispose of those aircraft in excess of joint readiness requirements" (DOD, 2010, p. 2). The last proposed requirement for a minimum of 27 USMC OSA aircraft came from the Marine Requirements Oversight Council (MROC) decision memorandum in 2010 (Amos, 2010). This was over ten years ago during wartime conditions. Although not currently in a time of war we must prepare and maintain the capabilities equal to our near peer competitors. The Marine Corps transition to the WESTPAC invites the opportunity to increase the minimum requirements. My analysis identifies two COA's that would increase the OSA inventory to 31 total aircraft. Per my analysis, I would recommend increasing the OSA inventory by at least three aircraft and making the minimum requirement 30 aircraft. As shown in my analysis the O&S cost spread over a 30-year LCC cost provide additional cost savings for the Marine Corps.

(2) What is the cost effectiveness of restructuring the current USMC OSA fixed wing assets consisting of UC-12 King Air and UC-35 Citation variants?

To answer this question, I conducted a CBA to evaluate the costs and benefits associated with two alternative COA's, which are the addition of three UC-12W aircraft, or the addition of three UC-35D aircraft, against the current OSA UC-12W and UC-35D inventory. My analysis involved making assumptions regarding manpower, facilities, and lifespan of each aircraft. The main component of net benefits in my analysis is tied to flight hours. This creates cost estimation issues, related to the variability in costs due the fluctuation on flying hours per T/M/S. My recommendation would be to use a more reliable route, such as the PAI metric used throughout my analysis, when analyzing aviation cost. The only variability in this metric comes from the changes in total O&S costs, not the number of flight hours.

Table 9 illustrates the comparison between COA's and shows the net benefit from the status quo. Based off the above COA comparison my recommendation would be to invest in COA 1 by adding three additional UC-12W aircraft. The costs for operating the UC-12W is approximately $161,000 less than the UC-35D per aircraft. After calculating the NPV over the five-year period for the project the cost savings are approximately $900,000. Aside from just cost, the UC-12 provides the short-range mission capability but by purchasing the extended range UC-12W the Marine Corps OSA program can facilitate the medium- range mission too. The only trade off investing in the UC-12W is eliminating the element of speed, which relates to the primary mission of OSA that is "to provide time-sensitive air transport" (HQMC, 2020, p. 3).

Table 9. COA Comparison FY22

*Base year 2022	Status Quo		Costs (PAI)	COA 1		Costs (PAI)	COA 2		Costs (PAI)
Personnel	**Active Duty**	**$**	**1,583,365**	**Active Duty**	**$**	**1,395,901**	**Active Duty**	**$**	**1,376,596**
	(UC-12W)	$	687,367	(UC-12W)	$	499,903	(UC-12W)	$	687,367
	(UC-35D)	$	895,998	(UC-35D)	$	895,998	(UC-35D)	$	689,229
	Civilian	**$**	**957,150**	**Civilian**	**$**	**848,883**	**Civilian**	**$**	**827,880**
	(UC-12W)	$	396,980	(UC-12W)	$	288,713	(UC-12W)	$	396,980
	(UC-35D)	$	560,170	(UC-35D)	$	560,170	(UC-35D)	$	430,900
Aircraft (Procurement)	**UC12W/UC-35D**			**UC-12W**	**$**	**594,128**	**UC-35D**	**$**	**870,851**
Fuel	**JP-5**	**$**	**617,636**	**JP-5**	**$**	**551,510**	**JP-5**	**$**	**531,057**
	(UC-12W)	$	242,460	(UC-12W)	$	176,335	(UC-12W)	$	242,460
	(UC-35D)	$	375,175	(UC-35D)	$	375,175	(UC-35D)	$	288,596
Operations/Training	**Unit**	**$**	**753,708**	**Unit**	**$**	**670,627**	**Unit**	**$**	**650,075**
	(UC-12W)	$	304,631	(UC-12W)	$	221,550	(UC-12W)	$	304,631
	(UC-35D)	$	449,077	(UC-35D)	$	449,077	(UC-35D)	$	345,444
Sustainment	**Program**	**$**	**87,568**	**Program**	**$**	**64,251**	**Program**	**$**	**103,017**
	(UC-12W)	$	85,498	(UC-12W)	$	62,180	(UC-12W)	$	85,498
	(UC-35D)	$	2,070	(UC-35D)	$	2,070	(UC-35D)	$	17,519
Maintenance	**AVDLR/AFM**	**$**	**3,353,810**	**AVDLR/AFM**	**$**	**2,923,429**	**AVDLR/AFM**	**$**	**2,838,083**
	(UC-12W)	$	1,118,991	(UC-12W)	$	688,610	(UC-12W)	$	1,118,991
	(UC-35D)	$	2,234,819	(UC-35D)	$	2,234,819	(UC-35D)	$	1,719,091
System Improvements	**Modifications/Updates**	**$**	**499,041**	**Modifications/Updates**	**$**	**430,011**	**Modifications/Updates**	**$**	**442,288**
	(UC-12W)	$	253,112	(UC-12W)	$	184,082	(UC-12W)	$	253,112
	(UC-35D)	$	245,929	(UC-35D)	$	245,929	(UC-35D)	$	189,176
Total		**$**	**7,852,278**		**$**	**7,478,739**		**$**	**7,639,847**
Difference from Status Quo		**$**	**-**		**$**	**373,539**		**$**	**212,431**

(3) What is the cost effectiveness of outsourcing USMC OSA missions to current USMC tactical aircraft?

I analyzed a third alternative COA, that uses Marine Corps tactical aircraft to facilitate the OSA mission and compared it to the status quo of using the UC-12W and UC-335D. The key element to this COA development was choosing the correct tactical aircraft that possesses similar capabilities as the UC-12W and the UC-35D. The MV-22B provides similar or greater range, speed, and cargo capacity than both aircraft in the status quo. Through my analysis this COA did not provide additional cost savings. Using tactical aircraft for OSA missions although not cost-effective can be useful at times. As previously discussed, the process of approval for use of OSA assets is a lengthy and time consuming one. For the purpose of this thesis, I decided not to analyze the OSA approval process. An example where this COA provides additional benefits is when an aircraft on a cross country training mission becomes inoperable for maintenance. The Marine Aircraft Group (MAG) commander can authorize a tactical aircraft to take parts and personnel to retrieve the down aircraft. OSA aircraft should facilitate this mission, but it is considerably faster and much more expensive to send a MV-22B.

B. FUTURE RESEARCH

Future research can be conducted with the wartime requirements and capabilities in mind. There are a multitude of uses for OSA aircraft especially for CONUS missions. Future areas for future research are as follows:

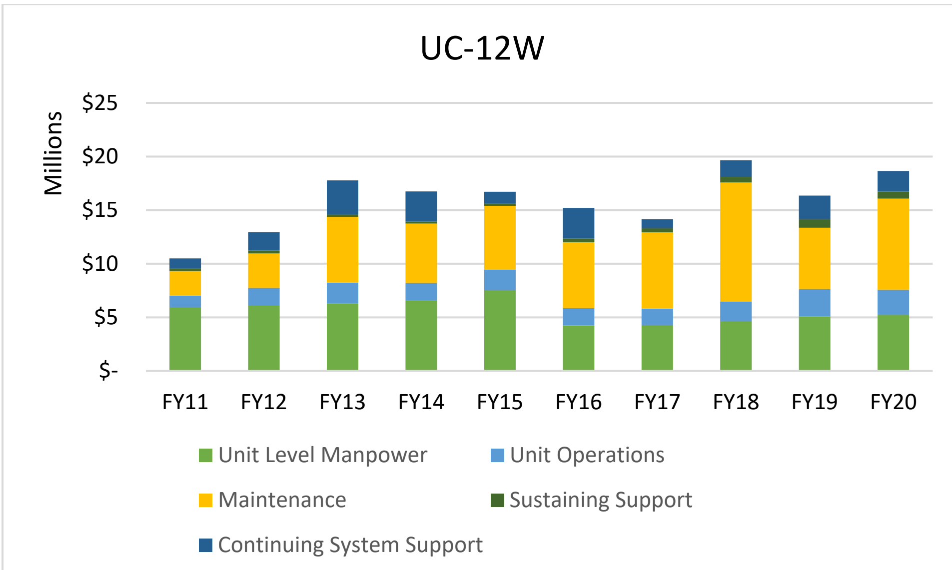
(1) I recommend further research into OSA policy, regarding the approval process for the aircraft. This area could increase the use of OSA assets and eliminate using tactical aircraft for OSA missions.

(2) I recommend further research in OSA force structure specifically the C-40A. This aircraft provides passenger and cargo transport. This could enhance the Marine Corps OSA mission.

APPENDIX A. GENERAL INFORMATION

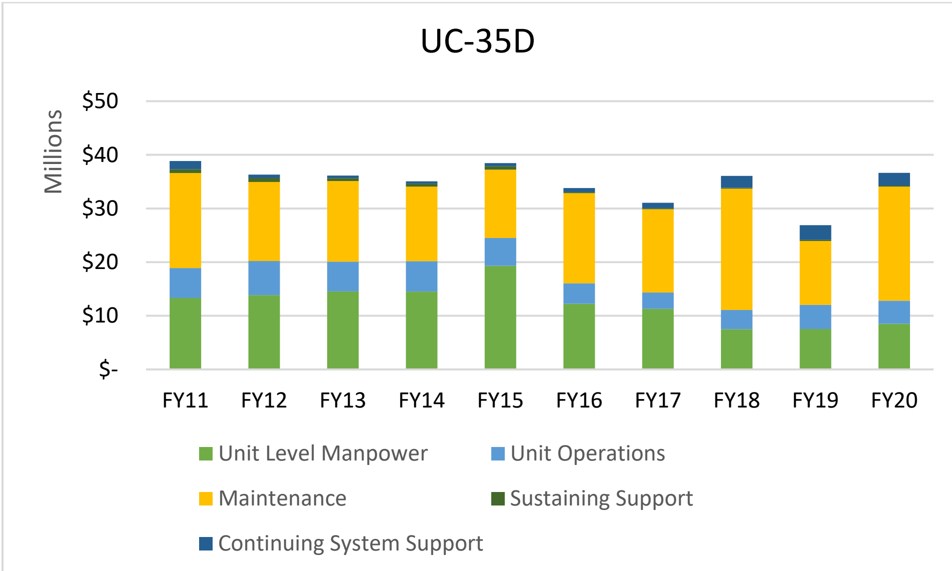
This appendix contains data and information that was applied to the COA development for the analysis.

Table 10. UC-12W Historical O&S Costs



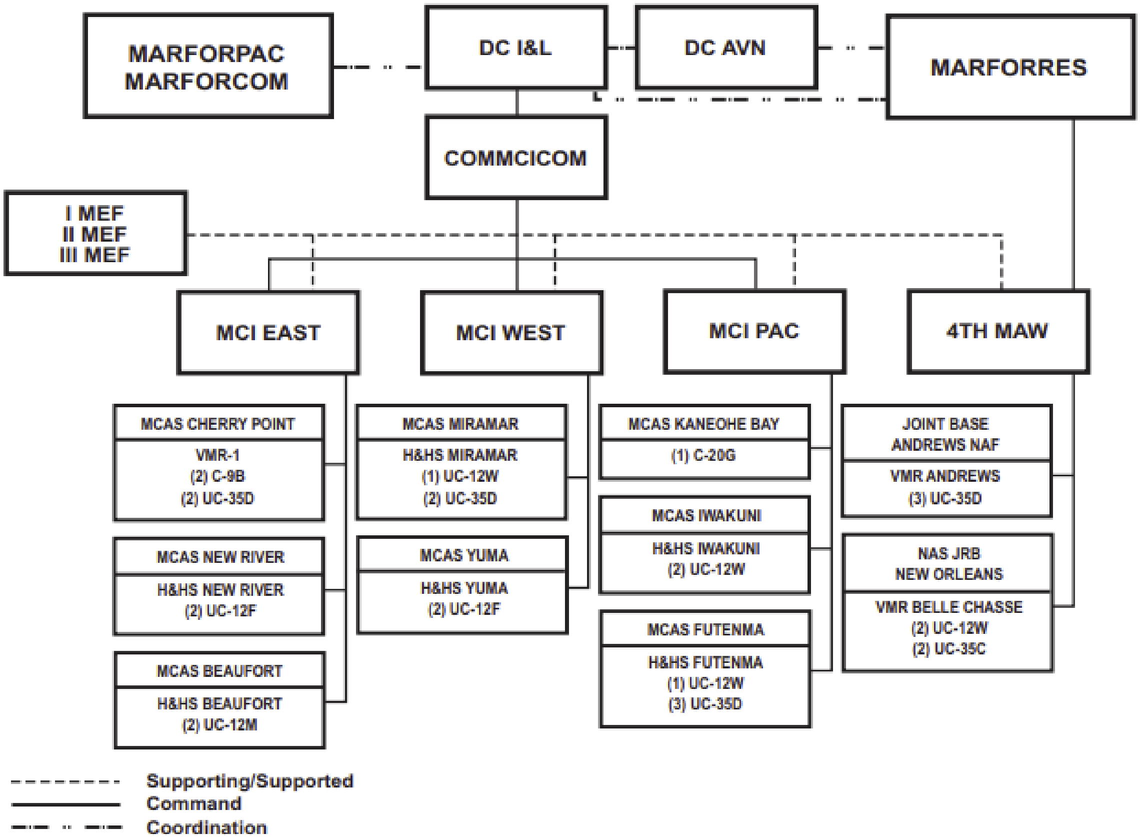
Costs were obtained from the VAMOSC data.

Table 11. UC-35D Historical O&S Costs



Costs were obtained from the VAMOSC data.

Table 12. Operational Support Airlift Organizational Structure. Adapted from HQMC (2020).



LEGEND

COMMCICOM	Commander, Marine Corps Installations Command
DC AVN	Deputy Commandant for Aviation
DC I&L	Deputy Commandant for Installations and Logistics
JRB	joint reserve base
MARFORCOM	United States Marine Corps Forces Command
MARFORPAC	United States Marine Corps Forces, Pacific
MARFORRES	United States Marine Corps Forces Reserve
MCB	Marine Corps base
MEF	Marine expeditionary force
NAF	naval air facility
NAS	naval air station
PAC	Pacific

Table 13. Aircraft Costs

Aircraft	Year	Then Year Dollars			Inflated for 2022
UC-12W	2020	$18,625,514	8	$2,328,189.25	$2,386,393.98
UC-35D	2020	$36,631,499	10	$3,663,149.90	$3,754,728.65
UC-12W	2020	$18,625,514	11	$1,693,228.55	$1,735,559.26
UC-35D	2020	$36,631,499	13	$2,817,807.62	$2,888,252.81
	UC-12W	UC-35D			
Aircraft Lifepsan hours	22,000	18,000			
Cost per hour (30-yr LCC)	$ 650.00	$ 1,111.11			
Cost per year	$ 565,500.00	$ 828,888.89			
	UC-12W	UC-35D			
Total Cost of (8)UC-12W (10)UC-35D PAI	$2,386,393.98	$3,754,728.65			
Total Cost of (11)UC-12W (13)UC-35D PAI	$1,735,559.26	$2,888,252.81			

UC-12W and UC-35D lifespan hours were calculated using historical flight hours and service life.

Cost per hour was calculated by the acquisition cost divided by lifespan hours.

Cost per year was calculated by multiplying cost per hour by average flight hours per year.

Table 14. COA Comparison FY23

2023	Status Quo	Costs (PAI)	COA 1	Costs (PAI)	COA 2	Costs (PAI)	COA 3	Costs (PAI)
Personnel	Active Duty	$ 1,622,949.04	Active Duty	$ 1,430,798.67	Active Duty	$ 1,411,011.11	Active Duty	$ 1,439,611.06
	(UC-12W)	$ 704,551.36	(UC-12W)	$ 512,400.99	(UC-12W)	$ 704,551.36		
	(UC-35D)	$ 918,397.69	(UC-35D)	$ 918,397.69	(UC-35D)	$ 706,459.76		
	Civilian	$ 981,078.64	Civilian	$ 870,104.62	Civilian	$ 848,576.98		
	(UC-12W)	$ 406,904.75	(UC-12W)	$ 295,930.73	(UC-12W)	$ 406,904.75		
	(UC-35D)	$ 574,173.90	(UC-35D)	$ 574,173.90	(UC-35D)	$ 441,672.23		
Aircraft (Procurement)	UC12W/UC-35D		UC-12W	$ 608,981.65	UC-35D	$ 892,622.67	MV-22	
Fuel	JP-5	$ 620,455.90	JP-5	$ 554,028.39	JP-5	$ 533,481.65	JP-5	$ 195,765.32
	(UC-12W)	$ 243,567.51	(UC-12W)	$ 177,140.01	(UC-12W)	$ 243,567.51		
	(UC-35D)	$ 376,888.39	(UC-35D)	$ 376,888.39	(UC-35D)	$ 289,914.14		
Operations/Training	Unit	$ 772,550.43	Unit	$ 687,392.31	Unit	$ 666,326.44	Unit	$ 330,443.49
	(UC-12W)	$ 312,246.46	(UC-12W)	$ 227,088.33	(UC-12W)	$ 312,246.46		
	(UC-35D)	$ 460,303.97	(UC-35D)	$ 460,303.97	(UC-35D)	$ 354,079.98		
Sustainment	Program	$ 89,757.69	Program	$ 65,857.09	Program	$ 105,592.20	Program	$ 821,651.41
	(UC-12W)	$ 87,635.54	(UC-12W)	$ 63,734.94	(UC-12W)	$ 87,635.54		
	(UC-35D)	$ 2,122.15	(UC-35D)	$ 2,122.15	(UC-35D)	$ 17,956.66		
Maintenance	AVDLR/AFM	$ 3,437,655.54	AVDLR/AFM	$ 2,996,514.69	AVDLR/AFM	$ 2,909,034.93	AVDLR/AFM	$ 3,916,738.63
	(UC-12W)	$ 1,146,966.22	(UC-12W)	$ 705,825.37	(UC-12W)	$ 1,146,966.22		
	(UC-35D)	$ 2,290,689.32	(UC-35D)	$ 2,290,689.32	(UC-35D)	$ 1,762,068.71		
System Improvements	Modifications/Updates	$ 511,517.22	Modifications/Updates	$ 440,760.82	Modifications/Updates	$ 453,345.58	Modifications/Updates	$ 1,931,105.63
	(UC-12W)	$ 259,440.12	(UC-12W)	$ 188,683.73	(UC-12W)	$ 259,440.12		
	(UC-35D)	$ 252,077.10	(UC-35D)	$ 252,077.10	(UC-35D)	$ 193,905.46		
Total		$ 8,035,964.47		$ 7,654,438.24		$ 7,819,991.57		$ 8,635,315.53
Difference from Status Quo		$ -		$ 381,526.23		$ 215,972.90		$ (599,351.07)

Table 15. COA Comparison FY24

2024	Status Quo	Costs (PAI)	COA 1	Costs (PAI)	COA 2	Costs (PAI)	COA 3	Costs (PAI)
Personnel	Active Duty	$ 1,663,522.77	Active Duty	$ 1,466,568.64	Active Duty	$ 1,446,286.39	Active Duty	$ 1,475,601.33
	(UC-12W)	$ 722,165.14	(UC-12W)	$ 525,211.01	(UC-12W)	$ 722,165.14		
	(UC-35D)	$ 941,357.63	(UC-35D)	$ 941,357.63	(UC-35D)	$ 724,121.25		
	Civilian	$ 1,005,605.61	Civilian	$ 891,857.24	Civilian	$ 869,791.40		
	(UC-12W)	$ 417,077.37	(UC-12W)	$ 303,328.99	(UC-12W)	$ 417,077.37		
	(UC-35D)	$ 588,528.24	(UC-35D)	$ 588,528.24	(UC-35D)	$ 452,714.03		
Aircraft (Procurement)	UC12W/UC-35D		UC-12W	$ 624,206.19	UC-35D	$ 914,938.24	MV-22	
Fuel	JP-5	$ 623,289.03	JP-5	$ 556,558.20	JP-5	$ 535,917.64	JP-5	$ 196,659.22
	(UC-12W)	$ 244,679.69	(UC-12W)	$ 177,948.87	(UC-12W)	$ 244,679.69		
	(UC-35D)	$ 378,609.34	(UC-35D)	$ 378,609.34	(UC-35D)	$ 291,237.95		
Operations/Training	Unit	$ 791,864.19	Unit	$ 704,577.11	Unit	$ 682,984.60	Unit	$ 338,704.57
	(UC-12W)	$ 320,052.62	(UC-12W)	$ 232,765.54	(UC-12W)	$ 320,052.62		
	(UC-35D)	$ 471,811.57	(UC-35D)	$ 471,811.57	(UC-35D)	$ 362,931.98		
Sustainment	Program	$ 92,001.63	Program	$ 67,503.52	Program	$ 108,232.01	Program	$ 842,192.70
	(UC-12W)	$ 89,826.43	(UC-12W)	$ 65,328.31	(UC-12W)	$ 89,826.43		
	(UC-35D)	$ 2,175.20	(UC-35D)	$ 2,175.20	(UC-35D)	$ 18,405.58		
Maintenance	AVDLR/AFM	$ 3,523,596.93	AVDLR/AFM	$ 3,071,427.55	AVDLR/AFM	$ 2,981,760.80	AVDLR/AFM	$ 4,014,657.10
	(UC-12W)	$ 1,175,640.38	(UC-12W)	$ 723,471.00	(UC-12W)	$ 1,175,640.38		
	(UC-35D)	$ 2,347,956.55	(UC-35D)	$ 2,347,956.55	(UC-35D)	$ 1,806,120.42		
System Improvements	Modifications/Updates	$ 524,305.15	Modifications/Updates	$ 451,779.84	Modifications/Updates	$ 464,679.22	Modifications/Updates	$ 1,979,383.27
	(UC-12W)	$ 265,926.13	(UC-12W)	$ 193,400.82	(UC-12W)	$ 265,926.13		
	(UC-35D)	$ 258,379.03	(UC-35D)	$ 258,379.03	(UC-35D)	$ 198,753.10		
Total		$ 8,224,185.31		$ 7,834,478.30		$ 8,004,590.31		$ 8,847,198.19
Difference from Status Quo		$ -		$ 389,707.02		$ 219,595.01		$ (623,012.88)

Table 16. COA Comparison FY25

2025	Status Quo	Costs (PAI)	COA 1	Costs (PAI)	COA 2	Costs (PAI)	COA 3	Costs (PAI)
Personnel	Active Duty	$ 1,705,110.84	Active Duty	$ 1,503,232.85	Active Duty	$ 1,482,443.55	Active Duty	$ 1,512,491.37
	(UC-12W)	$ 740,219.27	(UC-12W)	$ 538,341.29	(UC-12W)	$ 740,219.27		
	(UC-35D)	$ 964,891.57	(UC-35D)	$ 964,891.57	(UC-35D)	$ 742,224.28		
	Civilian	$ 1,030,745.75	Civilian	$ 914,153.67	Civilian	$ 891,536.19		
	(UC-12W)	$ 427,504.30	(UC-12W)	$ 310,912.22	(UC-12W)	$ 427,504.30		
	(UC-35D)	$ 603,241.45	(UC-35D)	$ 603,241.45	(UC-35D)	$ 464,031.89		
Aircraft (Procurement)	UC12W/UC-35D		UC-12W	$ 639,811.34	UC-35D	$ 937,811.70	MV-22	
Fuel	JP-5	$ 626,135.10	JP-5	$ 559,099.57	JP-5	$ 538,364.76	JP-5	$ 197,557.21
	(UC-12W)	$ 245,796.95	(UC-12W)	$ 178,761.42	(UC-12W)	$ 245,796.95		
	(UC-35D)	$ 380,338.15	(UC-35D)	$ 380,338.15	(UC-35D)	$ 292,567.81		
Operations/Training	Unit	$ 811,660.80	Unit	$ 722,191.54	Unit	$ 700,059.21	Unit	$ 347,172.19
	(UC-12W)	$ 328,053.93	(UC-12W)	$ 238,584.68	(UC-12W)	$ 328,053.93		
	(UC-35D)	$ 483,606.86	(UC-35D)	$ 483,606.86	(UC-35D)	$ 372,005.28		
Sustainment	Program	$ 94,301.68	Program	$ 69,191.11	Program	$ 110,937.81	Program	$ 863,247.51
	(UC-12W)	$ 92,072.09	(UC-12W)	$ 66,961.52	(UC-12W)	$ 92,072.09		
	(UC-35D)	$ 2,229.58	(UC-35D)	$ 2,229.58	(UC-35D)	$ 18,865.72		
Maintenance	AVDLR/AFM	$ 3,611,686.85	AVDLR/AFM	$ 3,148,213.24	AVDLR/AFM	$ 3,056,304.82	AVDLR/AFM	$ 4,115,023.52
	(UC-12W)	$ 1,205,031.39	(UC-12W)	$ 741,557.78	(UC-12W)	$ 1,205,031.39		
	(UC-35D)	$ 2,406,655.46	(UC-35D)	$ 2,406,655.46	(UC-35D)	$ 1,851,273.43		
System Improvements	Modifications/Updates	$ 537,412.78	Modifications/Updates	$ 463,074.34	Modifications/Updates	$ 476,296.20	Modifications/Updates	$ 2,028,867.85
	(UC-12W)	$ 272,574.28	(UC-12W)	$ 198,235.84	(UC-12W)	$ 272,574.28		
	(UC-35D)	$ 264,838.50	(UC-35D)	$ 264,838.50	(UC-35D)	$ 203,721.92		
Total		$ 8,417,053.79		$ 8,018,967.66		$ 8,193,754.24		$ 9,064,359.66
Difference from Status Quo		$ -		$ 398,086.13		$ 223,299.55		$ (647,305.87)

Table 17. COA Comparison FY26

2026	Status Quo	Costs (PAI)	COA 1	Costs (PAI)	COA 2	Costs (PAI)	COA 3	Costs (PAI)
Personnel	Active Duty	$ 1,747,738.61	Active Duty	$ 1,540,813.68	Active Duty	$ 1,519,504.64	Active Duty	$ 1,550,303.65
	(UC-12W)	$ 758,724.75	(UC-12W)	$ 551,799.82	(UC-12W)	$ 758,724.75		
	(UC-35D)	$ 989,013.86	(UC-35D)	$ 989,013.86	(UC-35D)	$ 760,779.89		
	Civilian	$ 1,056,514.40	Civilian	$ 937,007.51	Civilian	$ 913,824.59		
	(UC-12W)	$ 438,191.91	(UC-12W)	$ 318,685.02	(UC-12W)	$ 438,191.91		
	(UC-35D)	$ 618,322.49	(UC-35D)	$ 618,322.49	(UC-35D)	$ 475,632.68		
Aircraft (Procurement)	UC12W/UC-35D		UC-12W	$ 655,806.63	UC-35D	$ 961,256.99	MV-22	
Fuel	JP-5	$ 628,994.16	JP-5	$ 561,652.53	JP-5	$ 540,823.04	JP-5	$ 198,459.30
	(UC-12W)	$ 246,919.31	(UC-12W)	$ 179,577.68	(UC-12W)	$ 246,919.31		
	(UC-35D)	$ 382,074.85	(UC-35D)	$ 382,074.85	(UC-35D)	$ 293,903.73		
Operations/Training	Unit	$ 831,952.32	Unit	$ 740,246.33	Unit	$ 717,560.69	Unit	$ 355,851.49
	(UC-12W)	$ 336,255.28	(UC-12W)	$ 244,549.30	(UC-12W)	$ 336,255.28		
	(UC-35D)	$ 495,697.04	(UC-35D)	$ 495,697.04	(UC-35D)	$ 381,305.41		
Sustainment	Program	$ 96,659.22	Program	$ 70,920.88	Program	$ 113,711.25	Program	$ 884,828.70
	(UC-12W)	$ 94,373.89	(UC-12W)	$ 68,635.56	(UC-12W)	$ 94,373.89		
	(UC-35D)	$ 2,285.32	(UC-35D)	$ 2,285.32	(UC-35D)	$ 19,337.36		
Maintenance	AVDLR/AFM	$ 3,701,979.02	AVDLR/AFM	$ 3,226,918.57	AVDLR/AFM	$ 3,132,712.44	AVDLR/AFM	$ 4,217,899.11
	(UC-12W)	$ 1,235,157.17	(UC-12W)	$ 760,096.72	(UC-12W)	$ 1,235,157.17		
	(UC-35D)	$ 2,466,821.85	(UC-35D)	$ 2,466,821.85	(UC-35D)	$ 1,897,555.27		
System Improvements	Modifications/Updates	$ 550,848.10	Modifications/Updates	$ 474,651.20	Modifications/Updates	$ 488,203.61	Modifications/Updates	$ 2,079,589.55
	(UC-12W)	$ 279,388.64	(UC-12W)	$ 203,191.74	(UC-12W)	$ 279,388.64		
	(UC-35D)	$ 271,459.46	(UC-35D)	$ 271,459.46	(UC-35D)	$ 208,814.97		
Total		$ 8,614,685.82		$ 8,208,017.33		$ 8,387,597.26		$ 9,286,931.80
Difference from Status Quo		$ -		$ 406,668.49		$ 227,088.56		$ (672,245.98)

Table 18. COA Comparison FY27

2027	Status Quo	Costs (PAI)	COA 1	Costs (PAI)	COA 2	Costs (PAI)	COA 3	Costs (PAI)
Personnel	Active Duty	$ 1,791,432.07	Active Duty	$ 1,579,334.02	Active Duty	$ 1,557,492.26	Active Duty	$ 1,589,061.24
	(UC-12W)	$ 777,692.87	(UC-12W)	$ 565,594.81	(UC-12W)	$ 777,692.87		
	(UC-35D)	$ 1,013,739.20	(UC-35D)	$ 1,013,739.20	(UC-35D)	$ 779,799.39		
	Civilian	$ 1,082,927.25	Civilian	$ 960,432.70	Civilian	$ 936,670.21		
	(UC-12W)	$ 449,146.71	(UC-12W)	$ 326,652.15	(UC-12W)	$ 449,146.71		
	(UC-35D)	$ 633,780.55	(UC-35D)	$ 633,780.55	(UC-35D)	$ 487,523.50		
Aircraft (Procurement)	UC12W/UC-35D		UC-12W	$ 672,201.79	UC-35D	$ 985,288.41	MV-22	
Fuel	JP-5	$ 631,866.28	JP-5	$ 564,217.15	JP-5	$ 543,292.55	JP-5	$ 203,420.78
	(UC-12W)	$ 248,046.80	(UC-12W)	$ 180,397.67	(UC-12W)	$ 248,046.80		
	(UC-35D)	$ 383,819.48	(UC-35D)	$ 383,819.48	(UC-35D)	$ 295,245.76		
Operations/Training	Unit	$ 852,751.12	Unit	$ 758,752.49	Unit	$ 735,499.71	Unit	$ 364,747.78
	(UC-12W)	$ 344,661.66	(UC-12W)	$ 250,663.03	(UC-12W)	$ 344,661.66		
	(UC-35D)	$ 508,089.46	(UC-35D)	$ 508,089.46	(UC-35D)	$ 390,838.05		
Sustainment	Program	$ 99,075.70	Program	$ 72,693.90	Program	$ 116,554.03	Program	$ 906,949.42
	(UC-12W)	$ 96,733.24	(UC-12W)	$ 70,351.45	(UC-12W)	$ 96,733.24		
	(UC-35D)	$ 2,342.46	(UC-35D)	$ 2,342.46	(UC-35D)	$ 19,820.79		
Maintenance	AVDLR/AFM	$ 3,794,528.50	AVDLR/AFM	$ 3,307,591.54	AVDLR/AFM	$ 3,211,030.25	AVDLR/AFM	$ 4,323,346.59
	(UC-12W)	$ 1,266,036.10	(UC-12W)	$ 779,099.14	(UC-12W)	$ 1,266,036.10		
	(UC-35D)	$ 2,528,492.40	(UC-35D)	$ 2,528,492.40	(UC-35D)	$ 1,944,994.15		
System Improvements	Modifications/Updates	$ 564,619.30	Modifications/Updates	$ 486,517.48	Modifications/Updates	$ 500,408.70	Modifications/Updates	$ 2,131,579.29
	(UC-12W)	$ 286,373.35	(UC-12W)	$ 208,271.53	(UC-12W)	$ 286,373.35		
	(UC-35D)	$ 278,245.95	(UC-35D)	$ 278,245.95	(UC-35D)	$ 214,035.35		
Total		$ 8,817,200.23		$ 8,401,741.07		$ 8,586,236.13		$ 9,519,105.10
Difference from Status Quo		$ -		$ 415,459.16		$ 230,964.11		$ (701,904.87)

Table 19. NPV COA Comparison

Year	t	Benefits	Costs	Disount Factor	PV of Benefits	PV of Costs	NPV
2022	0	373,539	0.00	100%	373,539	0.00	373,539
2023	1	381,526	0.00	93%	356,567	0.00	356,567
2024	2	389,707	0.00	87%	340,385	0.00	340,385
2025	3	398,086	0.00	82%	324,957	0.00	324,957
2026	4	406,668	0.00	76%	310,245	0.00	310,245
2027	5	415,459	0.00	71%	296,217	0.00	296,217
Total		2,364,986	0.00		2,001,910	0.00	2,001,910
Table of Net Present Value - COA 2							
Year	t	Benefits	Costs	Disount Factor	PV of Benefits	PV of Costs	NPV
2022	0	212,431	0.00	100%	212,431	0.00	212,431
2023	1	215,973	0.00	93%	201,844	0.00	201,844
2024	2	219,595	0.00	87%	191,803	0.00	191,803
2025	3	223,300	0.00	82%	182,279	0.00	182,279
2026	4	227,089	0.00	76%	173,245	0.00	173,245
2027	5	230,964	0.00	71%	164,674	0.00	164,674
Total		1,329,351	0.00		1,126,276	0.00	1,126,276
Table of Net Present Value - COA 3							
Year	t	Benefits	Costs	Disount Factor	PV of Benefits	PV of Costs	NPV
2022	0	0.00	-576,305	100%	0.00	-576,305	576,305
2023	1	0.00	-599,351	93%	0.00	-560,141	560,141
2024	2	0.00	-623,013	87%	0.00	-544,164	544,164
2025	3	0.00	-647,306	82%	0.00	-528,394	528,394
2026	4	0.00	-672,246	76%	0.00	-512,853	512,853
2027	5	0.00	-701,905	71%	0.00	-500,448	500,448
Total		0.00	-3,820,126		0.00	-3,222,306	3,222,306

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APPENDIX B. UC-12W SUPER KING AIR

Table 20. UC-12 Super King Air Characteristics. Adapted from HQMC (2020).

Passenger/cargo load	8 passengers with 500 pounds cargo
Range	1,500 nautical miles with wing tank fuel 2,000 nautical miles when equipped with extended range fuel tanks
Speed	Cruises at 280 knots
Maximum takeoff weight	16,500 pounds
Ceiling	35,000 feet
Maintenance	Contractor supported
Power plant	Two Pratt and Whitney PT6A-60A turboprop engines
Thrust	1050 shaft horsepower (each engine)
Length	46 feet 8 inches
Height	14 feet 4 inches
Wingspan	57 feet 11 inches

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APPENDIX C. UC-35D CITATION

Table 21. UC-35D Citation Characteristics. Adapted from HQMC (2020).

Passenger/cargo load	7 passengers with 300 pounds cargo
Range	1,400 nautical miles
Speed	Cruises at 400 knots
Maximum takeoff weight	16,500/16,630 pounds
Ceiling	45,000 feet
Maintenance	Contractor supported
Power plant	Pratt & Whitney JT15D-5D/PW535A
Thrust	3,045/3,400 pounds (each engine)
Length	48 feet 9 inches
Height	15 feet
Wingspan	52 feet 2 inches

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