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THESIS

OPTIMIZING PERMANENT CHANGE OF STATION COST ESTIMATION AND COST COMPARISON FOR MANAGERS

by

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OPTIMIZING PERMANENT CHANGE OF STATION COST ESTIMATION AND COST COMPARISON FOR MANAGERS

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ABSTRACT

Marine Corps occupational monitors currently make human resource relocation decisions without the capability to systematically compare the costs of alternative assignments. A primary weakness of current practice is a lack of communication between the assignment process and the financial systems administering permanent change of station (PCS) costs amounts. This thesis presents a systematic cost estimation and comparison tool to facilitate managerial decisions relevant to PCS assignments. To identify PCS-related managerial decisions, this study reviews the Marine Corps' personnel assignment process, the impacts sustained by service members and their dependents, and the ensuing costs associated with PCS moves. The thesis demonstrates the model's ability to inform managerial decisions and capture cost estimations to better assess personnel assignments. Further development is required to improve the capacity of the model, which would bolster managers' ability to regulate assignment costs and be resilient in times of fiscal stress.

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LIST OF ACRONYMS AND ABBREVIATIONS

1stLt	First Lieutenant
ASR	Authorized Strength Report
Capt	Captain
CLNC	Camp Lejeune, North Carolina
CONUS	Contiguous United States
CPEN	Camp Pendleton
DC CD&I	Deputy Commandant, Combat Development and Integration
DC M&RA	Deputy Commandant, Manpower and Reserve Affairs
DC P&R	Deputy Commandant, Programs and Resources
DLA	Dislocation Allowance
DoD	Department of Defense
DPS	Defense Personal Property System
DTMO	Defense Travel Management Office
EFMP	Exceptional Family Member Program
FMOS	Free Military Occupational Specialty
FMR	Financial Management Regulations
GAO	General Accounting Office or Government Accountability Office
HHG	Household Goods
JTR	Joint Travel Regulations
MALT	Monetary Allowance in Lieu of Transportation
MCO	Marine Corps Order
MCRD	Marine Corps Recruiting Depot
M&IE	Meals and Incidentals Expense
MOS	Military Occupational Specialty
OCD	Overseas Control Date
OCONUS	Outside Contiguous United States
OCS	Officer Candidates School
PCA	Permanent Change of Assignment
PCS	Permanent Change of Station
PMOS	Primary Military Occupational Specialty

TFSMS	Total Force Structure Management System
TLE	Temporary Lodging Expense
TOS	Time on Station

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I. INTRODUCTION

Service members of the United States military forces and their dependents relocate from duty station to duty station several times throughout their careers. The execution of these moves is called permanent change of station (PCS) and the government as well as service members and their dependents sustain high costs, both monetary and non-monetary. The costs incurred by executing PCS moves have been a popular congressional debate over the past four decades (Office of the Inspector General, Department of Defense [DoD IG], 1997). In addition to dollar amounts, morale and welfare among service members and their dependents, unit readiness, career progression, and leadership succession planning are a few of the concerns that arise in the debate. The U.S. military, along with the rest of government, is under the threat of sequestration, a budgetary resource cancellation policy. The across-the-board cuts were expected to decrease the deficit by $1.2 trillion over a ten-year period (Budget Control Act, 2011; Congressional Budget Office, 2018). Budget cutbacks are the leading threats to national security and stifle the effort to modernize capabilities (Mattis, 2018). Cutting costs and doing "more with less" have become popular rhetoric in public policy.

To be clear, there is nothing "permanent" about permanent change of station moves. In fact, one explanation for the high costs is the result of the frequency of PCS moves, which is prescribed every 24 to 36 months (Commandant of the Marine Corps [CMC], 2014). One suggestion for decreasing PCS expenditures is to increase the amount of time a service member serves at a particular duty station, otherwise known as time on station (TOS) (Lilley, 2018; Bond et al., 2016). Longer tours of duty mean fewer PCS moves throughout a military career, which translates to fewer disruptions to career opportunities and education (General Accounting Office, 2001; Morales, 2011; Morgan, 1991). Fewer PCS moves mean a decrease in the financial burden to the government.

However, increasing TOS requirements also increases tours of duty for those stationed at less-than-desirable geographical locations. The potentially negative impact to morale may require additional incentives to offset the location (Grayson & Mireles, 2016). Some theories suggest the Department of the Defense (DoD) already has enough systems and programs in place to alleviate the disruptions associated with PCS moves (Tong et al., 2018), and therefore the increase in TOS is not required. Other investigations have uncovered DoD policies meant to capture PCS analytical data have not been enforced (DoD IG, 1997; Government Accountability Office [GAO], 2015). Congress advised the DoD to correct its incomplete and inconsistent PCS move data before any further changes are recommended (McCain, 2015). The advisement of Congress implies the problem is not the current fiscal stress, but rather the inability to respond to fiscal stress. Resilient policies and systems would better serve managerial decisions when presented with budget cutbacks more so than strategies to prevent them (Bozeman, 2010, p. 561). Developing a modeling tool that can simulate the costs of different organizational strategies is one approach to developing this type of budgetary resilience (Brien et al., 2018).

Approximately 97,624 Marines, along with their dependents, are estimated to execute PCS orders in FY18, at a cost of $481.6 million (Department of the Navy, 2018, p. 78). The estimation is based on historical costs and not associated with the costs resulting from the personnel assignment process (Tong et al., 2018). There are currently no methods in place to capture or rein in this expense, or the frequency at which it occurs. This thesis will explore one such method using a Linear Programming assignment model to develop a systematic cost estimation and comparison tool to facilitate managerial decision relevant to PCS assignments. Using a hypothetical simulation to assign Marine officers to available billets throughout the United States, the model will seek to minimize PCS costs to the Marine Corps. This thesis will explain the methodology, review the analysis of the model's simulations, and finally make recommendations for possible application and further research.

II. BACKGROUND

Understanding the costs of PCS moves (monetary and non-monetary) incurred by the government, the service members, and their dependents requires an examination of the personnel assignment process. This thesis will focus mainly on the Marine Corps personnel assignment process and applications, but will include a review surrounding other military branches of the DoD to illustrate the extent of the impact of PCS moves is not exclusive to one branch. The sensitivity towards the impact of PCS moves on other branches will provide a recommendation towards generalizability of a PCS assignment cost estimation model.

There are several regulations that govern the Marine Corps personnel assignment process and the travel policies associated with DoD travel; this thesis will review three of them. The three Marine Corps Orders (MCO) provide the genesis of PCS moves, which include the needs of the Marine Corps and the consideration of the individual Marine's career and family needs. The ensuing PCS cost estimation and budget formulation guidance are promulgated throughout the DoD in the form of Financial Management Regulations (FMR), the Joint Travel Regulations (JTR), and the Defense Personal Property System (DPS). These provide all monetary costs calculations and the presentation of costs associated with PCS moves. This thesis will compare the uses of these regulations and systems with the actual execution of PCS travel. In addition, this thesis will review a similar optimization model conducted in 2012 at the Naval Postgraduate School, which will provide a baseline to measure an assignment cost estimator tool.

A. MARINE CORPS ORDERS (MCO) ON PERSONNEL ASSIGNMENT

1. MCO 5320.12H: Precedence Levels for Manning and Staffing

This order provides the distinction between the phrases "manning" and "staffing," and governs how the levels of personnel end strength relate to assignments. "Manning" is defined as an allocation of the total authorized end strength, stated each year in the National Defense Authorization Act, "against requirements stated in the Total Force Structure Management System (TFSMS)" (CMC, 2017, p. 1). The Deputy Commandant for Combat

Development and Integration (DC CD&I) builds the TFSMS, which establishes these requirements, otherwise known as the Tables of Organization (T/O), for allocation of the total authorized end strength. This means that the DC CD&I determines what type and how many occupational fields, and billets within those occupational fields, should comprise each Marine Corps unit based on how many Marines are allowed by congress. This "manning" process then produces the Authorized Strength Report (ASR), which represents an "ideal solution" (CMC, 2017, p. 1) of how many and where Marines should be assigned.

"Staffing" is defined as the management and actual distribution of "the current inventory of Marines" (CMC, 2017, p. 1). Once the DC CD&I produces the ASR, the Deputy Commandant for Manpower and Reserve Affairs (DC M&RA) then establishes "staffing" goals. An assignment plan is built amidst structure and policy changes, cyclical recruiting trends, and other constraints to staff as much of the positions already determined through the "manning" process. The goal is to have every unit manned to the fullest extent, in accordance with the ASR, however, due to the constraints; many Marine Corps units will be staffed with fewer Marines than the T/O prescribed.

In short, the DC CD&I builds the requirement for personnel, and the DC M&RA attempts to fill those requirements. Whether it is through "manning" or "staffing" each designed position and available Marine are considered to be "bought" (CMC, 2017, p. 1), referring specifically to the monetary cost of training and equipping a Marine for a particular position. This notion exemplifies the importance of budgetary realities in the assignment process.

2. MCO P1300.8S: Marine Corps Personnel Assignment Policy

The language in this order is very specific as it pertains to its prioritization of assignment goals. The assignment process is managed under the DC M&RA whose intent is articulated upfront:

> The Marine Corps will limit the number of Permanent Change of Station (PCS) moves to those required to achieve/maintain combat readiness or to ensure equitable treatment and career development of individual Marines. This policy further improves combat readiness by controlling personnel

> turnover, increasing the stability of Marine families, and reducing PCS costs. (CMC, 2014, p. 1)

The prioritization of goals stated above places combat readiness with the greatest importance for assignment, next to career development and equitable treatment and above unit cohesion and family stability. These goals fall in the category of non-monetary costs; costs that are not necessarily unquantifiable, but difficult to associate with a dollar amounts. The final intent of limiting PCS moves is to reduce monetary cost.

a. PCS Move Types

The guidance to reduce monetary costs directs minimal use of Fully Funded PCS orders. Fully funded orders require a Marine and his or her dependents (if applicable) to relocate to a different geographical location, possibly transcontinental or transoceanic, which would incur a sizeable monetary cost to the government. Low Cost PCS and no cost permanent change of assignment (PCA)[1] orders are considered the preferred method of personnel reassignment (CMC, 2014). Low Cost PCS orders are defined as orders that reassign Marines to duty stations within "close proximity" (approximately 50 miles or less) of the previous duty station. Two examples of Low Cost PCS moves are from Marine Corps Air Station (MCAS) Miramar in Southern California to Marine Corps Recruit Depot San Diego, and Camp Lejeune North Carolina to MCAS Cherry Point North Carolina. No Cost PCA orders transfer a Marine between units aboard the same military installation, thus incurring "no [PCS] cost" to the government.

b. Time on Station

Before a service member can be eligible for assignment to a new position, MCO P1300.8S requires the completion of a prescribed tour of duty. Tours of duty translate to how long Marines and their dependents remain at a particular duty station. This is also known as Time on Station (TOS). Several regulations within the DoD set the length of time service members will remain on station before they are eligible to relocate. This MCO

[1] Permanent changes of assignments transfer Marines to a different billet and different command but remains at the same duty station. No cost is incurred by the government (CMC, 2014).

along with DoD Instruction 1315.18, and Navy Military Personnel Manual (MILPERSMAN) 1306-106 prescribe tour lengths, or TOS, within the Contiguous United States (CONUS) to be 36 months. Tours executed Outside CONUS (OCONUS), i.e., Okinawa, Japan, require a minimum TOS of 24 months. All three regulations also echo similar language citing the stabilization of service members and their dependents, the enhancement of unit readiness, and the reduction of PCS costs as the purpose behind the 36-month minimum requirement. It is also important to note that there is no prescribed maximum length of tour.

c. MOS Monitors

Once a Marine is eligible to PCS, communication with a military occupational specialty (MOS) monitor commences. All Marines hold a rank and MOS corresponding to a billet within an occupational field, the amount and location of which are published in the ASR as discussed in MCO 5320.12H. MOS monitors represent one or more of these MOSs and attempt to assign the best fit Marine to an available billet, with the ideal solution benefitting both the Marine Corps and the individual Marine. MOS monitors will communicate available billets and their associated requirements to the Marines they represent. Marines, in turn, are expected to communicate any desires or concerns regarding the available billets and their locations.

MOS monitors are directed to assign Marines, specifically officers, in accordance with the needs of the Marine Corps, the Marine officer's individual career progression, an Overseas Control Date (OCD), and finally individual preference (CMC, 2014). They will create PCS orders for each Marine officer they assign.

3. MCO 1000.6: Assignment, Classification, and Travel System Manual

The last MCO provides "guidance and compliance of all functions relative to personnel management" (CMC, 2013, p. 2). The process of personnel management refers to classifying, assigning, and distributing Marines in accordance with the above two orders. This order governs how MOS monitors determine the needs of the Marine Corps, career progression, and the importance of individual preference. It mitigates a MOS monitor from assigning a Marine and his or her dependents to geographical locations that may otherwise create unnecessary hardships. For example, Marine sponsors may be enrolled in the Exceptional Family Member Program (EFMP). This program identifies whether or not a dependent possesses a "medical and/or an educational requirement that cannot be adequately supported" (CMC, 2013, p. 1-26) at particular duty stations. A MOS monitor would then be unable to assign a Marine officer enrolled in the EFMP to those identified duty stations.

MCO 1000.6 also ensures that a Marine is assigned to billets that require similar, and valid acumen already possessed by that Marine as annotated by said Marine's Basic training Record (BTR). The MCO then defines the types of orders Marines can receive, along with the entitlements associated, due to their new assignment. The amount of the entitlements and their calculations are not articulated within this MCO; those can be found in the following to regulations.

B. COST ESTIMATION AND BUDGET FORMULATION

1. DoD 7000.14-R: Financial Management Regulation (FMR)

The DoD FMR is a multi-volume authority that directs statutory and regulatory financial management procedures and their functions for all funding authorized by congress, and the departments that manage funding activities within the DoD. Regarding PCS moves, the DoD FMR requires average annual PCS costs by type be recorded and estimated for future year budget planning. PCS costs include mileage, monetary allowance in lieu of transportation, per diem, temporary lodging expense, travel of dependents, etc. These monetary costs are not defined or calculated in the DoD FMR. PCS move types, however, are defined and determined by the reason for travel and the location to where travel is executed. Accession travel pertains to those authorized travel from civilian life, military academy, or Reserve Officer Training Command (ROTC) to either a Marine Corps Recruit Depot (MCRD) or Officer Candidates School (OCS). Rotational travel refers to transoceanic travel usually between CONUS and Outside the Contiguous United States (OCONUS) duty stations. Operational travel is travel between two duty stations within the CONUS. For simplicity this thesis will focus on Operational travel of Marine officer assignments.

Although the DoD FMR standardizes how costs incurred should be captured and presented for historical data and cost estimation purposes, it does not directly align with the personnel assignment process. Both the DoD FMR and the Joint Travel Regulations (JTR) are publicly available, however, this thesis found no requirement or supporting assets for MOS monitors to calculate the monetary costs resulting from their assignments (Tong et al., 2018). These regulations guide the actions of personnel under the Deputy Commandant for Programs and Resources (DC P&R). In actual practice, PCS cost estimation begins with Programs and Resources (P&R) conducting a review of the ASR developed by CD&I. P&R then compare the ASR against historical costs and budgeted costs for affordability. Then P&R will communicate their analysis to Manpower and Reserve Affairs (M&RA) with an approximate number or percentage of personnel allowed to execute PCS orders. These numbers do not include number of dependents or the cost incurred to relocate them. In addition, costs incurred by transporting a Marine's Household Goods (HHG) is captured in a bulk line of accounting created for a specific travel type (i.e., Accession, Rotational, and Operational) (Department of Defense [DoD], 2017). In other words, cost estimation is performed through a comparison of historical costs incurred by an average over the aggregate against predictions of the fiscal landscape. The inability to review all PCS costs associated with individual Marines and their dependents impedes clear analytics.

2. The Joint Travel Regulation (JTR)

The JTR "implements policy and laws establishing travel and transportation allowances" (DoD, 2018a, Intro-1) afforded to both service members and civilians within the DoD. This regulation, in conjunction with the Defense Travel Management Office (DTMO), provides a breakdown of all allowances authorized to all service members and their dependents when executing all types of travel. Allowances include the amount of travel time (measured in days) a service member is authorized for reimbursement depending on the distance between duty stations, as well as how much per diem is afforded a dependent under the age of twelve per travel day. The amounts authorized in the JTR are calculated to determine the travel pay allowances during PCS move execution.

3. The Defense Personal Property System (DPS)

The DoD United States Transportation Command and the Military Surface Deployment and Distribution Command developed the Defense Personal Property System (DPS) in an effort to give service members more control in planning a PCS move (Military.com, 2018). More specifically, the system allows a service member to schedule to the logistical transportation of their Household Goods (HHG) from home on an account online. The government authorizes HHG transportation up to an amount based on rank and dependent status to service members executing PCS move orders (DoD, 2018a). The distances between duty stations used to calculate travel and transportation allowances is found on the Defense Table of Official Distances (DTOD) website (CMC, 2014, p. A-3; Defense Personal Property System, n.d.)

C. OPTIMIZING PERSONNEL ASSIGNMENTS MODEL

A 2012 study utilized Linear Programming (LP) to create an optimization model to minimize the cost of PCS moves while efficiently assigning Marine officers to available billets (Hooper & Ostrin, 2012). The study developed a model to compare the costs of relocating 15 Marine officers, from the specific location of Monterey, CA to 15 available billets with the actual costs authorized to relocate the 15 officers according to the orders they actually received. The model measured the allowances authorized for PCS travel (i.e., Per Diem and Transportation of Household Goods), but did not compare alternative assignment costs. The intent of the model instead established a one-time baseline assignment query to assist MOS monitors in the assignment process (Hooper & Ostrin, 2012).

D. SUMMARY

Each MCO mentioned above governs an approach to Marine Corps personnel assignments that beget more detail with each regulation. MCO 5320.12H published by DC CD&I establishes what type and how many Marines are authorized for each unit. The DC M&RA then publishes MCO P1300.8S to guide the attempted occupation of all authorized positions with the current inventory of personnel. The DC M&RA's guidance outlined in MCO 1000.6 further defines which personnel within the available inventory can be assigned and where. DoD 7000.14-R, the DoD FMR, does not provide guidance on personnel assignment but does allow the DC P&R to estimate PCS costs by type and develop an average cost against the amount of moves executed by M&RA PCS assignment orders. The JTR and DPS further articulate the calculations of each possible monetary PCS cost based on a service member's rank and dependent status to develop the total cost of one PCS move authorization. This thesis is not the first to review PCS assignment optimization, however, it will attempt to bring resiliency to a process that is one of many under constant scrutiny during times of fiscal stress.

III. LITERATURE REVIEW

The purpose of this thesis is to identify a method to facilitate PCS-related managerial decisions that impact the assignment and cost estimation process. To understand the impacts of the PCS assignment process, this thesis will review reports and congressional inquiries on the PCS program within the DoD. The reports include audits conducted by the General Accounting Office (GAO), now the Government Accountability Office (GAO),[2] and the RAND Corporation. These reports measure the performance of the PCS program and its ability to control costs incurred. They also measure career (of both service member and spouse) and educational disruptions resulting from PCS moves. This thesis will also review studies on PCS impacts, consisting of those monetary and non-monetary costs incurred by service members and their dependents, as well as the government. The studies include GAO reports, articles, and theses. Understanding the impacts of PCS moves frames the concerns that congress, the DoD, and service members have expressed over the past few decades.

This chapter will first review the literature on the recommendation to increase TOS. This proposed solution to the original concerns of high PCS costs that arose in the early 1980s (DoD IG, 1997) is a common theme in the literature. This chapter will then explore an alternate method of producing PCS cost savings. Finally, a comparison of the two recommendations will be performed based on the probability of acceptance among the culture found within the DoD.

A. INCREASING TIME ON STATION

1. Stability

As previously stated in MCO P1300.8S, Marine Corps officers are assigned based on priorities, both the Marine Corps' priorities and the individual service member's

[2] The General Accounting Office effectively changed its name to the Government Accountability Office July 7, 2004, "which better reflects the modern professional services organization GAO has become" (Government Accountability Office [GAO], n.d.). Henceforth in this thesis, the organization will be referred to simply as the GAO for consistency.

priorities. It further directs the limitation of PCS moves and requires a minimum TOS of 24 to 36 months, depending on geographical location. The goal of the limitation is to achieve or maintain combat readiness: "Combat readiness is further improved by increasing the stability of Marine families and reducing PCS costs" (Commandant of the Marine Corps [CMC], 2014, p. 1-1). But what is stability? The MCO does not directly define "stability" but does explain that maintaining it is paramount due to the "debilitating effect on combat readiness caused by excessive turbulence" (CMC, 2014, p. 1-7). Turbulence has been defined as the rate of "movement of soldiers" (Hix et al., 1998, p. xi), more commonly known as PCS moves. This thesis defines stability as a lack of disruptions to career opportunity and education.

The nature of a Marine Corps career inherently involves regular disruptions and shifts, and many service members do see the value of relocations (Grayson & Mireles, 2016). They may view it as the next stage in their career. However, it has the potential to affect proficiency if one must learn new command procedures, processes, and points of contact every two to three years. The more often Marines experience disruptions in duty, whether it be from relocating to a new position or receiving a new Marine in need of training, the less stability they experience. Military families experience disruptions as well. A spouse's career or a child's education may suffer from the lack of stability because a PCS move is not directed to facilitate their needs, but the needs of the Marine and the Marine Corps. Increasing TOS decreases the amount of times a service member conducts PCS moves throughout his or her career. Fewer required PCS moves reduce the disruptions to careers and education (GAO, 2001; Morales, 2011; Morgan, 1991; RAND, 2015; Tilghman, 2015). Fewer disruptions translate to a decreased financial burden to the government.

The Marine Corps' policy favors increased stability; however, studies show the policy is not being practiced (GAO, 2001). The report found the average time between PCS moves throughout the DoD was approximately two years, with the Marine Corps having the shortest time between PCS moves and the Air Force displaying the longest time. The report did acknowledge the more frequent moves on average for the Marine Corps may result from the fact its force is younger and its members serve mainly one term. There is also a stigma associated with remaining in a geographical location for longer than 36 months. Known as "homesteading," it can have a negative effect on the likelihood of promotion due to the belief it is correlated to frequent PCS moves (Grayson & Mireles, 2016; Hunt, 1994). The recent 'Force of the Future' initiative in 2015 recommended service members and their dependents execute PCS moves once every four years to achieve more stability (Tilghman, 2015). The Air Force had increased its average TOS in 2006 from three years to four years (Lilley, 2018). But in 2015, the GAO found that the DoD was unable to determine whether service members were even meeting TOS requirements (GAO, 2015).

A study in 1991 reviewed the stressors associated with the lack of stability (Morgan, 1991). These stressors refer to the perceived negative affects to spousal employment, child development, and patient care. Increased stability, which translates to increasing TOS, has the capacity to positively affect these concerns. However, there is an argument against increasing TOS. The increase in TOS for one service member at one duty location means another service member must remain at a different duty station, which may not be desirable (Hernandez & Johnson, 2014). This argument will be echoed throughout the following proposed benefits:

a. Spousal Employment

Morgan's (1991) study was conducted in response to the fact that more than half of the Army's force specifically was married, compared to less than 40 percent in the 1970s. Forty-six percent of those Army wives[3] possessed at least a bachelor's degree. Those with higher degrees struggled to find work that made adequate use of their skills. The driving factor for a spouse to transition from part time to full time work was not the service member's amount of income, but rather how long the service member was assigned to a particular duty station (Morgan, 1991).

More and more households in the United States contain two working parents, and the employment rate and career tracks of spouses can suffer with instability (Morales,

[3] The author is aware the focus is on a specific gender but it was the common demographic at the time of this particular study.

2011). This has been addressed within the DoD with the creation of spousal employment programs aimed at assisting spouses with their careers. However, service members still desire stability to provide career growth and education opportunities (Hernandez & Johnson, 2014). If PCS moves continue at an average of every two years, the employment programs may be limited in their assistance. According to the U.S. Department of Labor, the current average tenure of both wage and salary workers is 4.2 years (Department of Labor, 2018). If the Marine Corps increased its average TOS from two years to four or even five years, then a spouse will have more leverage when applying for a job because the company would almost be guaranteed the same return on investment as the average employee. In turn, the spouse would be provided with the opportunity for career growth.

The most recent RAND study on family stability and PCS moves reviewed Social Security Administration Form W-2 wage earnings and found spouses lost an average 14 percent in earnings in the calendar year of a PCS move (Tong et al., 2018, p. 11). Unlike their civilian counterparts, service members cannot refuse their orders to relocate. A military spouse does have the option to remain at a specific location to avoid disruption in employment, but the impact on relationships can be another added stressor (Morales, 2011). In fact, PCS moves that do not align with their spouse's career have been a reason personnel leave military service (Hunt, 1994).

An argument against increasing TOS, specifically for spousal employment benefits, is the possibility of being stationed in a location that does not promote career growth. Longer TOS may provide career-building opportunities in an area catering to a wide variety of careers but not in an area with little opportunity, which can be described as a less-than-desirable location. An example of a perceivable location that is less-than-desirable is the Air Force Base in Minot, ND. Besides the military base, there are only five businesses with more than 400 employees and the eleventh largest employer is the local Wal-Mart store (The Finance Department, City of Minot, ND, 2016). LT Robert P. Lennon counters this argument in his *Military Medicine* editorial. Changing the tour length "mean[s] 4 less moves over the course of a career; you may have to spend 2 more years at a less desirable duty station, but you will only have to be there once" (Lennon, 2014). Lennon's argument assumes desirability of assignments is equitably distributed, which may not be so.

Nevertheless, the possibility of longer tours of duty at less-than-desirable locations could favor duty station preference over an individual service member's career progression.

b. Child Development

A semblance of stability has the potential to positively affect a child's educational and behavioral development. Behaviorally, research has shown a "child's identity is centered around an attachment to people and places, both of which change frequently with constant relocations" (Morgan, 1991, p. 8). The increase in child stress associated with frequent PCS moves could lead to "difficulties with children's psychosocial outcomes, including mental health issues, behavior problems, substance use and abuse" (Tong et al., 2018, p. 8).

Disruptions in education, with the changing of schools, and in peer groups that are associated with PCS moves also increase child stress (Tong et al., 2018). The emotional levels experienced by the average child are more extreme in a military child due to the constant relocation, compounded with the range of educational standards throughout duty stations (Morales, 2011). Some service members have cited they have accepted an unaccompanied tour, a tour of duty without relocating the dependents in exchange for a shorter tour, to avoid disrupting their child's education (GAO, 2001, p. 3). The service member's absence from the family in this situation is the trade off in favor of education. However, the absence creates a "disruption to the parent-child relationship" (Tong et al., 2018, p. 8). Parents also feel stressors related to the loss or decrease in childcare caused by frequent moves (GAO, 2001, p. 21).

The counter argument is found in the travel opportunities provided to families that are not often afforded to their civilian counterparts. Some children's ability to adapt to new surroundings may be enhanced by the frequent moves. Research shows that it is not until a child's teenage years that the negative effects of frequent PCS moves become apparent (Morales, 2011; Morgan, 1991). Conceivably, the frequent moves also mitigate prolonged exposure to sub-standard education. Public schools adjacent to many military installations are found to be "low-performing" (Goldman et al., 2016, p. 78).

c. *Patient Care*

Disruptions in the continuity of healthcare are also a concern. The less a health care provider can gain familiarity with a patient and his or her medical history, the less they can effectively manage health conditions (Cabana & Jee, 2004). Constant provider turnover could lead to a delay in preventative services, and quite possibly a disincentive to seek out services if a service member and dependents are scheduled to relocate again. A lack of continuity of healthcare has been shown to "worsen patient satisfaction, childhood immunization rates, the number of well-child visits, and cervical cancer screenings" (Lennon, 2014). Therefore, the increase in TOS can improve the continuity of care of service members and their dependents. The trade off, however, is similar to the issues threatening spousal employment and child development if TOS is increased. There is the possibility of extended exposure to sub-standard healthcare.

2. Retention

Stability has also been linked to retention. Much of what has already been mentioned with regards to stability, spousal employment, and child development, contribute to morale. The transition from conscription to an all-volunteer force in 1973 was possible because the monetary cost to the government was acceptable. The costs were incurred by providing benefits such as educational incentives and pay that was competitive to civilian jobs. Analysis from social psychology and sociology research conducted in the 1960s assisted in the development of and subsequent implementation of policies that had a positive effect on accession and retention (Rostker, 2006). The individual Marine's morale is related to retention. Morale can be divided into two categories, job satisfaction and satisfaction at home. The duration of TOS has shown to be related to both categories (GAO, 2001). Service members with more time in a particular position can expect to gain more experience and possibly better proficiency than those who spend less time in the same position. Those service members and their dependents that executed longer TOS were more satisfied, while satisfaction among service members towards their job and the military decreased once TOS was two years or less. This dissatisfaction translates to retention issues. More service members with a spouse or a significant other indicated they might not continue their service than those who experience longer TOS (GAO, 2001).

Job satisfaction can also be a result of career progression. Similar to the argument against increasing TOS if remaining in a less-than-desirable location for families' satisfaction, a Marine may potentially be forced to remain in a less-than-desirable job. The study by Major Thomas R. Hunt suggests that "annual PCS movement... is unavoidable because vacancies occur" due to timelines of professional development (i.e., career level schools), or career progression opportunities (i.e., command tours) (Hunt, 1994, p. 2). There are many positions that fulfill the "needs of the Marine Corps" but they may not fulfill leadership succession requirements, which can set up a Marine for promotion. Some observations reveal that an increase in PCS moves can increase the likelihood for promotion (Morales, 2011). Therefore, Marines able to diversify their career through increased PCS moves may increase their chances of promotion, which could increase their job satisfaction and ultimately positively affect retention.

MCO P1300.8S facilitates career progression through its assignment intent, "to ensure equitable treatment and career development of individual Marines" (CMC, 2014). This MCO provides MOS monitors the ability to limit PCS moves by giving priority to those requiring career enhancing opportunities, whether it be special training, education or a command position. However, the priority mainly delineates position and location possibilities, not the priority to relocate. According to a Government Accountability Office report on Military Compensation, the services arbitrarily move service members out of a cultural habit, and not to enhance individual career development or unit readiness (GAO, 2015). This fact, compounded with current TOS requirements not being met, suggests that many PCS moves are either unnecessary, or need to better align with the current policies designed to limit the number of PCS moves.

3. Combat Readiness

If increasing TOS has the potential to increase stability within the family unit then it can be assumed it will also improve readiness, or cohesion, within the military unit.

A 2011 study applied Tuckman's Stages of Team Development to unit readiness (Morales, 2011, p. 16). This theory breaks down the production process of any organization into five stages; *forming*, *storming*, *norming*, *performing*, and *adjourning*. The stages were assigned to the readiness of a unit preparing for deployment; the receiving of new Marines fell into the *forming stage,* the chain of command was established in the *storming stage*, training was executed in the *norming phase* as cohesiveness was achieved, then the unit deploys in the *performing stage*. The execution of PCS orders to leave the unit was assigned in the *adjourning phase*. The study surmised that units would experience better effectiveness, and the individual Marine would become more proficient if TOS was increased to 48 months, thus reaching the *performing stage* quicker due to fewer turnovers.

Although the theory of increasing TOS to better establish unit cohesion appears to be sound, other sources suggest that an increase of TOS "as a variable by itself" (Morales, 2011, p. 39) may not affect unit cohesion either way. One can also argue that the relaxed tempo may introduce complacency within a unit, which can potentially debilitate combat readiness.

4. Cost Savings

Approximately one-third of military service members and their dependents will execute a PCS move every year (Tong et al., 2018, p. 1). In the Marine Corps alone, an average of 106,712 members conduct PCS moves annually, which is currently more than half the Marine Corps' authorized end strength (Morales, 2011). With the amount of personnel potentially packing up and relocating to a different geographical location annually, both the monetary and non-monetary costs will add up. According to the 2011 study by Morales, the Marine Corps could save, at minimum, an estimated $14.6 million annually just by increasing the Marines' average TOS from 24 to 36 months. Another study recommends increasing the TOS to five years, which found an annual savings of $38 million (Grayson & Mireles, 2016).

Congress has insisted on eliminating frequent PCS moves to reduce cost and increase stability since the mid-1980s (DoD IG, 1997). The cost of PCS moves has increased since 2001, despite the decrease in the number of PCS moves, and the DoD does not have complete data to evaluate and explain the increase (GAO, 2015). The DoD also reports different average dollar amounts per move by service. For example, an average Air Force PCS move costs “more than 45 percent higher” than an average Marine Corps PCS move (McCain, 2015, p. 2). An explanation for the variance may be the Marine Corps is a younger force than the Air Force and quite possibly have a larger unmarried population, which translates to lower PCS move costs. However, the Marine Corps had higher dependent move costs than the other services. The higher costs were due to a service-specific approach to “improve the stability of military families” (GAO, 2015, p. 14). Dependents have the option to relocate prior to or after the service member relocates to align career and child education schedules. Unfortunately, the result obligates the Marine Corps to fund two separate PCS moves instead of one (GAO, 2015). In 2015 both services also requested an additional $69 million to cover unanticipated PCS move costs (McCain, 2015) and most recently, the DoD failed its audit (Mehta, 2018). It appears the DoD has failed to both adequately budget for, and decrease the cost of PCS moves for four decades. Today, more than $4 billion is spent by the DoD to conduct PCS moves annually (McCain, 2015).

The research suggests tangible savings can be realized, and unit readiness and overall morale may improve. So why has the TOS not been increased? The answer lies in the lack of supporting PCS move data and the number of current policies and procedures that would have to be eliminated or modified. The GAO could not properly evaluate the PCS program to reach a decision on the DoD’s recommendation to increase TOS due to incomplete and inconsistent data (GAO, 2015). As for eliminating or modifying current policies, leadership succession models, promotion guidelines, and the current “Up or out” model, which limits the number of times a service member can be passed over for promotion, are just a few of the cultural norms that have been submitted for change in the past (Tilghman, 2015). This year, the services have once again recommended an increase in TOS to increase stability and decrease costs (Lilley, 2018).

5. Summary

The DoD is not practicing its current PCS move policies. Even if TOS increases, the DoD still needs to correct its implementation of assignment methods, and the collection and assessment of PCS move data. It is evident that savings can be found if TOS is increased, but only in the tangible dollar amount. It is still unknown what the effect will be on the intangibles, those possible benefits to stability for families, personnel retention, and combat readiness. Those benefits may be realized just by aligning PCS moves with the policies currently in place. Constant relocation is an inherent part of being a service member and members do see the value in PCS moves (Grayson & Mireles, 2016).

Regarding the argument against increasing TOS due to a forced, prolonged stay in a less-than-desirable location, many have suggested monetary incentives (GAO, 2015; Grayson & Mireles, 2016). However, it is uncertain whether the increase in monetary rewards would offset the costs saved from increasing TOS. Therefore, before the DoD's recommendation to increase TOS is evaluated again, the DoD should attempt to practice current policies, capture relevant PCS move data, and decrease PCS move costs.

B. DECISION MODELING

If the DoD must capture relevant PCS move data and decrease PCS move costs, perhaps decision modeling should be explored. In contrast to the qualitative work performed by MOS monitors, decision modeling provides insight into the solution of a managerial decision with quantifiable results. This is an alternative to increasing TOS. There are broadly two categories of decision modeling—Deterministic and Probabilistic. A deterministic model assumes "all relevant input data values are known with certainty" (Balakrishnan, Render, & Stair, 2013, p. 1), and probabilistic models contain uncertainty of some data input values. The information afforded to MOS monitors during the assignment process is known—the Marines to be assigned, the number of available billets and their locations, and the communicated concerns and situations of individual Marines. Because the information is known to the MOS monitor the type of decision model suited for this thesis is a deterministic model.

The decision modeling process consists of three steps—formulation, solution, and interpretation and sensitivity analysis. The formulation process is considered the most challenging, as it requires the identification of a problem to be defined and translated into terms expressed as a mathematical equation, with the assumption that all relevant issues are addressed. In this case minimizing the cost of PCS moves considering the available variables, i.e., Marines to conduct a PCS move and the available billets and locations to be filled, is the intent of the equation. The subsequent solution and analysis steps have become easier to attain thanks to computer software, for example, Microsoft Excel (Balakrishnan et al., 2013).

A widely used mathematical programming platform designed to assist in managerial decisions is Linear Programming (LP). Microsoft Excel has become an increasingly capable tool to solve decision modeling techniques (Balakrishnan et al., 2013). All LP models contain the following properties:

- An objective function that seeks to maximize or minimize a specific quantity.
- Included constraints that limit the degree of pursuit, which is determined by the available resources.
- A series of alternative solutions from which to choose.
- The relationship between the objective and the constraints are linear vice exponential.

By applying the objective function, the model will seek to minimize PCS costs. The variables comprising the costs of PCS moves are found using the calculations published in the JTR, like personnel travel allowances associated with lodging and meals, and the DPS, which provides HHG cost authorizations. Examples of constraints to be used in a LP to minimize PCS costs include the rank of a service member waiting to be assigned. A MOS monitor would not have the authority to assign a First Lieutenant to a billet designated for a Lieutenant Colonel (Commandant of the Marine Corps, 2014). Therefore, the LP model would require a programmed constraint to prevent that assignment. The assignment process already has a series of alternative solutions since more than one service member must be assigned to one of many available billets from which to choose. Finally, the relationship between the objective, to minimize costs, and the constraints, who can go where, is a linear relationship. One service member has a PCS cost according to available locations; typically, the farther the distance and the greater number of dependents, the higher the cost. The cost does not change exponentially when one variable is changed.

By considering all relevant costs associated with PCS moves and successfully testing its cost minimization equation, the decision model created for the 2012 study displayed the capability to satisfy the GAO's recommendations of capturing relevant PCS cost data and decreasing PCS costs (GAO, 2015).

C. COMPARISON OF RECOMMENDATIONS

The two suggestions to address repeated congressional concerns of high PCS costs presented in this thesis are to either increase time on station (TOS) or to utilize decision modeling. The increase of TOS has the potential to address a host of other concerns possibly caused by the current PCS move process. The research has shown that both the DoD and many service members desire stability. This stability can provide career-building opportunities for spouses, uninterrupted education for children, and continuity of health care. It may also increase job satisfaction, positively affecting retention and unit cohesion. More stability could also lead to uninterrupted experience and proficiency, which can increase combat readiness.

However, a forced increase of TOS for service members and their dependents in less-than-desirable locations could arrest career growth, decrease job satisfaction, discourage retention, and leave military units complacent. Monetary incentives to offset location may not be enough to encourage service members to accept longer tours in less-than-desirable locations, or may be too much to see cost savings by increasing TOS.

Increasing TOS is also an initiative that would affect other policies and procedures. Frequent relocation is inherent to serving in the military and therefore it is a cultural norm. Changing culture is not as feasible as modifying a number on PCS orders. If something must change to decrease the cost of PCS moves, perhaps attempting to alter culture may be too cumbersome.

An optimization decision model may relieve the necessity of rewriting policy. If developed to be user-friendly and require little training, a decision model can be a useful tool to which MOS monitors can effortlessly transition. The model would provide instant cost comparisons for better assignment cost minimization and accurate cost capturing for future budget formulation. The model has the potential to assist the DoD in achieving complete and consistent PCS move data, something it has been lacking for the past 40 years.

D. SUMMARY

The DoD requires complete and consistent data to address repeated congressional concerns. The optimization decision model has the ability address the concerns without the DoD sustaining a culture shock due to multiple program modification initiatives resulting from an increase in TOS. The regulations governing personnel assignments are already in use and the DoD offers programs aimed at assisting service members and their dependents cope with frequent disruptions caused by PCS moves. Child and youth programs are offered on military installations to provide assimilation support and other activities to help school-aged dependents cope with disruptions caused by a PCS move. Employment assistance can provide spouses with career planning and counseling, and assist with employment search after completing a PCS move. Service members and their dependents can also take advantage of financial counseling that is offered on military installations. There are also many online websites intended to help families locate other resources that mitigate PCS move-related disruptions (Tong et al., 2018).

The most recent study of these programs by the RAND Corporation suggests that the DoD offers enough broad and comprehensive services to service members and their dependents that no new policies or programs are necessary to address the current disruptions caused by frequent PCS moves (Tong et al., 2018). The study, however, did find opportunities where the current services and policies can improve. One recommended improvement is to increase “the lead time given to families prior to a PCS move” (Tong et al., 2018, p. 46). This would remedy the unknown service members face when a tour of duty is coming to an end and allow families time to properly prepare for disruptions or decrease the disruptions. If no new policies and programs are necessary nor require cultural changes then increasing TOS may not be a priority.

The study also found the personnel assignment processes and the financial execution systems do not communicate (Tong et al., 2018). This means the possible costs resulting from an assignment are unknown until after the PCS move has concluded. It also explains why the services do not report complete data and why the DoD’s PCS move information is inconsistent. Since no accurate costs are identified with each potential assignment, there is also no opportunity to compare costs and enhance planning. The communication between M&RA and P&R regarding an approximate number of PCS moves to be executed does provide some mitigation of cost overruns, but, as identified above, current methods do not calculate the impact of assignments during the personnel assignment process. If the model can centralize all authorized PCS move costs and capture the results the Marine Corps and the DoD will benefit from decision modeling to improve upon the efficiency and accuracy of the PCS program. The next chapter will further explain the application of decision modeling with regards to connecting the assignment and PCS budgeting process.

IV. METHODOLOGY

A. OVERVIEW: THE MODEL

This chapter describes the methodology used to develop a cost simulation model of PCS moves. Linear programming techniques are used to develop an assignment model. This class of model "seeks to find the optimal one-to-one assignment" of one resource from one location to another (Balakrishnan et al., 2013, p. 180). In this case, Marines-to-be-assigned are the resources and the duty stations are the locations. The characteristics of the model involve assigning Marines, supplied by one duty station, to another duty station, after receiving a demand signal. The "typical objective [of an assignment model] is to minimize the total cost of the assignment" (Balakrishnan et al., 2013, p. 180). The model developed for this thesis will be referred to as the PCS Assignment Cost Model.

In the Marine Corps' personnel assignment process, MOS monitors assign one Marine from his or her current duty station to a new duty station.[4] The objective function (to minimize cost) is subject to constraints, or parameters, to assign personnel in a manner that is aligned with assignment guidance. The result of running the objective function, in theory, is a solution at the lowest cost to the government, given said parameters, and only one Marine officer is assigned to only one new duty station. This thesis will create Marines-to-be-assigned and use publicly obtained duty stations to simulate a hypothetical scenario using the PCS Assignment Cost Model.

Opponents of using linear programming may argue that the objective function denies the diverse experience that comes with serving on different coasts at different commands. If the model seeks to minimize cost, then there is a potential that Marines will either be retained at the same duty station, or at least always remain on the same coast throughout their career. It is a valid concern but unlikely for several reasons. For one, the same number of available billets on each coast with the same level of requirements for each

[4] This study uses the term "duty station" to represent "billets." MOS monitors assign Marines to billets located at duty stations. However, for cost estimation purposes, the duty station to which a Marine is assigned from another duty station determines the cost of a PCS move.

Marine-to-be-assigned would be required to retain Marines on the same coasts. Other reasons are that Marines have different career paths and do not always relocate with the same cohort and have opportunities to conduct resident military education located on specific coasts. The PCS Assignment Cost Model will reveal assignment conflicts and analysis of the results will decide if this concern is supported.

B. ASSIGNMENT DATA INPUT

1. Marines-to-Be-Assigned and Available Duty Stations

The first stage of developing the PCS Assignment Cost Model is to identify the current duty stations of the Marines-to-be-assigned, as well as the new duty stations with availability. The duty stations selected for this simulation were found through an Internet search of Marine Corps installations. A total of twelve "supply" and twelve "demand" duty stations were selected. Figure 1 lists the twelve current duty stations used in the model. Figure 2 lists the twelve new duty stations with availability.

- Camp Pendleton (CPEN), CA
- 2D Marine Air Wing (MAW), Cherry Point, NC
- The Pentagon, Arlington, VA
- Weapons Training Battalion (WTBN), Quantico, VA
- 1st Marine Division (MARDIV), CPEN, CA
- I Marine Expeditionary Force (MEF), CPEN, CA
- Marine Corps Recruiting Depot (MCRD), San Diego, CA
- Officer Selection Office (OSO), Seattle, WA
- The Pentagon, Arlington, VA
- Manpower and Reserve Affairs (M&RA), Quantico, VA
- Marine Corps Air Station (MCAS), Miramar, CA
- Communications (COMM) School, Twentynine Palms, CA

Figure 1. Current duty stations: Marines-to-be-assigned

- Education Command, Quantico, VA
- 1st Marine Division (MARDIV), CPEN, CA
- Marine Corps Recruiting Office, New Cumberland, PA
- The Pentagon, Arlington, VA
- The United States Naval Academy (USNA), Annapolis, MD
- HQTRS Marine Corps Forces Command, Norfolk, VA
- Officer Candidates School (OCS), Quantico, VA
- 2D Marine Logistics Group (MLG), Camp Lejeune, NC (CLNC)
- Marine Corps Recruiting Depot (MCRD), Parris Island, SC
- Training Command (TRNG COM), Twentynine Palms, CA
- Training and Education Command (TECOM), Yuma, AZ
- 4th Marine Air Wing, McGuire Air Force Base (AFB), NJ

Figure 2. New duty stations: Available billets to be filled

Assigning twelve Marine officers to twelve different duty stations yield 12! (=12 x 11 x 10 x 9 x 8 x 7 x 6 x 5 x 4 x 3 x 2 x 1) or 479,001,600 possible solutions. It would be impractical to individually examine the alternatives; the number is too great (Balakrishnan, 2013). This is the reason for using the PCS Assignment Cost Model.

2. Rank and Dependent Status

The model takes as inputs the rank and the number of dependents for each simulated individual. For the purposes of simplification, the model only currently simulates costs for the First Lieutenant (1stLt) and Captain (Capt) ranks. MOS monitors do not host all ranks within their respective MOS. Marines-to-be-assigned are grouped into cohorts according to their current rank and the ranks required by the available billets/duty stations (CMC, 2014). For example, both 1stLts and Capts can be considered for billets designated for Capts. However, a 1stLt would not be considered for a billet designated for a Major, and vice versa. Therefore, a 1stLt would not be in the same cohort, or assigned by the same MOS monitor as a Major. The model also accepts the age of the dependents of Marines-to-be-assigned, as a dependent twelve years of age or older will cost more than a dependent younger than twelve.

3. Cost

The next component of the model estimates the costs of individual PCS moves. The cost components of assigning Marines from one location to another are identified within the model. These are Monetary Allowance in Lieu of Transportation (MALT), Per Diem, Dislocation Allowance (DLA), Temporary Lodging Expense (TLE), Distance, and transportation of Household Goods (HHG) (DoD, 2018a). These costs are then aggregated to compute a total cost for a given PCS Move. The next section will define each of these components of the overall costs. The costs of multiple PCS scenarios can be calculated and then compared using the model. Initiating the objective function, a Solver add-in within the Excel application will decide the combination of these costs total PCS expenditures to optimize the model.

C. COST COMPONENTS OF PCS ASSIGNMENTS

Service members and their dependents (if applicable) are relocated based on orders, not by choice, therefore, they are entitled to certain allowances that mitigate the burden of the many costs incurred due to the relocation. The General Services Administration (GSA), an independent agency of the U.S. Federal Government, along with the Department of State (DoS), and the Defense Travel Management Office (DTMO) determine these allowances and their applicability is defined within the Joint Travel Regulations (JTR). The allowances are updated either every fiscal year, like per diem rates, or every calendar year, as in the case of Dislocation Allowance (DLA) (DoD, 2018b).

PCS move types were discussed in Chapter II. To recap, Fully Funded PCS moves relocate service members to a different geographical location, possibly transoceanic; Low Cost PCS moves relocate service members fewer than 51 miles, and are preferred; and No Cost PCA orders do not relocate service members. Of the PCS move types, service members can be ordered to conduct one of several travel types; Accession, Rotational, and Operational. The model developed for this thesis will only focus on Operational travel (travel between duty stations within the CONUS) and will optimize as many Low Cost PCS and No Cost PCA orders as possible to minimize cost.

1. Monetary Allowance in Lieu of Transportation (MALT)

Service members and their dependents have several transportation options. Government transportation and Government-procured commercial transportation, like air travel if executing transoceanic travel, are advantageous to the government due to the control of travel modes already set in place. Personally procured commercial transportation is not advantageous to the government, however, thresholds do stabilize the amount of reimbursements to the service member. Finally, there is privately owned transportation, which is the most common mode used while relocating from a duty station in the CONUS to another duty station also in the CONUS. The travel allowance that reimburses a service member for mileage driven is called Monetary Allowance in Lieu of Transportation (MALT) (DoD, 2018a). The current MALT rate for calendar year 2018 is $0.18 per mile (DoD, 2018b). Authorized mileage is calculated from duty station gate to duty station gate rather than a service member's residence at the old duty station to his/her new residence (DoD, 2018a). The distance amounts used in this thesis' model were provided through the DPS website. Each distance in the model had to be calculated by setting mock PCS moves to and from each duty station used in the model.

The optimization model utilizes a simple formula—the product of the distance between duty stations within the CONUS, as determined through the Defense Personal Property System (DPS) website, and MALT rate. For example, there is a probability for a service member, currently stationed at the Pentagon in Arlington, VA, to be assigned to Camp Lejeune, NC (CLNC). The mileage between the two duty stations is 343 miles. The equation will be written as follows:

$$\mathbf{343 \times \$0.18 = \$61.74}$$

2. Per Diem Allowance

While traveling to the new duty station, service members and their dependents are authorized Per Diem to assist with lodging, meals and incidentals M&IE. The determinants of this reimbursement are the "mode of transportation authorized and used, official distance, number and age of dependents, and whether or not a dependent is traveling with the service member" (DoD, 2018a, p. 5A-1). While executing PCS travel, the Per Diem reimbursement is established by GSA every fiscal year as a Standard CONUS Rate. The FY18 Standard CONUS Rate is $144.00, which is an aggregate of $93.00 for lodging, $46.00 for meals, and $5.00 for incidentals (or $51.00 for M&IE). This means that each service member rates $144.00 for each day of authorized travel to the new duty station. Each dependent (if applicable) is also authorized a Per Diem amount based on age; dependents 12 years of age and older receive 75 percent of the Standard CONUS Rate, and dependents younger than 12 years of age receive 50 percent of the Standard CONUS Rate for each authorized day of travel.

The distance between the old and new duty stations determines the amount of authorized travel time, which is the number of days Per Diem is reimbursed. If the calculated distance is equal to or greater than fifty-one miles but not more than 400 miles, then one travel day is authorized. The standard number of 350 is divided into all distances greater than 400 miles to determine the progressive amount of travel days. If the remaining miles are 51 or greater, then one more day is added to the authorized amount. For example, 450 miles divided by 350 is equal to a number greater than one. The difference between 450 and 350 is 100, which is greater than the aforementioned 51 miles. Therefore, a service member traveling from one duty station to another duty station 450 miles away is authorized two travel days.

The equations to find the Per Diem rates per traveler for the above scenario are as follows:

- Service member—2 travel days x $144 per diem = $288.00
- Two Dependents ≥ 12—2 days x 2 dependents x $144 x 75% = $432.00
- One Dependents < 12—2 days x 1 dependent x $144 x 50% = $144.00

The sum of all three equations ($864.00) is the total authorized Per Diem.

3. Dislocation Allowance (DLA)

The government has acknowledged that service members can incur many different expenses in addition to gas, food, and lodging when they relocate. Expenses like cookware, linen, and additional clothing become necessary when awaiting household goods. The purpose of the Dislocation Allowance (DLA) is to “partially reimburse a service member” for these expenses (DoD, 2018a, p. 5A-16). DLA amounts are published every calendar year and are a flat rate determined by the rank and dependent status of the service member, regardless of the authorized travel distance or travel days. The following amounts are used in the model:

- Captain (O-3) without dependents—$2,548.76
- Captain (O-3) with dependents—$3,026.27
- 1st Lieutenant (O-2) without dependents—$2,021.79
- 1st Lieutenant (O-2) with dependents—$2,584.07

4. Temporary Lodging Expense (TLE)

Service members may have to vacate their living quarters prior to the departure date from their old duty station and may also be unable to move into their living quarters at the new duty station upon arrival. For this common occurrence, the Temporary Lodging Expense (TLE) reimburses the service member. TLE is similar to Standard Per Diem in that it reimburses the service member for lodging and M&IE, but it is based off of the locality per diem rate where the expense was incurred rather than the standard CONUS rate (DoD, 2018a). These rates used in this thesis were found on the Defense Travel Management Office (DTMO) website (DoD, 2018b). Its use is extended only to ten days, but these days can be split between duty stations. For the purposes of this thesis TLE will be split evenly for all possible solutions—five days at the old duty station locality Per Diem rate and five days at the new duty station locality Per Diem rate.

The calculations for determining the cost of TLE are also different from the Standard Per Diem calculations. A service member, if traveling alone, only rates 65 percent of the locality Per Diem as a reimbursement instead of the 100 percent like with Per Diem. If the service member travels with one or more dependents, the first dependent, regardless of age, rates 35 percent, which increases the total reimbursement to 100 percent. Additional dependents 12 years of age or older rate 35 percent reimbursement and those younger than 12 years of age rate 25 percent reimbursement (DoD, 2018a). The equations to find the TLE rates per traveler for the current duty station with a locality rate of $199.00 are as follows:

- Service member—$199 x 65% x 5 days = $646.75
- First dependent traveling, regardless of age—$199 x 35% x 5 = $348.25
- One Dependents ≥ 12—$199 x 1 dependent x 35% x 5 = $348.35
- One Dependents < 12—$199 x 1 dependent x 25% x 5 = $248.75

These four equations will then be repeated with the new duty station TLE rates. The sum of all eight equations ($3,184.00) is the total authorized TLE.

5. Transportation of Household Goods (HHG)

The final common PCS move authorization is the transportation of service members and their dependents' Household Goods (HHG). The JTR provides the weight authorized for HHG transportation according to rank and dependent status, as depicted below:

- Captain (O-3) with dependents—14,500 lbs.
- Captain (O-3) without dependents—13,000 lbs.
- 1st Lieutenant (O-2) with dependents—13,500 lbs.
- 1st Lieutenant (O-2) without dependents—12,500 lbs.

The costs of each PCS move was determined by using the DPS website. Similar to finding the MALT calculations, mock PCS moves were built and used to determine the authorized distances between each duty station used in this model. Those mock ups had to be replicated an additional three more times per each duty station, changing only the weight allowance per rank and dependent status. The results were authorized HHG costs between each duty station in the model representing all four rank and dependents statuses.

D. CONSTRAINTS

1. Overview

As discussed earlier, constraints limit the degree to which a model can pursue an optimal solution for matching the Marines-to-be-assigned to an available billet/duty station (Balakrishnan et al., 2013). This thesis is using Microsoft Excel to develop the PCS Assignment Cost Model and take advantage of the Linear Programming capabilities. Once the rank and dependent statuses of each Marine-to-be-assigned are inputted to the model, the objective function will compare all costs and eligible assignments, and ensure a one-to-one match is performed. Appendix A depicts the model.

2. Billet

Navy Marine Corps (NAVMC) 1200.1D defines the military occupational specialties (MOSs) described in the tables of organization (T/O) within the Total Force Structure Management System (TFSMS) (CMC, 2018). As discussed earlier the TFSMS is the suggested allocation of all MOSs available in the total Marine force. Each Marine is designated a primary MOS (PMOS), which identifies the Marine's current qualifications and determines the assignments for which they are eligible (CMC, 2013). Each MOS monitor assigns Marines according to PMOS. As a proof of concept, this model will simulate assignments for one PMOS—MOS 0102, Manpower Officer. A manpower officer serves as a unit's general personnel, administrative coordinator, or adjutant. They facilitate very important, day-to-day functions within the Marine Corps and a command is not without one (CMC, 2018). Therefore, this MOS provided virtually limitless and more varied outcome possibilities than an MOS with limited duty station options, like a MOS 3404, Financial Management Officer (CMC, 2018).

The inclusion of a free MOS (FMOS) will achieve more variety in outcomes. A FMOS is a "non-PMOS billet that can be filled by any Marine regardless of primary MOS" (CMC, 2018, p. xiv). Examples of a FMOS are Platoon Commanders at Officer Candidates School, Series Commanders at Marine Corps Recruit Depots, Legislative Affairs Officers, and Marine Corps Recruiters. These positions are unrestricted and allow Marines the opportunity to gain experience in other facets of the Marine Corps, potentially increasing the likelihood of promotion. The FMOS included in the model is 8006, Unrestricted Officer.

FMOS 8006 billets are designated as supporting establishment billets and not a part of the operating forces. Career progression prioritizes operating forces billets over supporting establishment billets; therefore, MOS monitors make every attempt to leverage the former to prevent repeated tours in the latter (CMC, 2014). Together the two MOSs (0102 and 8006) will act as a constraint for the model, prohibiting a Marine exiting a FMOS 8006 position to be assigned to another FMOS 8006 position. The formula will be set up, however, to allow a PMOS 0102 to be assigned to either another PMOS 0102 or a FMOS 8006. The formula below, written as an inequality, facilitates this constraint:

$$\mathbf{8006 + 0102 \leq 10,000}$$

By adding the two numerical MOS codes together and ensuring the sum is less than or equal to the number 10,000, it prevents the model from choosing an 8006 Marine to be assigned to another 8006 billet; 8006 + 8006 is not less than or equal to 10,000. However, adding 8006 and 0102 together, or simply 0102 and 0102 together, the sum will be less than or equal to 10,000. The confirmation of this constraint to assign Marines to an eligible MOS is seen in Figure 3. This equation can easily translate to other MOS codes to facilitate each MOS monitor's use of the model just by incrementally increasing the inequality amount (10,000) with each new MOS. For example, the inequality for the MOS 7220, Air Traffic Control Officer, requires an increase to 16,000. This would allow the sum of 8006 and 7220 to be less than or equal to 16,000, while still preventing 8006 and 8006 to be added together.

MOS Consideration Check			
Location	Check	Sign	Available
CPEN	8006	<=	10,000
Cherry Point	8006	<=	10,000
Arlington	8006	<=	10,000
Quantico	0102	<=	10,000
CPEN	0102	<=	10,000
CPEN	0102	<=	10,000
Sane Diego	0102	<=	10,000
Seattle	8006	<=	10,000
Arlington	0102	<=	10,000
Quantico	0102	<=	10,000
Miramar	0102	<=	10,000
29 Pams	0102	<=	10,000

Figure 3. MOS assignment eligibility

3. Availability

Each current duty station represents a billet that is vacated by a Marine-to-be-assigned, while each new duty station represents one available billet to which Marines will be assigned. Therefore, the assignment of the Marines is subject to two conditions; that each current duty station loses one Marine and each new duty station gains one Marine. This is accomplished simply by assigning ones and zeros to represent whether a Marine is assigned (1), or not assigned (0). The use of a flow balance equation totaling either a one or a zero is seen in Figure 4. Since one Marine will vacate each current duty the availability of that duty station (the “flow out”) must equal a negative one. Therefore, the availability of each new duty station gaining a Marine (the “flow in”) will equal a positive one. The “Net Flow,” as seen in Figure 4, will auto populate with its respective integer once the objective function is performed to will provide confirmation of the assignments.

Flow Balance Equation Check					
Locations	**Flow In**	**Flow Out**	**Net Flow**	**Sign**	**Available**
CPEN		0	0	=	-1
Cherry Point		0	0	=	-1
Arlington		0	0	=	-1
Quantico		0	0	=	-1
CPEN		0	0	=	-1
CPEN		0	0	=	-1
Sane Diego		0	0	=	-1
Seattle		0	0	=	-1
Arlington		0	0	=	-1
Quantico		0	0	=	-1
Miramar		0	0	=	-1
29 Pams		0	0	=	-1
Quantico	0		0	=	1
CPEN	0		0	=	1
Recruiting	0		0	=	1
Arlington	0		0	=	1
USNA	0		0	=	1
Norfolk	0		0	=	1
Quantico	0		0	=	1
CLNC	0		0	=	1
Parris Island	0		0	=	1
29 Palms	0		0	=	1
Yuma	0		0	=	1
McGuire AFB	0		0	=	1

Figure 4. Flow balance equation prior to initiating the objective function

E. LIMITATIONS AND ASSUMPTIONS

The model in this thesis was developed as a feasibility study to determine if it has the potential to satisfy congressional concerns of high PCS costs as well as the lack of the DoD's complete and consistent PCS move cost data. The data defining the model's calculations, like the MALT and Per Diem rates, can easily be updated to reflect the current authorized amount without having to recalculate the formulas. However, in its current state the model is limited in its ability to assign all Marines to all duty stations. Some limitations and assumptions fell victim to this thesis' finite preparation schedule and the author's restricted knowledge of Excel. The use of data validation and conditional formulas and functions, for example, were self-taught. This section will discuss the assignment limitations as well as the assumptions made when developing the model.

1. Transoceanic Travel

The model is programmed to calculate only the common authorized allowances associated with a PCS move in the CONUS. Transoceanic assignments were considered but not included. This limits the model's ability to assign personnel to or from a duty station OCONUS. The cost functions for such travel were not available during research and the assignment of oversea duty is determined by other factors like the Oversea Control Date (OCD) (CMC, 2014). An OCD ensures equitable treatment allowing personnel more tours of duty in the CONUS, if desired, and preventing others from constantly serving OCONUS, where they may be away from family for an extended period of time. The calculations for estimating transoceanic travel and its addition to this model are feasible, however. The authorizations and cost estimates for HHG transportation were calculated using the DPS website, the same may be possible for transoceanic travel. The inclusion of an OCD constraint to ensure equitable treatment among Marine officers to be assigned is similar to the billet constraint. If maintained as a date, the model can fall subject to the oldest dates out of the eligible travelers to identify the amount of personnel to be assigned overseas as determined by the number of available billets overseas.

2. Separate Travel

The model assumes service members and their dependents will conduct a standard PCS move without deviating circumstances that may present additional costs. For example, there is no option to calculate the cost of travel if a service member conducts a PCS move separate from his or her dependents, or if the family travels together but one out of two vehicles is shipped to the new destination. Travel reimbursements, like MALT and Per Diem are calculated differently if a service member travels separately from dependents, and there is a reimbursement for shipping a privately owned vehicle (POV) up to a certain dollar amount. This thesis considers these costs as a rounding error on top of the base costs. Subsequent analysis could measure the percentage of PCS moves that are conducted separately to determine the average cost per separate travel. The weighted average can then be added to the cost estimate to avoid estimates that omit costs due to deviating circumstances. The calculations can be corrected with conditional Excel formulas similar to the ones utilized in this model determining DLA and HHG costs.

3. Per Diem

Service members conducting a PCS move may not want to travel the duration of the authorized amount of days. The model does not account for those who travel to their new duty station in a shorter amount of time that what is authorized. However, as this action would cost less than the estimated amount, the impact is not undesirable. The model estimates all of the possible PCS costs, based on the travel information provided by the service member, using the amounts authorized by the government. Based on that function alone, this model is unmatched within the DoD (RAND, 2108).

4. TLE

Another assumption is the even split of TLE between the duty stations. Service members can utilize the TLE allowance as they find necessary; a two-day stay at one duty station and an eight-day stay at the other or even the full ten days located at one duty station. The difference in the estimated dollar amounts would be visible between TLE authorized at a duty station like Quantico, VA, which uses the Standard CONUS rate of $144.00 per day, and the Pentagon, which uses the locality rate of $322.00 per day (DoD, 2018b). This assumption, similar to the Per Diem usage, was determined with the knowledge that the model is calculating the best estimate in accordance with authorized amounts.

5. Preference

Mentioned in both Chapter II and III is the relevance of preference. In Chapter II, preference was defined as an assignment directive parameter for MOS monitors (CMC, 2014). Although it is lower in precedence compared to the needs of the Marine Corps and career progression requirements, it is still a parameter. Chapter III discussed duty station preference as a contributor to morale. Even if not always satisfied, service members' current ability to request their next duty station based on time in grade or just personal preference is important for morale (Morales, 2011). However, this model did not include an option to give weight to the time in grade or the duty station preference of each Marine officer to be assigned. The morale of service members is important to consider as it does affect retention (Rostker, 2006), but the congressional concerns over frequent and high PCS costs over the past 40 years prompted a requirement to minimize and capture costs above honoring preference. That is not to say this model cannot or should not be modified to include a preference function. In fact, if budgetary constraints are not present, the objective function may be unnecessary to run because the model, containing all personnel to be assigned and their information, stands alone. Once all assignments are complete, MOS monitors need only cross reference which Marine was sent where and the authorized PCS costs are already calculated and can be captured. This means MOS monitors can still assign the Marine officers according to the needs of the Marine Corps, or career progression requirements, or personal duty station preference. The objective function is optional to optimize cost minimization.

F. SUMMARY

As stated at the beginning of this chapter, there is currently no central system that provides all calculated costs associated with PCS moves. The model developed for this thesis calculates the most common travel authorizations associated with PCS moves within the CONUS. The model's calculations respond to personnel data as well as updated travel authorization amounts. It has an objective function to optimize the efficiency of personnel assignments while minimizing costs. Finally, the model captures all PCS cost estimation amounts.

Since the capability is present, the model for this thesis further studied the feasibility in developing a model that is practical, updatable, and user-friendly. It is currently limited in its ability but not in its application nor is it incapable of improvement. The next chapter will analyze the results of the objective function and if the model can facilitate personnel assignments for each MOS monitor and estimate the total costs of all annual personnel assignments within the Marine Corps.

V. RESULTS AND ANALYSIS

The PCS Assignment Cost Model is intended to provide the costs of all available personnel assignments to facilitate MOS monitors' ability to make relocation decisions. The variables change annually—the number of Marines to be assigned and their location, and the locations of available billets. This fluidity requires a practical model able to adapt to the circumstances with which it is presented. With the knowledge of the model's limitations, the simulations conducted will provide insight to its effectiveness and applicability.

The first simulation focused on the model's objective function - cost minimization. The second observed the model's ability to adapt to varied information inputted. The third assessed alternative applications of the model. To ensure a one-to-one assignment of Marines and to prevent repeat assignments to MOS 8006 billets, the constraints remained constant throughout all three simulations. The analysis will decide the model's effectiveness and applicability to the current assignment and PCS move cost estimation process.

A. CETERIS PARIBUS SIMULATION

The first simulation conducted focused on the model's ability to minimize PCS move costs while holding all else equal. All 12 Marines-to-be-assigned were prescribed the same rank ("1stLt") and no dependents ("w/o Dependents") as depicted in Figure 5. Therefore, the model only compared the costs of the distances between the current and new duty stations to optimize the assignments. Using Excel Solver, the model's objective function minimized the cost of assigning all 12 Marines, which found the lowest cost solution.

Rank	First Dependent Traveling with You		Additional Dependents	Additional Dependents	Current Duty Station	
	≥ 12 yrs old	< 12 yrs old	≥ 12 yrs old	< 12 yrs old		
1stLt w/o Dependents	0	0	0	0	Camp Pendleton, CA	8006
1stLt w/o Dependents	0	0	0	0	Cherry Point, NC	8006
1stLt w/o Dependents	0	0	0	0	Arlington, VA	8006
1stLt w/o Dependents	0	0	0	0	WTBN Quantico, VA	0102
1stLt w/o Dependents	0	0	0	0	Camp Pendleton, CA	0102
1stLt w/o Dependents	0	0	0	0	Camp Pendleton, CA	0102
1stLt w/o Dependents	0	0	0	0	MCRD San Diego, CA	0102
1stLt w/o Dependents	0	0	0	0	OSO Seattle, WA	8006
1stLt w/o Dependents	0	0	0	0	Arlington, VA	0102
1stLt w/o Dependents	0	0	0	0	Quantico, VA	0102
1stLt w/o Dependents	0	0	0	0	MCAS Miramar, CA	0102
1stLt w/o Dependents	0	0	0	0	29 Pams, CA	0102

Figure 5. Marines-to-be-assigned held equal

The total PCS move cost of the simulation is $88,119.01 (see Appendix A). The simulation assigned the following:

- 4 Marines remained at the same duty station—No Cost PCA orders
- 2 Marines assigned less than 51 miles away—Low Cost PCS orders
- 2 Marines assigned 61-180 miles away—Fully Funded PCS orders
- 4 Marines assigned across the country—Fully Funded PCS orders

Since there were more available duty stations on the east coast, Marines from the west coast duty stations filled in the available billets. The fact that one third of the sample of Marines were assigned to duty stations on the opposite coast should assuage the argument that a model designed to minimize PCS costs will keep Marines on the same coast.

To confirm the effectiveness of the model's objective function it was programmed to seek the maximum estimated PCS move cost. This simulated the same PCS move requirements as the previous low cost estimate but the solver maximized the cost. The results more than doubled the total PCS move cost—$195,148.99 (see Appendix B). Using this tool to minimize costs generated an estimated cost savings up to 55 percent.

B. MULTI-VARIABLE SIMULATION

The next simulation tested the model's ability to respond to permutations in input. Rank and dependent status was changed for a few Marines in the sample; this simulates a real world scenario, as not all Marines remain constant or equal. Changing the rank and dependent status affects PCS move costs independent of distance and will increase the cost to assign a higher-ranking Marine with dependents.

The series of simulations that held all Marines equal in Section A assigned four of them across the country. The ranks and dependent status of those four Marines were changed to "Capt w/ Dependents," as seen in Figure 6, and the number of dependents was increased. The ranks and dependents statuses of the other eight Marines were not changed because the model's objective function is to minimize cost, and the optimal solution is to retain Marines in an area where there is availability. If the costs to relocate those Marines increased the outcome would not change, as it would still decrease the PCS cost to retain them in the same area.

Once again, as predicted, four Marines were assigned to a duty station across the country, but it was not the same four who were assigned in the first simulation (see Appendix C). The Marines of higher rank and with dependents now cost more to move than the 1stLts without dependents. Therefore, the minimizing objective function assigned 1stLts across the country to minimize cost.

This outcome indicates that higher-ranking Marines with dependents will always remain in place while younger and possibly single Marines remain mobile. The minimizing objective function, when initiated, may reduce career exposure of those with families when cost comparison includes Marines of different rank and dependent status. Although it has been argued in this thesis that service members with families desire more stability, the determining factors of rank and dependents present an interesting problem that should be addressed. One option is to only run the model for people of the same rank. However, the outcome may still be undesirable for those with many dependents. In addition, those

Marines without dependents may desire stability but may not attain it when compared with Marines with families. This problem is something that requires further research.

	First Dependent Traveling with You					
Rank	≥ 12 yrs old	< 12 yrs old	Additional Dependents ≥ 12 yrs old	Additional Dependents < 12 yrs old	Current Duty Station	
Capt with Dependents	1	0	2	2	Camp Pendleton, CA	8006
1stLt w/o Dependents	0	0	0	0	Cherry Point, NC	8006
1stLt w/o Dependents	0	0	0	0	Arlington, VA	8006
1stLt w/o Dependents	0	0	0	0	WTBN Quantico, VA	0102
Capt with Dependents	1	0	2	2	Camp Pendleton, CA	0102
Capt with Dependents	1	0	2	2	Camp Pendleton, CA	0102
1stLt w/o Dependents	0	0	0	0	MCRD San Diego, CA	0102
Capt with Dependents	1	0	2	2	OSO Seattle, WA	8006
1stLt w/o Dependents	0	0	0	0	Arlington, VA	0102
1stLt w/o Dependents	0	0	0	0	Quantico, VA	0102
1stLt w/o Dependents	0	0	0	0	MCAS Miramar, CA	0102
1stLt w/o Dependents	0	0	0	0	29 Pams, CA	0102

Figure 6. Marines-to-be-assigned with increased rank and dependents

C. SELECTIVE SIMULATION

If circumstances arise that require manual override for all Marines-to-be-assigned, then the objective function is simply not applied. The last two series of simulations resulted in one Marine always remaining in the same location—Twentynine Palms. Because two billets exist at Twentynine Palms, both as the current duty station billet and the new duty station billet, the objective function of the model will retain that Marine in the same location to minimize PCS costs. Subjectively, Twentynine Palms may be a desirable location but it may also be a less-than-desirable location. If the latter is the case the MOS monitor can assign that Marine to a different duty station and exclude them and their new duty station from the minimizing objective function (see Appendix D).

The objective function will only evaluate the variables selected. Although the Marine is excluded from the function, the cost to relocate is still captured. As long as the Marine's rank and dependent status is in the model, the costs are calculated and captured.

D. SUMMARY

As stated in the last section, the objective function does not need to be applied. If the maximum amount to relocate all Marines-to-be-assigned is less than the budgeted amount, then the MOS monitors are free to assign the Marines as they see fit and in accordance to the Marine Corps Orders that regulate the personnel assignment process. When the minimizing objective function is applied the model can generate a cost savings of up to 55 percent and capture alternative assignment costs to aid managerial decisions during times of fiscal stress.

The model is not without flaws. Because rank and dependent status determines cost as well as distance, the cost minimizing objective function will decrease mobility and possible exposure of higher-ranking Marines with families. This potential issue identifies the objective function as a tool only to be used when PCS budgets are constrained.

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VI. CONCLUSION AND RECOMMENDATIONS

The model developed for this thesis was designed to execute the basic functions of a decision model—optimize assignments by minimizing cost. The type of model selected, the assignment model, allows customizable data to produce associated costs for comparison. These capabilities will assist manpower managers to address congressional concerns of high PCS costs and the lack of complete and consistent data.

A. FURTHER DEVELOPMENT

The model is limited in its capacity. It favors lower-ranking Marines without dependents for mobility, and higher-ranking Marines with dependents for stability. Segregating Marines-to-be-assigned by rank, or removing rank as a consideration altogether are options to overcome this issue. Omitting dependent status as an assignment determinant should be researched as well. The rank and dependent status could still be captured for final cost reporting, but they would not inhibit or endorse a Marine's duty station assignment.

The model is incapable of producing the cost components on its own. Although MALT, Per Diem, and DLA amounts can be updated with a one-time entry, the information to update the TLE and HHG allowances must be manually researched from other systems. The RAND study on enhancing family stability recommends the synchronization of assignment and financial systems (Tong et al., 2018, p. 46). This model can serve as that centralized system. In order to do so the model must be transferred from an excel spreadsheet to a net-ready system capable of receiving and synchronizing the assignment and financial data associated with PCS moves.

B. APPLICATION OF THE MODEL

This model is not intended to be fully automated nor replace MOS monitors. It is a tool that provides alternative personnel assignment options based on PCS allowances to assist managers in making informed decisions. The option to utilize the model's minimizing objective function generates a cost savings of up to 55 percent[5] when compared with the maximized cost. This opportunity enhances resiliency in times of fiscal stress. If budgetary concerns are not present, omitting the objective function and assigning personnel based on the needs of the Marine Corps or personal duty stations preference is an option as well. Whether the objective function is utilized or not the model still captures PCS move cost estimates of alternative solutions. The anticipated result is an estimated cost of planned PCS moves for each Marine assigned, captured by each MOS monitor, and maintained to enhance PCS-related managerial decisions. It is a tool that can systematically strengthen the managers' ability to regulate assignment costs by providing a more rational menu of choices that help deal with scarce budgetary resources (Bozeman, 2010; Brien et al., 2018).

[5] Real world savings would be less because MOS monitors do not assign Marines by maximizing the distance between duty stations (CMC, 2014), however these are real savings.

APPENDIX A. CETERIS PARIBUS SIMULATION—MINIMUM COST

	First Dependent Traveling with You						New Duty Station											
							Ed Cmnd Quantico	CPEN	New Cumberland, PA	Arlington, VA	Naval Academy	Norfolk, VA	OCS, Quantico, VA	CLNC	Parris Island	29 Palms, CA	Yuma, AZ	McGuire AFB, NJ
Rank	≥ 12 yrs old	< 12 yrs old	Additional Dependents ≥ 12 yrs old	Additional Dependents < 12 yrs old	Current Duty Station		0102	0102	0102	0102	0102	0102	8006	0102	8006	8006	0102	8006
1stLt w/o Dependents	0	0	0	0	Camp Pendleton, CA	8006	17,250	0	17,139	17,780	17,213	17,143	17,250	16,855	16,679	10,074	10,399	17,553
1stLt w/o Dependents	0	0	0	0	Cherry Point, NC	8006	9,886	16,634	10,537	10,751	10,044	9,407	9,886	8,628	10,225	16,072	15,622	10,853
1stLt w/o Dependents	0	0	0	0	Arlington, VA	8006	0	17,834	10,687	0	0	647	0	11,185	12,247	17,222	16,889	11,168
1stLt w/o Dependents	0	0	0	0	WTBN Quantico, VA	0102	0	16,631	10,148	0	9,660	10,963	0	10,445	11,381	16,482	16,242	10,541
1stLt w/o Dependents	0	0	0	0	Camp Pendleton, CA	0102	17,194	0	17,139	17,780	17,213	17,143	17,250	16,855	16,679	10,074	10,399	17,553
1stLt w/o Dependents	0	0	0	0	Camp Pendleton, CA	0102	17,250	0	17,139	17,780	17,213	17,143	17,250	16,855	16,679	10,074	10,399	17,553
1stLt w/o Dependents	0	0	0	0	MCRD San Diego, CA	0102	17,190	0	17,282	17,830	17,280	17,282	17,190	17,002	16,849	10,313	10,324	17,689
1stLt w/o Dependents	0	0	0	0	OSO Seattle, WA	8006	17,905	14,237	17,792	18,432	17,925	18,010	17,905	17,959	18,362	13,910	14,049	18,345
1stLt w/o Dependents	0	0	0	0	Arlington, VA	0102	2,509	17,834	10,687	0	0	10,465	0	11,185	12,247	17,222	16,889	11,168
1stLt w/o Dependents	0	0	0	0	Quantico, VA	0102	0	16,631	10,148	0	9,660	10,025	0	10,445	11,381	16,482	16,242	10,541
1stLt w/o Dependents	0	0	0	0	MCAS Miramar, CA	0102	17,190	0	17,282	17,830	17,280	17,282	17,190	17,002	16,849	10,313	10,324	17,689
1stLt w/o Dependents	0	0	0	0	29 Pams, CA	0102	16,338	10,074	16,437	17,079	16,365	16,429	16,482	16,296	15,975	0	10,067	16,988

Total Cost of PCS Travel Allowances	
	$88,119.01

		New Duty Station												
		Ed Cmnd Quantico	CPEN	New Cumberland, PA	Arlington, VA	Naval Academy	Norfolk, VA	OCS, Quantico, VA	CLNC	Parris Island	29 Palms, CA	Yuma, AZ	McGuire AFB, NJ	
Current Duty Station		0102	0102	0102	0102	0102	0102	8006	0102	8006	0102	0102	8006	Flow Out
Camp Pendleton, CA	8006	0	0	0	0	0	1	0	0	0	0	0	0	1
Cherry Point, NC	8006	0	0	0	0	0	0	0	1	0	0	0	0	1
Arlington, VA	8006	0	0	0	1	0	0	0	0	0	0	0	0	1
WTBN Quantico, VA	0102	0	0	0	0	0	0	1	0	0	0	0	0	1
Camp Pendleton, CA	0102	0	0	0	0	0	0	0	0	1	0	0	0	1
Camp Pendleton, CA	0102	0	0	0	0	0	0	0	0	0	0	0	1	1
MCRD San Diego, CA	0102	0	1	0	0	0	0	0	0	0	0	0	0	1
OSO Seattle, WA	8006	0	0	1	0	0	0	0	0	0	0	0	0	1
Arlington, VA	0102	0	0	0	0	1	0	0	0	0	0	0	0	1
Quantico, VA	0102	1	0	0	0	0	0	0	0	0	0	0	0	1
MCAS Miramar, CA	0102	0	0	0	0	0	0	0	0	0	0	1	0	1
29 Pams, CA	0102	0	0	0	0	0	0	0	0	0	1	0	0	1
Flow In		1	1	1	1	1	1	1	1	1	1	1	1	

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APPENDIX B. CETERIS PARIBUS SIMULATION—MAXIMUM COST

Rank	First Dependent Traveling with You ≥ 12 yrs old	First Dependent Traveling with You < 12 yrs old	Additional Dependents ≥ 12 yrs old	Additional Dependents < 12 yrs old	Current Duty Station		New Duty Station: Ed Cmnd Quantico 0102	CPEN 0102	New Cumberland, PA 0102	Arlington, VA 0102	Naval Academy 0102	Norfolk, VA 0102	OCS, Quantico, VA 8006	CLNC 0102	Parris Island 8006	29 Palms, CA 8006	Yuma, AZ 0102	McGuire AFB, NJ 8006
1stLt w/o Dependents	0	0	0	0	Camp Pendleton, CA	8006	17,250	0	17,139	17,780	17,213	17,143	17,250	16,855	16,679	10,074	10,399	17,553
1stLt w/o Dependents	0	0	0	0	Cherry Point, NC	8006	9,886	16,634	10,537	10,751	10,044	9,407	9,886	8,628	10,225	16,072	15,622	10,853
1stLt w/o Dependents	0	0	0	0	Arlington, VA	8006	0	17,834	10,687	0	0	647	0	11,185	12,247	17,222	16,889	11,168
1stLt w/o Dependents	0	0	0	0	WTBN Quantico, VA	0102	0	16,631	10,148	0	9,660	10,963	0	10,445	11,381	16,482	16,242	10,541
1stLt w/o Dependents	0	0	0	0	Camp Pendleton, CA	0102	17,194	0	17,139	17,780	17,213	17,143	17,250	16,855	16,679	10,074	10,399	17,553
1stLt w/o Dependents	0	0	0	0	Camp Pendleton, CA	0102	17,250	0	17,139	17,780	17,213	17,143	17,250	16,855	16,679	10,074	10,399	17,553
1stLt w/o Dependents	0	0	0	0	MCRD San Diego, CA	0102	17,190	0	17,282	17,830	17,280	17,282	17,190	17,002	16,849	10,313	10,324	17,689
1stLt w/o Dependents	0	0	0	0	OSO Seattle, WA	8006	17,905	14,237	17,792	18,432	17,925	18,010	17,905	17,959	18,362	13,910	14,049	18,345
1stLt w/o Dependents	0	0	0	0	Arlington, VA	0102	2,509	17,834	10,687	0	0	10,465	0	11,185	12,247	17,222	16,889	11,168
1stLt w/o Dependents	0	0	0	0	Quantico, VA	0102	0	16,631	10,148	0	9,660	10,025	0	10,445	11,381	16,482	16,242	10,541
1stLt w/o Dependents	0	0	0	0	MCAS Miramar, CA	0102	17,190	0	17,282	17,830	17,280	17,282	17,190	17,002	16,849	10,313	10,324	17,689
1stLt w/o Dependents	0	0	0	0	29 Pams, CA	0102	16,338	10,074	16,437	17,079	16,365	16,429	16,482	16,296	15,975	0	10,067	16,988

Total Cost of PCS Travel Allowances	
	$195,148.99

Current Duty Station		New Duty Station: Ed Cmnd Quantico 0102	CPEN 0102	New Cumberland, PA 0102	Arlington, VA 0102	Naval Academy 0102	Norfolk, VA 0102	OCS, Quantico, VA 8006	CLNC 0102	Parris Island 8006	29 Palms, CA 0102	Yuma, AZ 0102	McGuire AFB, NJ 8006	Flow Out
Camp Pendleton, CA	8006	1	0	0	0	0	0	0	0	0	0	0	0	1
Cherry Point, NC	8006	0	0	0	0	0	0	0	0	0	1	0	0	1
Arlington, VA	8006	0	1	0	0	0	0	0	0	0	0	0	0	1
WTBN Quantico, VA	0102	0	0	0	0	0	1	0	0	0	0	0	0	1
Camp Pendleton, CA	0102	0	0	0	0	0	0	1	0	0	0	0	0	1
Camp Pendleton, CA	0102	0	0	0	1	0	0	0	0	0	0	0	0	1
MCRD San Diego, CA	0102	0	0	1	0	0	0	0	0	0	0	0	0	1
OSO Seattle, WA	8006	0	0	0	0	0	0	0	1	0	0	0	0	1
Arlington, VA	0102	0	0	0	0	0	0	0	0	1	0	0	0	1
Quantico, VA	0102	0	0	0	0	0	0	0	0	0	0	1	0	1
MCAS Miramar, CA	0102	0	0	0	0	1	0	0	0	0	0	0	0	1
29 Pams, CA	0102	0	0	0	0	0	0	0	0	0	0	0	1	1
Flow In		1	1	1	1	1	1	1	1	1	1	1	1	

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APPENDIX C. MULTI-VARIABLE SIMULATION

	First Dependent Traveling with You						New Duty Station											
							Ed Cmnd Quantico	CPEN	New Cumberland, PA	Arlington, VA	Naval Academy	Norfolk, VA	OCS, Quantico, VA	CLNC	Parris Island	29 Palms, CA	Yuma, AZ	McGuire AFB, NJ
Rank	≥ 12 yrs old	< 12 yrs old	Additional Dependents ≥ 12 yrs old	Additional Dependents < 12 yrs old	Current Duty Station		0102	0102	0102	0102	0102	0102	8006	0102	8006	8006	0102	8006
Capt with Dependents	1	0	2	2	Camp Pendleton, CA	8006	26,612	0	26,489	28,518	26,279	26,485	26,612	26,159	26,532	15,381	15,725	26,959
1stLt w/o Dependents	0	0	0	0	Cherry Point, NC	8006	9,886	16,634	10,537	10,751	10,044	9,407	9,886	8,628	10,225	16,072	15,622	10,853
1stLt w/o Dependents	0	0	0	0	Arlington, VA	8006	0	17,834	10,687	0	0	647	0	11,185	12,247	17,222	16,889	11,168
1stLt w/o Dependents	0	0	0	0	WTBN Quantico, VA	0102	0	16,631	10,148	0	9,660	10,963	0	10,445	11,381	16,482	16,242	10,541
Capt with Dependents	1	0	2	2	Camp Pendleton, CA	0102	26,551	0	26,489	28,518	26,279	26,485	26,612	26,159	26,532	15,381	15,725	26,959
Capt with Dependents	1	0	2	2	Camp Pendleton, CA	0102	26,612	0	26,489	28,518	26,279	26,485	26,612	26,159	26,532	15,381	15,725	26,959
1stLt w/o Dependents	0	0	0	0	MCRD San Diego, CA	0102	17,190	0	17,282	17,830	17,280	17,282	17,190	17,002	16,849	10,313	10,324	17,689
Capt with Dependents	1	0	2	2	OSO Seattle, WA	8006	27,992	22,700	27,868	29,895	28,413	28,105	27,992	28,044	29,521	21,727	21,844	28,945
1stLt w/o Dependents	0	0	0	0	Arlington, VA	0102	2,509	17,834	10,687	0	0	10,465	0	11,185	12,247	17,222	16,889	11,168
1stLt w/o Dependents	0	0	0	0	Quantico, VA	0102	0	16,631	10,148	0	9,660	10,025	0	10,445	11,381	16,482	16,242	10,541
1stLt w/o Dependents	0	0	0	0	MCAS Miramar, CA	0102	17,190	0	17,282	17,830	17,280	17,282	17,190	17,002	16,849	10,313	10,324	17,689
1stLt w/o Dependents	0	0	0	0	29 Pams, CA	0102	16,338	10,074	16,437	17,079	16,365	16,429	16,482	16,296	15,975	0	10,067	16,988

Total Cost of PCS Travel Allowances	
	$113,242.99

		New Duty Station												
		Ed Cmnd Quantico	CPEN	New Cumberland, PA	Arlington, VA	Naval Academy	Norfolk, VA	OCS, Quantico, VA	CLNC	Parris Island	29 Palms, CA	Yuma, AZ	McGuire AFB, NJ	
Current Duty Station		0102	0102	0102	0102	0102	0102	8006	0102	8006	0102	0102	8006	Flow Out
Camp Pendleton, CA	8006	0	1	0	0	0	0	0	0	0	0	0	0	1
Cherry Point, NC	8006	0	0	0	0	0	0	0	1	0	0	0	0	1
Arlington, VA	8006	0	0	0	1	0	0	0	0	0	0	0	0	1
WTBN Quantico, VA	0102	0	0	0	0	0	0	1	0	0	0	0	0	1
Camp Pendleton, CA	0102	0	0	0	0	0	0	0	0	0	0	1	0	1
Camp Pendleton, CA	0102	0	0	0	0	0	1	0	0	0	0	0	0	1
MCRD San Diego, CA	0102	0	0	0	0	0	0	0	0	1	0	0	0	1
OSO Seattle, WA	8006	0	0	1	0	0	0	0	0	0	0	0	0	1
Arlington, VA	0102	0	0	0	0	1	0	0	0	0	0	0	0	1
Quantico, VA	0102	1	0	0	0	0	0	0	0	0	0	0	0	1
MCAS Miramar, CA	0102	0	0	0	0	0	0	0	0	0	0	0	1	1
29 Pams, CA	0102	0	0	0	0	0	0	0	0	0	1	0	0	1
Flow In		1	1	1	1	1	1	1	1	1	1	1	1	

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APPENDIX D. SELECTIVE SIMULATION

Rank	First Dependent Traveling with You: ≥ 12 yrs old	First Dependent Traveling with You: < 12 yrs old	Additional Dependents ≥ 12 yrs old	Additional Dependents < 12 yrs old	Current Duty Station		New Duty Station: Ed Cmnd Quantico	CPEN	New Cumberland, PA	Arlington, VA	Naval Academy	Norfolk, VA	OCS, Quantico, VA	Parris Island	29 Palms, CA	Yuma, AZ	McGuire AFB, NJ
							0102	0102	0102	0102	0102	0102	8006	8006	8006	0102	8006
1stLt w/o Dependents	0	0	0	0	Camp Pendleton, CA	8006	17,250	0	17,139	17,780	17,213	17,143	17,250	16,679	10,074	10,399	17,553
1stLt w/o Dependents	0	0	0	0	Cherry Point, NC	8006	9,886	16,634	10,537	10,751	10,044	9,407	9,886	10,225	16,072	15,622	10,853
1stLt w/o Dependents	0	0	0	0	Arlington, VA	8006	0	17,834	10,687	0	0	647	0	12,247	17,222	16,889	11,168
1stLt w/o Dependents	0	0	0	0	WTBN Quantico, VA	0102	0	16,631	10,148	0	9,660	10,963	0	11,381	16,482	16,242	10,541
1stLt w/o Dependents	0	0	0	0	Camp Pendleton, CA	0102	17,194	0	17,139	17,780	17,213	17,143	17,250	16,679	10,074	10,399	17,553
1stLt w/o Dependents	0	0	0	0	Camp Pendleton, CA	0102	17,250	0	17,139	17,780	17,213	17,143	17,250	16,679	10,074	10,399	17,553
1stLt w/o Dependents	0	0	0	0	MCRD San Diego, CA	0102	17,190	0	17,282	17,830	17,280	17,282	17,190	16,849	10,313	10,324	17,689
1stLt w/o Dependents	0	0	0	0	OSO Seattle, WA	8006	17,905	14,237	17,792	18,432	17,925	18,010	17,905	18,362	13,910	14,049	18,345
1stLt w/o Dependents	0	0	0	0	Arlington, VA	0102	2,509	17,834	10,687	0	0	10,465	0	12,247	17,222	16,889	11,168
1stLt w/o Dependents	0	0	0	0	Quantico, VA	0102	0	16,631	10,148	0	9,660	10,025	0	11,381	16,482	16,242	10,541
1stLt w/o Dependents	0	0	0	0	MCAS Miramar, CA	0102	17,190	0	17,282	17,830	17,280	17,282	17,190	16,849	10,313	10,324	17,689

Total Cost of PCS Travel Allowances
$81,828.44

Current Duty Station		New Duty Station: Ed Cmnd Quantico	CPEN	New Cumberland, PA	Arlington, VA	Naval Academy	Norfolk, VA	OCS, Quantico, VA	Parris Island	29 Palms, CA	Yuma, AZ	McGuire AFB, NJ	Flow Out
		0102	0102	0102	0102	0102	0102	8006	8006	0102	0102	8006	
Camp Pendleton, CA	8006	0	0	0	0	0	0	0	0	1	0	0	1
Cherry Point, NC	8006	0	0	0	0	0	1	0	0	0	0	0	1
Arlington, VA	8006	0	0	0	1	0	0	0	0	0	0	0	1
WTBN Quantico, VA	0102	0	0	0	0	0	0	1	0	0	0	0	1
Camp Pendleton, CA	0102	0	0	0	0	0	0	0	0	0	0	1	1
Camp Pendleton, CA	0102	0	0	0	0	0	0	0	1	0	0	0	1
MCRD San Diego, CA	0102	0	1	0	0	0	0	0	0	0	0	0	1
OSO Seattle, WA	8006	0	0	1	0	0	0	0	0	0	0	0	1
Arlington, VA	0102	0	0	0	0	1	0	0	0	0	0	0	1
Quantico, VA	0102	1	0	0	0	0	0	0	0	0	0	0	1
MCAS Miramar, CA	0102	0	0	0	0	0	0	0	0	0	1	0	1
	Flow In	1	1	1	1	1	1	1	1	1	1	1	

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