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**An Analysis of the Relationship Between the Professionalism
of Defense Acquisition Program Managers and Program
Outcomes**

30 November 2011

by

Dr. Keith F. Snider, Associate Professor
Graduate School of Business & Public Policy
Naval Postgraduate School

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Abstract

This paper documents a research project to examine the relationship between major defense program managers' attributes and the outcomes of their programs. It develops a model based on the research hypothesis that program manager (PM) professionalism is positively correlated with program outcomes. Dependent variables consist of metrics, such as cost variance, that indicate program outcomes. Independent variables consist of PM attributes, such as tenure duration, along with several extraneous variables, such as the program commodity (e.g., ships, aircraft). Data were obtained from Selected Acquisition Reports for major defense acquisition programs for the years 1997–2010. Expert interviews were recorded and used to frame various aspects of the analysis and conclusions. No significant correlation was found between any of the independent variables and program outcomes. The findings suggest that (1) further research is needed to determine good predictors of program outcomes; (2) policy-makers should look to sources other than the PM as a cause of poor outcomes; and (3) a contingency approach to PM career management is appropriate.

Keywords: Defense acquisition; program managers; program management; professionalism; program outcomes



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Dr. Snider is a co-recipient of the 2009 Richard W. Hamming Annual Faculty Award for Achievement in Interdisciplinary Activities, and he received the 2008 Khi V. Thai Research Scholar of the Year award from the National Institute of Governmental Purchasing.

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Disclaimer: The views represented in this report are those of the author and do not reflect the official policy position of the Navy, the Department of Defense, or the Federal Government.



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Executive Summary

The professionalism of defense acquisition program managers (PMs) has been an important issue in policy discussions on defense reform for the past fifty years. Numerous sources have identified the lack of professional qualifications (e.g., training, education, experience) among PMs as a contributing factor to unfavorable outcomes such as cost overruns and schedule slips. In 1990, Congress enacted the Defense Acquisition Workforce Improvement Act (DAWIA) with the goal of professionalizing the workforce, including PMs, to help achieve acquisition reform.

Such actions presume that enhanced PM attributes contribute to improved program outcomes, yet no studies have attempted to validate this presumption. This paper documents a research project to examine the relationship between PM attributes and the outcomes of their programs. The project develops a model based on the research hypothesis that *PM professionalism is positively correlated with program outcomes*, and it conducts appropriate statistical testing and analysis. Dependent variables consist of metrics, such as cost variance, that indicate program outcomes. Independent variables consist of PM attributes, such as tenure duration, along with several extraneous variables, such as the program commodity (e.g., ships, aircraft). Data were obtained from Selected Acquisition Reports for major defense acquisition programs for the years 1997–2010. Expert interviews were recorded and used to frame various aspects of the analysis and conclusions.

The findings provide insights into policies to pursue increased PM professionalism as a component of acquisition reform. Specifically, no significant correlation was found between any of the independent variables and program outcomes. The findings suggest that (1) further research is needed to determine good predictors of program outcomes; (2) policy-makers should look to sources other than the PM as a cause of poor outcomes; and (3) a contingency approach to PM career management is appropriate.



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Introduction

For over fifty years, the professionalism¹ of program managers (PMs) charged with the acquisition of major weapon systems has been an important issue in policy discussions on defense reform in the U.S. (Baumgartner, 1979; Denny, 1985; Fox, 1974, 1984, 1988; Ladner, 1983; Peck & Scherer, 1962).² Numerous studies and reports from academia, the Department of Defense (DoD), General Accounting Office (now Government Accountability Office [GAO]), Congressional Research Service (CRS), and various commissions have identified the lack of professional qualifications (e.g., training, education, experience) among PMs as a contributing factor to undesirable acquisition program outcomes such as cost overruns and schedule slips (Blue Ribbon Commission, 1986; DoD, 1989; Lockwood, 1985).

To address this issue, Congress during the 1980s and 1990s enacted legislation—most notably, the Defense Acquisition Workforce Improvement Act (DAWIA; 1990)—designed to enhance professional attributes of DoD PMs (Lockwood, 1986, 1990; Mavroules, 1991; Snider, 1996). These actions established standards for a variety of PM attributes and qualifications such as minimum levels of training, education, experience, and tenure-in-office requirements to reduce PM turnover. Concern with this issue has also been evident in studies that seek to determine desired PM attributes and competencies to be imparted through training, education, or experience, with the objective of improving acquisition outcomes (Crawford, 2002; Cullen & Gadeken, 1990; Gadeken, 1994, 2002; McVeigh, 1994; Tragar, Hausmann, & Sayala, 2008).

¹ “Professionalism” and “professional” in this report refer to standards, characteristics, and attributes of persons or groups with specialized knowledge, skills, and experience required for membership in a profession. “Professionalize” and “professionalization” refer to means by which one is made professional. While few argue that acquisition or program management is a profession, most agree that professionalism is desirable for managers of defense acquisition, as this report will show.

² This report presumes that the reader has working knowledge of the main structural features of the U.S. defense acquisition system, including program management, and is familiar with the long-standing criticisms of its performance.



A. Issue

Despite these measures to improve PM professionalism, observers continue to judge that acquisition outcomes generally have not improved (see, for example, GAO, 2010a, 2011a). At the same time, studies continue to point out the need for enhanced PM professionalism as a component of acquisition reform (Assessment Panel, 2005; Defense Business Board [DBB], 2011). This apparent failure of these efforts calls into question the conventional wisdom regarding the extent to which PM professionalism influences the outcomes of very large, complex, and, because of their large budgets, often politically-charged defense acquisition programs. Indeed, this researcher has found no studies that support the presumption that PM professionalism is related to program outcomes.

B. Purpose

This report documents a research project to examine the conventional wisdom surrounding PM professionalization, specifically, the view that PM attributes are related to program outcomes. Essentially, the project entails development of a model based on the research hypothesis that *PM professionalism is positively correlated with program outcomes*, along with appropriate statistical testing and analysis. Dependent variables consist of several metrics, such as cost variance, that indicate program outcomes. Independent variables consist of PM attributes, such as duration in office, along with several extraneous variables, such as the program commodity (e.g., ships, aircraft, missiles). Data were obtained from a database of annual Selected Acquisition Reports (SAR) for major defense acquisition programs for the years 1997–2010. Expert interviews were recorded and used to frame various aspects of the analysis and conclusions.

C. Benefit

To the extent that the research hypothesis (conventional wisdom) may be supported, the extent to which the DoD has taken a proper approach in pursuing increased PM professionalism as a component of acquisition reform may also be



shown. Findings of positive correlations between PM professionalism and program outcomes may indicate that even further investments to enhance PM qualifications may be warranted. On the other hand, if PM qualifications are uncorrelated with program outcomes, it may be concluded that meaningful reform is possible only through other means, for example, radical overhaul of the entire acquisition system (see, for example, Lockwood, 1985, p. 5).

D. Organization

Following this introduction, the report provides a policy and literature review that documents in more detail the historical context of, legislation related to, and relevant scholarship on the issue of PM professionalization. The report then turns to develop various hypotheses and models that are suggested by that discussion, and it describes the data to be employed. It then presents the statistical analyses and provides interpretation of the results. The report concludes with a summary of findings and policy recommendations.

E. Challenges

This project entails several challenges that should be acknowledged at the outset. First, defense acquisition represents a controversial public policy issue around which there is little consensus (except, perhaps, on the need for reform). Thus, any models and data that purport to capture and describe factors contributing to program outcomes are subject to criticism. Second, the fidelity of SAR data may be questioned, since it is reported by program management offices and not automatically collected nor audited. Third, the models in this project should reasonably and logically attempt to account for the contributions of PM attributes to program outcomes. One would expect, however, that those contributions would not necessarily be manifested in any single time period, but rather may occur both while the PM is in office and after the PM has left office. Some simplifying assumptions are necessary to take this into account.



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II. Policy Review

This section provides a background of policy pertaining to the issue of PM professionalism. The policy section consists of summaries of selected relevant legislation and reports by commissions, committees, and bodies like the GAO and CSR; these are presented roughly in chronological order.

A. The Second Hoover Commission

From 1953 to 1955, the second Hoover Commission's 19 task forces and committees conducted a comprehensive review of federal executive branch functions, organization, and policies. Their evaluation criteria emphasized preservation and enhancement of Constitutional concerns such as rule of law, separation of powers, Congressional power of the purse, and civilian control. They also addressed, however, the economic and efficient operation of federal bureaus, reflecting taxpayer concerns with waste and duplication of effort which the first Hoover Commission had documented (MacNeil & Metz, 1956, pp. 13–17).

When asked which of the Commission's 314 recommendations he would judge as the single most critical, Hoover named the recommendation to set up a senior civil service (MacNeil & Metz, 1956, p. 29). His choice reflected the view that, considering the growing complexities of 20th century governance, professional administrators were essential to achieve the reconciliation of efficient management within a Constitutional framework of law and politics. This perspective is evident not only in the Commission's recommendations on managers for defense acquisition,³ but also in almost all legislative and commission recommendations regarding PMs since then.

³ Because *acquisition* had not yet entered general usage, the Commission used terms like *supply* and *research and development* to refer to acquisition-related activities.



The need for program management. The Commission noted that the DoD's organizations and processes were ill-suited for the acquisition of 20th century weaponry and that, due to complexities of requirements and operations, a "single integrated program" (MacNeil & Metz, 1956, p. 245) is required to develop and produce a technically advanced defense system. This view reflects the emergence of project management (thus also the position and role of the PM) during these years as a discipline for managing complex and unique acquisition efforts, such as the Manhattan Project and development of the first U.S. intercontinental ballistic missiles (Baumgartner, 1979, pp. 3–4).

Specialists vs. generalists. The Commission found that the military's preference for generalists in the uniformed ranks was inconsistent with the specialization needed to address the increasing complexity of defense management, especially since many key management positions were filled by uniformed personnel (MacNeil & Metz, 1956, pp. 268–269). In particular, the Commission cited the military Services' practice of frequently rotating officers in and out of administrative and operational positions as detrimental to efficient management (p. 246). It recommended that, with necessary Congressional approval, the DoD develop a personnel system that would provide career-trained managers for functional areas such as acquisition. Such a system would address specialized requirements for training, assignments, rotations, and promotions, both for uniformed and civilian personnel (pp. 269–270). Such recommendations promote the view of the PM as a professional member of a specialized career field.

Civilian vs. military control. The Commission remarked on military officers' general "anti-economic and unbusinesslike" attitude that, understandably, favors getting as many resources necessary to do their job (i.e., win armed conflicts), as opposed to getting along with as little as possible (MacNeil & Metz, 1956, p. 198). It opined that "[t]he management aspect of national defense ... requires specialized skills and attitudes normally found among civilians" (p. 273). While recognizing the benefits of a military officer's field experience in understanding the requirements and



operational employment of proposed weapons system (also recognized in many of the studies cited in subsequent sections), the Commission advocated strengthening and increasing civilian control of military administrative functions and increased application of business methods, particularly in supply-related activities (MacNeil & Metz, 1956, pp. 268–269). These positions presaged policy initiatives in later years to increase the numbers of civilians in PM positions and to emphasize business skills in PM training.

B. Early DoD Professionalism Actions

In 1965, the DoD published its first regulations on the required qualifications, training, and tenure durations for acquisition PMs. These were revised in 1971 and 1974, and again in 1986, to reflect evolving legislative requirements.

In 1964, the DoD established the Defense Weapon Systems Management Center at Dayton, OH, for the purpose of training defense acquisition PMs, mainly via a 10-week Project Management Course. It was replaced in 1971 by the Defense Systems Management School (later College [DSMC]) at Fort Belvoir, VA, which was intended to provide in-depth knowledge and preparation on advanced management concepts to prospective PMs (Layton, 2007, pp. 6–7). PM training continues at Fort Belvoir to the present under the Defense Acquisition University (DAU).

From the late 1960s through the 1980s, each of the military Services also established its own programs to train PMs, for example, the Army's PM Development Program (Baumgartner, 1979, p. 100) and the Navy's Weapon System Acquisition Management and Materiel Professional programs (Fox, 1988, p. 201).

C. Commissions during the 1970s

The Fitzhugh Commission. The 1970 report of President Nixon's Blue Ribbon Defense Panel, chaired by Gilbert Fitzhugh, presented the first in-depth examination of weapons acquisition as part of its comprehensive review of national defense management (McKinney, Gholz, & Sapolsky, 1994). It noted deficiencies similar to



those found by the Hoover Commission. Specifically, the Fitzhugh Commission found that the personnel systems of the military Services did “not facilitate career development in the technical and professional activities, such as research and development [and] procurement” (Blue Ribbon Defense Panel, 1970, p. 2). Regarding PMs, it found “[no] indication of consistent efforts ... to select Program Managers from among those officers who have the most promising potential. ... [A PM] should possess both managerial and technical skills and experience in the operational employment” of the system under development (p. 80). It made extensive recommendations for improvement, including several focused on the PM, as follows:

- Establishing career specialty codes for military PMs, along with selection and training criteria to ensure an adequate supply of qualified officers;
- Increasing the number of qualified civilian PMs; and
- Increasing the duration of PM assignments and allowing for overlap of incumbent and replacement PM assignments to enhance program continuity and stability (Lockwood, 1985, p. 2).

The Commission on Government Procurement. Reporting two years after the Fitzhugh Commission, this Congressionally chartered commission addressed the same general issues of procurement problems and reform. It had few recommendations regarding the PM professionalism issue, however, other than to increase the number of civilians as major PMs as a means to increase managerial expertise and reduce turnover in that position (McKinney, Gholz, & Sapolsky, 1994, pp. 5, 13).

D. Congressional Interest and Actions during the '70s and '80s

As early as 1954, Congress had expressed concern that frequent rotations and short assignment durations among PMs were “disturbing and harmful to the productivity” of acquisition programs (in Fox, 1988, p. 178). These concerns



resurfaced occasionally, for example, in testimonies like those of the 1970 Fitzhugh Commission, of Deputy Secretary of Defense Packard in 1971 (Fox, 1974, p. 200), and of Admiral Rickover in 1971 when commenting on the inexperience, lack of skills, and short assignments of PMs in the DoD (Lockwood, 1985, pp. 11–12). The PM professionalism issue was typically presented in the context of concerns with acquisition management in general, like the GAO's (1979) report on government procurement which included criticisms of the lack of qualifications among DoD PMs.

Former Congressional staff members⁴ Colleen Preston (2011) and Jon Etherton (2011) both note that Congressional attention to PM tenure reflected its concerns with accountability, since frequent rotations made it difficult to hold a PM accountable for program shortcomings. As Preston put it, “[W]hen program managers came in to testify before members of the committee about their program, we got a lot of, ‘It didn’t happen on my watch’” (2011). Thus, lengthening PM tenure, whether by using civilian PMs to a greater extent or by mandating minimum tenure lengths, would serve the dual purposes of providing managerial stability to enhance program outcomes and, in the case of poor outcomes, helping to ensure that the responsible PM could be held accountable for those outcomes.

Exacerbating the tenure problem was the perception in the DoD that acquisition was not a particularly attractive or career enhancing field. One issue was that PMs were perceived to have, as Fox put it, “minimal authority [with] maximum responsibility” (1984, p. 156). That is, they had nominal charge over their programs, but with little real authority because of the many overseers and stakeholders who held sway over their programs’ direction (Etherton, 2011). Further, acquisition didn’t appear to have the same level of promotion opportunities as operational career fields. Gansler (2011b) has noted the absence of acquisition professionals in the most senior flag officer ranks of the DoD during these years. Regarding the four-star

⁴ Preston served as General Counsel to the Investigations Subcommittee of the House Armed Services Committee; Etherton served on the professional staff of the Senate Armed Services Committee’s Subcommittee on Acquisition and Technology.



general commander of Army Materiel Command (the Army's principal acquisition agency), four consecutive commanders had no acquisition experience, which sent clear signals to junior acquisition professionals about their career field: "[I]f you look up and see that the people above you don't have any acquisition experience, you know that [experience] is not going to be emphasized. Career planning for acquisition wasn't really important" (Gansler 2011b). Hence the view among reformers of the importance of structural changes to the DoD's acquisition career management systems.

In 1984, two years after President Reagan signed an executive order directing the establishment of career management programs for professional federal employees, a Senate Armed Services subcommittee began the first series of Congressional hearings targeted specifically on the issue of PM professionalism. These hearings coincided roughly with passage of the first legislative provisions in 1984 and 1985 (Department of Defense Authorization Act for 1985; Department of Defense Authorization Act for 1986). This legislation directed the lengthening of PM assignment durations to four years or the completion of a major program milestone, and for PMs, requirements for minimum training (mandatory attendance at DSMC) and experience (a minimum of eight years in acquisition-related assignments, two of which must be with major systems acquisition; Lockwood, 1985, pp. 3–4, 13, 15).

According to Etherton (2011), then-Senator Dan Quayle, chairman of the Defense Acquisition Policy Subcommittee, took a different tack on the PM professionalism issue in the mid-1980s. After meeting with several PMs (and hearing the "responsibility without authority" complaint referred to in this section), Quayle decided to focus on empowering them, an initiative that led to creation of the Defense Enterprise Program (DEP; enacted in the National Defense Authorization Act for 1987 [1986]). Something of a managerial experiment, the DEP authorized the DoD to nominate selected programs that would have reduced regulatory burdens and reporting requirements. Ideally, this would allow those PMs to have greater flexibility in exercising good managerial skills and discretion, while at the same time



improving PM accountability. The DEP encountered resistance within the DoD, however, and as Congressional leadership changed over the next few years, it proved to be short-lived.

In 1986, the GAO issued a detailed report on the acquisition workforce, concluding that DoD PMs in general lacked the appropriate training, education, and experience needed for the challenges of managing acquisition programs (GAO, 1986).

Throughout the 1980s, PM tenure remained the principal and most intractable professionalism reform issue for Congress (Etherton, 2011). One reason was the prominence of the personnel subcommittees of the Armed Services Committees in Congress which “ruled the roost” (Etherton, 2011) on any military personnel matters. Another reason was competing priorities about how to achieve lengthened tenure, whether through, for example, mandates for increased numbers of civilian PMs, or for establishment of dedicated career fields that would allow military PMs to serve for longer durations.

E. Executive Branch Actions during the 1980s

The Carlucci Initiatives. Only a few months after President Reagan’s inauguration in 1981, Deputy Secretary of Defense Frank Carlucci introduced a set of over 30 diverse measures (subsequently known variously as the Defense Acquisition Improvement Program [DAIP], or more informally, the Carlucci Initiatives) intended to improve acquisition outcomes. Among the initiatives was “Increase program stability” through measures such as increased PM tenure. Although some of the initiatives resulted in limited progress, by 1984 the DoD’s commitment to the DAIP had largely dissipated (Munehika, 1997, pp. 6–9).

The Grace Commission. President Reagan’s Private Sector Survey on Cost Control, the Grace Commission, addressed the entire scope of government operations to address waste in spending, as its name suggests. While making many acquisition-related recommendations, the Commission’s recommendations regarding PM



professionalism generally repeated prior calls for better trained and more experienced PMs (Grace Commission, 1984).

The Packard Commission. In late 1985, President Reagan established the Blue Ribbon Commission on Defense Management, chaired by former Deputy Defense Secretary David Packard, in response to the rash of acquisition “horror stories” during the mid-1980s (Blue Ribbon Commission, 1986, p. 1). Because its major task was to evaluate the entire U.S. defense acquisition system, the Commission also commented on the professionalism issue. Assuming the central importance of the PM position (Berteau, 2011) and the necessity of experience for success (Gansler, 2011b), the Commission found that, compared to that of private industry, the defense acquisition workforce is “undertrained, underpaid, and inexperienced” (p. 28). While supporting the legislation cited previously, it affirmed the importance of further improvements to PM training and career development, both for military and civilian members.

Secretary of Defense Cheney’s 1989 Defense Management Review generally echoed the Packard Commission’s findings on the state of the acquisition workforce (Mavroules, 1991, p. 18). Because recommendations for improvement efforts were developed by the individual military Services, implementation plans varied significantly across the DoD (Layton, 2007, pp. 10–11).

F. The 1990 House Armed Services Committee (HASC) Report

By the late 1980s, interest in PM professionalism in the context of continuing poor acquisition outcomes had grown to the point that Congress was considering major reform legislation (Etherton, 2011; Preston, 2011). According to Rep. Mavroules, Congress reflected a consensus that most previous efforts to reform the acquisition system had focused on processes and structures, and that what was presently needed was a focus on people. This consensus, however, was based mainly on anecdotal evidence (Preston, 2011). Thus, as a necessary prelude to



workforce reform legislation, the House Armed Services Committee (HASC) chartered an “in-depth analysis of the state of the acquisition workforce” (HASC, 1990, p. 1) to focus on the following four questions (p. 1):

1. Are acquisition managers, including PMs, being appointed with the required qualifications, and are they remaining in their positions for the minimum four-year duration?
2. Is there a career program to develop professional and qualified personnel, both military and civilian?
3. Does the workforce reflect an appropriate mix of military and civilian personnel?
4. What impediments exist to workforce professionalism, and how may those be overcome?

The 776-page HASC report provided detailed and comprehensive data on almost all facets of the workforce’s qualifications, providing unprecedented insights and a much-needed empirical basis for subsequent legislation. The report’s findings generally supported the momentum in Congress for major workforce legislation. For example, it found the following (Mavroules, 1991, pp. 17–21):

1. Fewer than half of major PM positions were filled with graduates of the statutorily required PM course at Fort Belvoir.
2. Since 1984, only six of 94 major PMs had remained in their assignments for the statutory four-year (or major milestone completion) requirement.
3. The DoD’s career programs for PMs lacked key elements leading to professionalism.
4. While civilians made up over 90% of the total acquisition workforce, only about 10% were assigned to major PM positions.

The report also found differing levels of attention to PM professionalism among the three military Services. For example, only the Air Force had a dedicated professional career development and certification program for military PMs.

Accordingly, the Air Force had more experienced PMs (with an average of 17 years



experience) than the Army or Navy, as well as a higher percentage (97%) of PMs with at least eight years of acquisition experience than either the Army (81%) or the Navy (71%). Regarding PM tenure, the least experienced Navy PMs had an average tenure of 41 months, while the more experienced Air Force PMs averaged only 25 months; Army PMs averaged 29 months (HASC, 1990, pp. 32–45).

G. Differences in PM Career Management Among the Military Departments

Differences in the career management approaches of each of the military departments had been evident prior to the HASC report. Preston (2011) and Etherton (2011) both describe the Air Force as having the most well-developed career management policies and procedures for PMs. As noted previously, the Air Force had a dedicated career path and was, as Preston put it, “growing true business managers from the very outset” (2011). Etherton (2011) explained the Air Force’s priority on PMs as a consequence of its higher capital–labor ratios than either of the other Services.

The Army’s PM career program envisioned accessing mid-level officers from the operational ranks and providing developmental assignments prior to their selection for PM by a centralized selection board. While the Army’s program was not as well developed as the Air Force’s, Baumgartner (1979, pp. 99–103) wrote in glowing terms of Army PMs and their professional qualifications, referring to them as “princes of the realm.”

The Navy was recognized as having the least developed PM career program. Preston recalls,

[T]hey were pulling people right off a ship, rotating through a short tour, turning them into program managers, and thinking that if they sent them to DSMC ... that was going to be enough. ... [T]hey would be capable of making ... multi-million dollar business decisions. (2011)



One interviewee, a former Navy PM who chose to remain anonymous, attributed the Navy's approach to its historical preference that its PMs be proven leaders with recent operational experience in the program's domain (e.g., a submariner as PM of a submarine program). The Navy saw career Air Force PMs as essentially "civilians wearing uniforms," because they had little to no operational experience. Business expertise and program continuity, in the Navy's model, were best provided by civilian deputies to the uniformed PMs.

As might be expected, these career management differences among the three departments complicated the task of PM reform efforts by both Congress and the DoD. Resistance was particularly strong from the Air Force, which—perhaps with some justification—felt that its program was already strong, and that it did not need "interference" from outside (Preston, 2011).

Etherton (2011) noted that the military departments' PM career programs were focused only on uniformed members:

Whether [career management for military PMs] was adequate was another question, but on the civilian side there was no equivalence. ... If you were a civilian you didn't have the same career opportunities as your military counterpart. [Congressional reformers wanted] to create room for civilian program managers to operate more effectively in the system and have more opportunities.

This new focus on civilians was related to the goal of making acquisition an attractive professional career field, as described by Etherton (2011):

...so that someone coming in from the outside who was a talented manager or had some interest in public service would look at the Acquisition Corps as something to be sought after—to make it more attractive, to make it something that would have special standing.

H. The Defense Acquisition Workforce Improvement Act (DAWIA)

Enacted in November 1990 as part of the 1991 Defense Authorization Act, the DAWIA provided for a broad range of workforce professionalization actions, not



only for PMs, but for other acquisition specialists as well. It required the Secretary of Defense to establish policies and procedures for acquisition career management and to ensure their uniformity throughout the DoD. Some of its main provisions regarding PMs included the following:

- Establishment of designated career fields, career managers, career advisory boards, and career paths for advancement;
- Establishment of an Acquisition Corps with certification levels in each acquisition career field, along with training, education, and experience requirements necessary for certification at each level;
- Limitations on preferences for military personnel and requirements to increase numbers of civilian PMs;
- Establishment of the Defense Acquisition University (DAU) for the professional education and development of the workforce;
- Reinforcement of the four-year/major milestone tenure requirement for major PMs; and
- Reinforcement of the requirement to attend the PM course prior to assignment, along with experience requirements: for a major PM, eight years of acquisition experience, two of which must be in a major program office; for a nonmajor PM, six years of acquisition experience.

Waivers could be granted for these last two requirements.

Etherton (2011) noted that policy-makers intended that the DAWIA (1990) and other reforms, such as the establishment of the program executive office (PEO) structure (Horgan, 1995), be mutually supportive regarding enhanced PM professionalism and accountability. It was presumed that removing managerial layers between the PM and milestone decisions authorities, along with establishing clearer lines of reporting and authority, would enable better decision making by better trained and more experienced PMs.

Compared with the years leading up to the DAWIA (1990), relatively little policy attention was paid to the PM professionalization issue following its passage through the early 2000s. This can be attributed to perceptions that the DAWIA's



sweeping reforms were for the most part adequate and that time was needed for their proper implementation. It also reflected the DoD's concern with larger issues of strategic human capital planning (GAO, 2002), which was sorely needed after the major acquisition workforce reductions during the 1990s.

One unintended consequence of the DAWIA (1990) was described in an anecdote related by a senior DoD acquisition official who chose to remain anonymous. At a meeting during the mid-1990s, the official inquired as to the quality of acquisition personnel compared to ten years previously. A 3-star flag officer replied, "Of course, it's lower. ... I have 36 O-6s⁵ coming up [for assignment] this year, and I have 42 jobs. ... There was a time when I had 42 O-6s and 31 jobs. You could weed [the weaker performers] out; we're not able to weed anymore." Thus, the DAWIA's certification and assignment standards appear to have had the effect of reducing the pool of available senior officers to the point that, at least according to this anecdote, "best qualified" criteria for selection to PM were rendered essentially meaningless.

I. Post-DAWIA Interest in PM Professionalization

Roughly ten years after the DAWIA's (1990) passage, major PMs resurfaced as an issue of interest, mainly regarding the problem of brief tenures. For example, an unpublished report in 2001 provided data on major PM tenure since passage of the DAWIA, noting that on average, DoD PMs had failed to meet its statutory requirements (Office of the Director, 2001).

In 2005, the Defense Acquisition Performance Assessment (DAPA) Project called for the PM tenure requirement to be established at the point of formal program initiation and proceed through completion of operational tests in order to enhance leadership stability (Assessment Panel, 2005). In 2008, the GAO reported once again on the issue of short PM tenure durations, stating that frequent program

⁵ Colonels in the Air Force and Army; Captains in the Navy



manager turnover has “potential to impact acquisition outcomes on individual programs” (p. 2). The GAO noted:

[F]or 39 major acquisition programs started since March 2001, the average time in system development was about 37 months. The average tenure for program managers on those programs during that time was about 17 months—less than half of what is required by DoD policy. (p. 11)

While not attributing adverse program outcomes to this tenure issue, the GAO concluded that outcomes in terms of cost, schedule, and performance had not improved since 2000.

The National Defense Authorization Act for 2007 (2006). Provisions of this legislation put a different emphasis on major acquisition PMs. Congress called for the DoD to increase PM empowerment and responsibility through revised guidance on their qualifications, resources, tenure, and accountability.

A year later, in reporting to Congress on its progress toward meeting these requirements, the DoD described acquisition as consisting of two related environments (2007, pp. 6-9). “Big A” acquisition is the larger DoD institutional environment that, in addition to strategic acquisition management, also entails requirements management and resource management, two activities that are typically outside a PM’s sphere of influence. “Little a” acquisition is the managerial environment of activities within a PM’s ability to influence. The DoD stated that even with Congressionally directed PM enhancements that might enable improvements in little a acquisition, improved outcomes were not likely without improvements to the Big A components of the acquisition system (2007, p. 8) the GAO rendered a similar opinion only three months later (2007, p. 7). This represented a substantive step back by DoD’s acquisition leadership from the conventional wisdom regarding PM professionalism and program outcomes.

Business Executives for National Security (BENS). This group, consisting of several industry leaders and former senior government officials (e.g., Norm Augustine, Gary Hart, Warren Rudman), published its report in 2009 on



recommendations for reforming defense acquisition. Like other commissions mentioned previously, it addressed a wide range of issues, including the acquisition workforce and major PMs, but it naturally reflected industry's perspectives. Pertinent recommendations included strengthening the role of industry in workforce training (BENS, 2009, p. 32), implementing private-sector organizational forms and management practices, improving PM training and experience, and lengthening durations of PM tenure (p. 34). Despite all of the professionalizing actions taken by the DoD since the DAWIA (1990), the report noted, "the acquisition career field is not viewed as a profession in the same sense as are operational billets" (BENS, 2009, p. 35).

Defense Business Board (DBB). In December 2010, Under Secretary of Defense Carter chartered the DBB to conduct a review of the DoD's PMs and make recommendations for improving their effectiveness based on private sector best practices. The DBB conducted its review and provided its report four months later after interviews with OSD staff, acquisition executives, six PMs, and representatives of eight large firms (DBB, 2011, pp. 1–2). It found "compelling reasons" to change the way the DoD manages its PMs (p. 2), specifically regarding the prevalence of short assignment durations that "negatively affect" acquisition programs (p. 2).

According to the DBB, industry perceived that the DoD's acquisition performance is complicated by absences and turnover of military PMs who tend to be in charge of major programs. It reported that, while private sector PMs enjoyed "increased PM tenure, continuity, and business acumen," the DoD's military PMs tended to be "risk adverse [sic]" due to their inexperience and excessive oversight requirements (pp. 2–3). The DBB offered two choices for reform: Professionalize PMs (in the sense of creating a "career destination" for them, as in a true profession such as law or medicine), or reserve major PM positions for civilians who can serve for longer durations.



J. Summary of Policy Review

This admittedly lengthy review is provided to make the following points: (1) the issue of PM professionalism has been a feature of defense acquisition reform policy for over fifty years; (2) numerous policy initiatives during those years have attempted to make PMs professional; and (3) because the PM issue persists, those attempts have provided less than satisfactory results. Notably absent from this review, however, is any policy analysis that attempts to establish a relationship between enhanced professionalism and improved program outcomes.



III. Literature Review

Because little research directly addresses the relationship between PM professionalism and program outcomes, this section also summarizes some relevant research from the field of human resource management.

A. Early Studies

Scholarly attention to the PM coincides roughly with the rise of modern project management in the mid-20th century with highly complex weapons projects such as the Manhattan Project and the Atlas project (Kwak, 2005). The leadership and skills of the two generals who managed these projects—Leslie Groves and Bernard Schriever, respectively—have been widely cited, reinforcing the view of the PM's importance in achieving successful results (Baumgartner, 1963, 1979). Gaddis' *Harvard Business Review* article (1959) described the unique roles and competencies of this new type of manager. Peck and Scherer's (1962) seminal study of defense acquisition noted the importance of PM experience and the disruption to programs that occur with frequent PM rotations (pp. 92–93). The influential works of Katz (1974) and Mintzberg (1975) documented the attributes and competencies of effective managers.

B. Fox's Studies

J. Ronald Fox's two books (1974, 1988) remain the two most influential and comprehensive analyses of U.S. defense acquisition management. In each, Fox devotes an entire chapter to the PM, with emphasis on the professionalism issue, covering the material summarized in the previous chapter in much greater detail. While lauding the efforts of individual PMs to do their best in a flawed system, Fox presents trenchant critiques of an acquisition culture that steadfastly resists reform, including PM professionalism efforts.



In these books, Fox makes claims regarding the PM issue that are relevant for this present study. For example, he states, “The capability of the program manager and his staff obviously determines the ultimate success of each weapon acquisition program” (1974, p. 180). Similarly, he cites “the reality that an effective and efficient acquisition program requires advanced program management skills, based on extensive practical training and years of program management experience” (1988, p. 196). Unfortunately, he offers no support for such claims. Thus, while he does give compelling evidence both for the lack of PM professionalism and for unfavorable program outcomes, he simply assumes the former contributes to the latter. Considering the widespread influence of Fox’s works, it is unsurprising that many apparently accept the “reality” of this relationship (see, for example, Blue Ribbon Commission, 1986, pp. 27–28; Lockwood, 1985, p. 1).

C. Project Management Studies

Project management literature contributes to the present study in several ways. First, the question of defining and measuring project success, especially for complex projects with diverse stakeholders, generates much attention (see, for example, Pinto & Slevin, 1988). Agreement on specific success criteria is elusive, and most agree on only general standards like overall mission accomplishment, stakeholder satisfaction, and conformance to quality, cost, and schedule targets (Baker, Murphy, & Fisher, 1988; Murphy, Baker, & Fisher, 1974). This problem is exacerbated by the lack of data on achievement of cost, schedule, and quality targets, whether because of proprietary concerns (mainly in the private sector) or simply because data have not been systematically collected. As a result, most studies rely on stakeholders’ subjective assessments to determine program outcomes (Crawford, 2002).

Several of these studies have attempted to quantify the benefits of project management and project management techniques in terms of favorable project



outcomes in the private sector (see, for example, Ibbs & Reginato, 2002; Morris, 2002). None, however, has focused on the PM or on defense acquisition projects.

Numerous studies have focused on the issue of desired PM competencies (Geoghegan & Dulewicz, 2008; Posner, 1987; Thamhain, 1991), to include defense acquisition PMs (Cullen & Gadeken, 1990; Gadeken, 1994, 2002; McVeigh, 1994). All of these studies, however, relied on subjective assessments, both for success factors and for program outcomes. Because they examined competencies (e.g., leadership skills), these studies did not address any of the criteria, such as training and tenure, that received attention in prior critiques of PM professionalism.

Like Fox, then, PM scholars have assumed, but failed to provide evidence of, a relationship between PM competencies or attributes and the outcomes of the programs they lead.

D. Human Resource Management (HRM) Literature

The difficulty in identifying relationships between PM professionalism and program outcomes is illustrated by human resource management (HRM) studies that address the issue of “return on investment” (ROI) from training, education, and other development programs (Dionne, 1996; Kirkpatrick, 1994; Rowden, 2005). As Wilson (2004) notes, many organizations take a “leap of faith” when it comes to HR development programs, presuming their inherently positive effects for all concerned, including for the bottom line. ROI studies attempt to replace faith with evidence, whether motivated by executive concerns with profitability (Bartel, 2000; Phillips, 1996) or by HR specialists’ concerns to justify their budgets (Geber, 1996; Institute of Management & Administration, 2003).

Despite occasional claims to the contrary (e.g., Phillips, 1997), most scholars find significant difficulties in establishing relationships between HR development efforts and effects such as increased profitability for any other than relatively formulaic or routine tasks (see, for example, Mikesell, Wilson, & Lawther’s [1975] study of training for tax auditors; also, Brown & Seidner, 1998; Stolovitch & Maurice,



1998; Swanson, 1998). For managerial and executive development efforts, issues of training validity (treatment effects from the program) and performance validity (transferring performance from the program to the job) present major challenges (Goldstein, 1979). These challenges would be even more severe in the context of a highly complex major defense acquisition program (Fox & Miller, 2006). Further, unless the development program has been designed and implemented with evaluation in mind—with concomitant resource investments—metrics and data are typically unavailable for analysis (Chmielewski & Phillips, 2002).

Such challenges are addressed generally but extensively in the literature of public program and policy evaluation (see, for example, Babbie, 2009; Langbein, 2006; Mohr, 1995; Poister, 2003).

The GAO (2010b) recently addressed the issue of measuring the effects of training in the defense acquisition workforce. The GAO reported that DAU, which has authority for acquisition training in the DoD, measures training effectiveness using Kirkpatrick's (1994) four-level model, as follows:

- Level 1: Reaction—the trainees' reaction to and satisfaction with the training.
- Level 2: Learning—the extent to which learning has occurred because of the training.
- Level 3: Behavior—the application of learning to work from changes in trainee's behavior.
- Level 4: Results—the impact of the training on the agency's organizational results (e.g., ROI; increased profitability).

The GAO noted that, while DAU attempts to measure its training effectiveness for the first three levels, it has not used Level 4 assessments extensively (2010b, pp. 14–15). Among other findings, it concluded that the DoD needs metrics for assessing “how certification training contributes to organizational performance results” (p. 28). In its comments on the report, the DoD disagreed with



this conclusion, stating its preference for existing metrics related to workforce capacity and proficiency, rather than new metrics on results (GAO, 2010b, p. 39).

While the HRM literature focuses on the organizational effects of HR development efforts, it has implications for studies that would examine organizational effects due to managerial attributes and competencies, for example, the effects of PM professionalism on program outcomes. Specifically, the same challenges (e.g., external validity, availability of data) are present for the latter as for the former. These issues are also reflected in business theorists' long-standing debates over the extent to which managerial competence contributes to firm profitability (Roquebert, Phillips, & Westfall, 1996; Skandalis, Liargovas, & Merika, 2008).

E. Summary of Literature Review

To summarize the main points of this section, while some assume that PM professionalism and program outcomes are positively correlated, no study has attempted to validate that assumption. Proximate research comes from HRM studies that seek to find relationships between HR development programs and organizational outcomes; these are, however, fraught with challenges in both method and data and have met with inconclusive results. The following question remains: To what extent may the benefits of PM professionalism be based on evidence rather than, apparently, on faith?



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IV. Research Hypothesis and Models

The discussion to this point provides background for the following research hypothesis: *PM professionalism is positively correlated with program outcomes*. This study examines this hypothesis through the analysis of dependent variables that correspond to program outcomes and which are presumed to vary according to changes in independent variables related to PM professionalism. This section presents the development of variables for multiple linear (ordinary least squares [OLS]) and logistic regression models, along with hypotheses for statistical analysis. Considering the methodological issues mentioned in the introduction to this report, the goal is for robust testing across a variety of specifications.

A. Dependent Variables (Outcomes)

Many have noted the difficulty in defining “success” in acquisition program outcomes, given the variety of stakeholders representing, for example, military, industry, political, and other interests (see, for example, Gansler, 2011a, pp. 129–234). Providentially, this study can avoid this problem, because most of the criticisms cited in prior chapters which focus on PMs’ lack of professionalism have emphasized adverse outcomes at the level of individual programs, such as cost increases, schedule slips, and performance shortfalls. Thus, in this study, dependent variables are outcomes for individual acquisition programs and are functions of several independent variables for those programs.

Percent unit cost variance (PUCV). At program initiation, initial baseline cost estimates must be established against which subsequent cost estimates can be compared. Estimates are prepared in several categories both for total costs and unit costs (i.e., total cost divided by quantity to be procured). Because both total costs and unit costs can differ significantly among programs (e.g., the unit cost for a missile program may be dozens of thousands of dollars, while for a ship, perhaps hundreds of millions of dollars), analysis of baseline cost variances in dollar terms



provides skewed results. Accordingly, this study will use PUCV as a dependent variable. For example, if in Year 1 the estimated baseline unit cost for a program was \$1 million, and in Year 2 the estimate rose to \$1.1 million, the variance was a positive (and unfavorable) 10%.⁶

Occasionally, unit cost variance appears excessive, as in the case of program termination, when all program costs would be allocated to perhaps only a few developmental platforms. Accordingly, this study sets plus and minus 100% variance as upper and lower limits and eliminates any data points outside these limits as outliers.

PUCV will be examined in the following three forms:

- PUCV PERIOD—PUCV reported in each SAR period
- PUCV DURATION—PUCV in the last reporting period of a PM's tenure duration⁷
- PUCV NOMINAL—PUCV as a nominal variable with binary values “favorable” (if PUCV PERIOD or DURATION is unchanged or decreases) or “unfavorable” (if PUCV PERIOD or DURATION increases).

Program breach. A breach occurs, and must be reported, when an estimate of a cost, schedule, or performance parameter is determined to be significantly less

⁶ Many circumstances could cause such a result, such as (1) cost increases due to poor initial estimates; (2) cost increases due to desired and beneficial changes (e.g., increased weapon system capability); or (3) changes in quantity to be procured. The extent to which a PM's professionalism might be determined to influence any such circumstances is problematical.

Discussion on reasons for program cost growth, appropriate cost metrics, and the idea that cost growth in some circumstances may be justifiable and worthy, is reflected in the DoD's responses to the recent GAO's critical assessments of acquisition programs. See, for example, GAO, 2011a, pp. 153, 179–180.

⁷ Conceptually, this would be the period in which the PM should have the most influence over the program's outcomes, according to conventional wisdom.



favorable than its baseline estimate. Breaches fall into two main categories: Nunn–McCurdy breaches⁸ and acquisition program baseline (APB) breaches.

A Nunn–McCurdy breach (GAO, 2011b) occurs and must be reported when a major increase (ranging from 15% to 50%, depending on the specific criteria used) is determined to have occurred in a program’s current estimate of unit cost from the baseline estimate. A Nunn–McCurdy breach is an indicator of potentially serious problems with a program, and reporting a breach triggers a variety of actions by higher authorities, including required reports to Congress on corrective actions that might include program termination.

An APB breach occurs and must be reported when the current estimate for any of a program’s key parameters is determined to exceed its threshold (or minimally acceptable) value as defined in the APB.⁹ Because APB thresholds are the minimally acceptable values of the most important program parameters, the determination that any might not be achieved represents a serious issue, requiring the attention of higher authorities, along with appropriate corrective action.

For this study, the breach variable will take on two nominal values: yes (if a program has experienced any type of breach) or no (if not). Obviously, this dependent variable is very general and accounts for almost any adverse circumstance of sufficient importance to be reported to higher authorities.

⁸ Named for Senator Sam Nunn and Rep. David McCurdy, co-sponsors of the provisions enacted in the Department of Defense Authorization Act for 1982 (1981).

⁹ The APB is established at program initiation and represents its approved description in terms of key cost, schedule, and performance parameters, expressed as both objective (desired) and threshold values. Examples of key parameters that might be included in an APB are as follows:

- Cost—estimated total cost for each appropriation type (e.g., procurement, military construction); unit cost; ownership cost
- Schedule—projected dates for major milestones, major tests, and initial operational capability
- Performance—projected system attributes such as operational availability, range, airspeed, accuracy

(See chapter 2.1.1 of Defense Acquisition University, 2011).



B. Independent Variables

The earlier discussion gave indications of several variables that, according to the research hypothesis, are presumed to contribute to program outcomes.

PM tenure. Longer tenures are presumed to contribute to favorable outcomes. This is presented in two ways for each acquisition program, depending on the model specification: first, the number of months that a PM has been in the position as of a SAR period report date (TENURE PERIOD); and second, the total duration of the PM's tenure in months (TENURE DURATION).

PM status—military or civilian. Programs with civilian PMs are presumed to have favorable outcomes; those with military PMs, less so. This is a nominal variable with two values.

Program component. This variable denotes the program's component, whether Air Force, Army, Navy, or DoD (joint programs) and is a nominal variable with one of these four values. This variable is an admittedly blunt surrogate for PM training, education, and experience levels. Such data were not readily available for individual PMs, nor were data available on whether a particular PM required a waiver from the statutory training, education, and experience levels required for assignment. However, the discussion in section II.G. noted that (1) only the Air Force has a dedicated career path for its officers; and (2) Air Force PMs have more training and experience than either Army or Navy PMs, and Army PMs have more experience than Navy PMs. Accordingly, Air Force programs are presumed to have better program outcomes than Army and Navy programs, and Army programs are presumed to have better outcomes than Navy programs.



Null Hypotheses. The following null hypotheses follow: *There is no relationship between program outcomes and*

- *H1₀: duration of PM tenure,*
- *H2₀: PM status, and*
- *H3₀: program component.*

C. Extraneous Variables

The following independent variables may influence the dependent variables but are not of interest to the question of PM professionalism:

System complexity. Unit cost (PAUC) is used as a proxy for the complexity of the system to be acquired. Systems with higher unit costs (e.g., ships, aircraft) are assumed to have higher levels of complexity. For simplicity, each program will take on the nominal value (Q1 – Q4) of the quartile in which its PAUC falls.

Program commodity (e.g., ship, aircraft, missile). Some commodities may have differing levels of risk due to factors such as technological maturity and the state of the U.S. industrial base, with concomitant potential effects on outcomes. This variable takes on a nominal value for one of eight program commodities listed in the next chapter.

Program phase. This variable has one of two nominal values: development or production. This variable is associated with the relative maturity and risk of the program, which may be reflected in its outcomes.

The model includes a lagged dependent variable to account for the prior period's outcome.

D. Multiple Linear Regression Model

Based on the variables identified previously the general model for the outcome—PUCV or breach—of a program during time period *t* is as follows:



$Outcome_t = f(\text{tenure}_t, \text{status}_t, \text{component}, \text{PAUC quartile}, \text{commodity}, \text{phase}_t, \text{outcome}_{t-1})$

(Component, PAUC quartile, and commodity are assumed unchanged over a program's life.)

Several different specifications of this model will be examined in the following chapter.



V. Data

This section describes the source of data for this study, explains the data elements that correspond to the relevant variables, and presents a summary of the data that were collected.

A. Source of Data

Data were obtained from the Defense Acquisition Management Information Retrieval (DAMIR) Purview¹⁰ system. Data were taken from Purview's records of all major defense acquisition program¹¹ (MDAP) Selected Acquisition Reports¹² (SARs) submitted between 1997—the first year for which Purview SAR data are available—and 2010. The data include any acquisition program that was designated as MDAP and which submitted a SAR during any of these years.¹³

¹⁰ DAMIR Purview is an executive information system operated by the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics (Acquisition Resources & Analysis); see <http://www.acq.osd.mil/damir/>.

¹¹ Defined as a DoD acquisition program that is designated as such by the Secretary of Defense and is not a highly sensitive classified program, that is estimated to require an eventual total expenditure for research, development, test, and evaluation of more than \$365 million or an eventual total expenditure for procurement of more than \$2.19 billion (both in FY 2000 constant dollars) (Department of Defense, 2008, p. 3-1).

¹² The Secretary of Defense must submit a SAR to Congress for each MDAP. The SAR reports the status of total program cost, schedule, and performance, as well as unit cost breach information. SARs are submitted annually and, on an exception basis, quarterly, when estimates for some cost and schedule parameters exceed their targets. (See section 10.9 of Defense Acquisition University, 2011.)

¹³ This study did not include the DoD's chemical demilitarization programs. While these are sometimes included in lists of acquisition programs and are required to submit SARs, they differ significantly in that their objective is to destroy weapons rather than acquire them.

The study also excluded the National Missile Defense program due to its extremely high unit cost (in excess of \$20 billion), which is attributable both to its very complex "system of systems" nature and to its production as one single system (i.e., quantity of one). Additionally, this program submitted only one SAR in 1999. Other programs are also very complex, with very low production quantities (e.g., Warfighter Information Network–Tactical); however, they typically have submitted SARs in several years. For this reason, they are included in the analysis of this study.



B. Data Elements

Purview provided the following for each year in which an MDAP submitted a SAR:

PUCV. The reported percentage variance between the current estimate and the baseline estimate of Program Acquisition Unit Cost (PAUC)¹⁴ is reported in the SAR. Estimates are in base year dollars, where the base year is typically the year in which the MDAP was approved and its baseline established.

Breach. Details on any type of breach that occurred during the report period are given in the SAR.

Tenure and Status. The SAR provides identifying information (assignment date and rank, if military) for the current PM. PM tenure for the current reporting period (TENURE PERIOD) is the difference in months between the PM's assignment date and the date of the SAR. PM total tenure (TENURE DURATION) is taken as the difference between the PM's assignment date and that of his or her successor.

Component. The SAR identifies each program's component.

Phase. The SAR gives information on program milestones, which allows for a determination of whether a program is in the development or production phase.

PAUC. PAUC is reported in each SAR in both base year and then year dollar. This study uses base year dollars.

¹⁴ Defined as the estimated cost of the development, procurement, and military construction necessary to acquire a system, divided by the total number of fully configured end items (to include research and development units) to be bought through the life of the program.



Commodity. The SAR classifies each program's commodity according to the type of weapon or system it acquires. For this study, the following eight commodities were used:

- aircraft (fixed- and rotary-winged, including unmanned aerial vehicles);
- ships (surface craft and submarines); ground vehicles (tracked and wheeled);
- missiles (air and surface);
- munitions (bombs, artillery projectiles, warheads);
- command, control, communications and intelligence (C3I; radios, information systems);
- space (satellites, launch vehicles); and
- other (systems such as those for soldier support which do not fit in the other commodities).

C. Data Summary

This study used Minitab 16 for all data analysis.

Overview. Table 1 lists numbers of SAR submissions and programs by commodity and component for the years 1997–2010.

Table 1. Number of SAR Submissions and Programs by Commodity and Component

SAR submissions	Air Force	Army	DoD	Navy	Programs	Air Force	Army	DoD	Navy
Space	128	0	0	15	Space	16	0	0	2
Aircraft	145	81	9	145	Aircraft	19	13	1	17
Missile	35	66	8	71	Missile	3	8	4	8
C3I	26	93	42	52	C3I	7	27	5	12
Ship	0	0	0	128	Ship	0	0	0	18
Munitions	39	38	0	31	Munitions	6	6	0	3
Ground Vehicle	0	59	0	13	Ground Vehicle	0	7	0	2
Other	15	5	6	2	Other	1	1	3	1



Figure 1 shows numbers of SAR submissions for programs by phase and component.

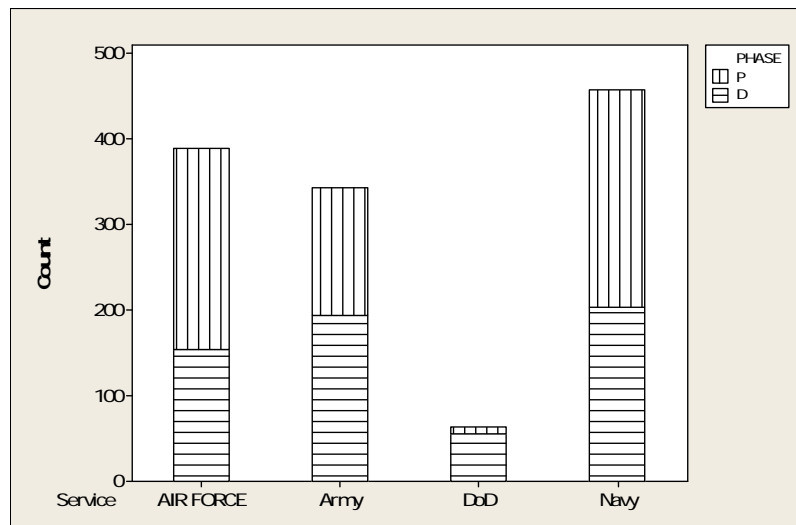


Figure 1. SAR Submissions by Phase (D = Development; P = Production) and Component

Program Complexity (PAUC Quartile). Figure 2 provides bar charts depicting percentages of SAR submissions per quartile according to component and commodity. As expected, Navy and Air Force programs, representing a preponderance of ship, space, and aircraft programs, appear to have the highest levels of complexity.

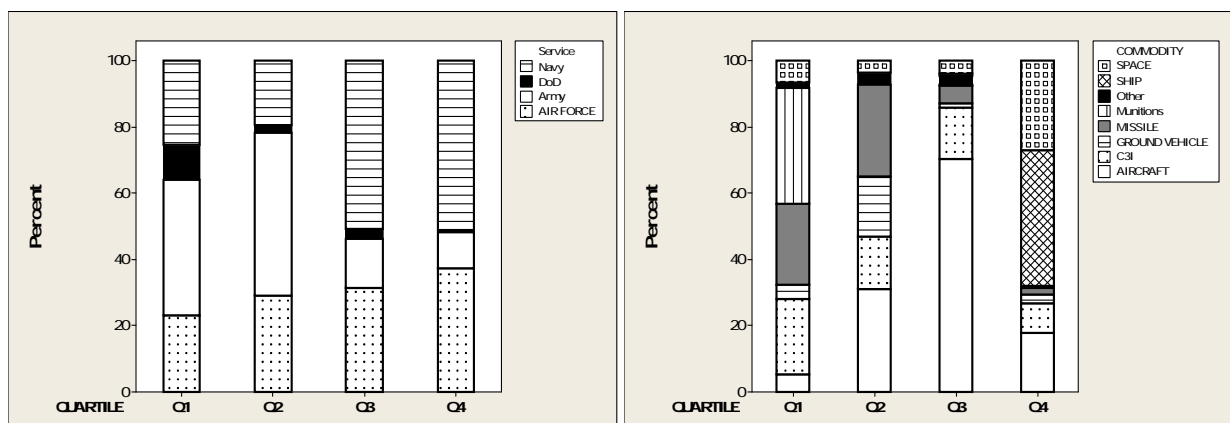


Figure 2. PAUC Quartile by Component and Commodity



VI. Data Analysis

This section presents descriptive statistics, graphical data displays, and results of regression analysis, together with commentary on how these relate to the study's hypotheses. It begins with data on PMs and then moves to data on outcomes (the study's dependent variables).

A. PM Data

PM Population. Earlier discussion documented the interest of various commissions and study groups in the composition of the PMs according to status (i.e., military or civilian). Table 2 presents data from the timeframe of this study (1997–2010) for the number and percent of PMs by status and according to their component and commodity. Table 3 provides a comparison of PM status between this present study and the 1990 HASC Report discussed earlier.

The data indicate roughly a 10% increase in civilian PMs of major programs over the past twenty years. Considering that over 80% of PM positions remain occupied by military members, however, this increase likely would be insufficient to satisfy past commissions and groups that advocated increased levels of civilian PMs. No striking differences are apparent from the distribution of PMs by component and commodity.¹⁵

¹⁵ The sole component/commodity area in Table 2 in which civilian PMs were a majority—Air Force “other” programs—achieved this distinction by having four of five civilian PMs in only one program—the National Airspace System—during the 1997–2010 timeframe. Thus, the increase in civilians appears to be relatively limited.



Table 2. PM Data by Status, Component, and Commodity

	Aircraft	Space	C3I	Missile	Munitions	Ground Vehicle	Ship	Other	Total
Military									
Air Force	53	46	17	18	10	0	0	1	145
Army	33	0	32	20	19	23	0	2	129
DoD	5	0	17	3	0	0	0	3	28
Navy	51	3	16	30	11	4	43	1	159
Total	142	49	82	71	40	27	43	7	461
Civilian									
Air Force	14	11	2	3	8	0	0	4	42
Army	5	0	4	7	0	3	0	0	19
DoD	0	0	2	1	0	0	0	1	4
Navy	4	2	7	2	1	2	8	0	26
Total	23	13	15	13	9	5	8	5	91
Percent Military									
Air Force	79	81	89	86	56			20	
Army	87		89	74	100	88		100	
DoD	100		89	75				75	
Navy	93	60	70	94	92	67	84	100	
Total	86	79	85	85	82	84	84	58	84

Table 3. Comparison of PM Status: Present Study and the 1990 HASC Report

	Percent Military	
	This study	1990 HASC Report
Air Force	78	96
Army	87	96
DoD	88	--
Navy	86	94
Total	84	96

Figure 3 indicates that military PMs tend to be assigned more frequently to programs with the highest levels of complexity (i.e., highest PAUC) than civilian PMs, especially in the Army and Navy. A two-sample T-test confirmed that PAUC for programs with military PMs ($M = \$497$ million, $SD = \$1,477$ million) is significantly



higher than those with civilian PMs ($M = \$224$ million, $SD = \$489$ million) ($t(788) = -4.59, p < .01$).

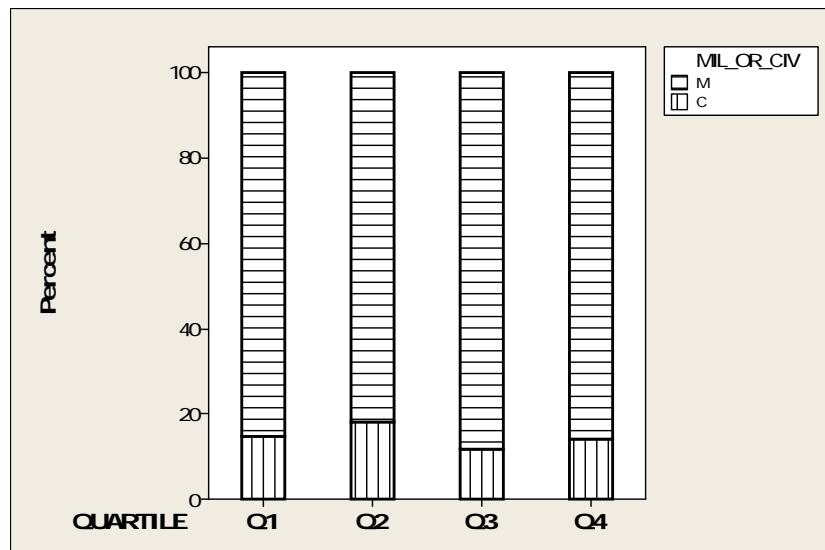


Figure 3. PM Status and PAUC Quartile

PM Tenure. This study has documented concerns with frequent PM turnover (short tenures in position) as contributing to unfavorable program outcomes. Statistics on PM tenure (TENURE PERIOD and TENURE DURATION) are given in Table 4.

Table 4. Summary Statistics for PM Tenure

Variable	Mean	Std Dev	Median
TENURE PERIOD (tenure for the SAR period in months) (N = 1251)	17.3	12.92	16.0
TENURE DURATION (total tenure duration in months) (N = 399)	32.4	14.17	35.0

Figures 4 through 7 provide graphical information in the forms of histograms and “box and whisker” plots¹⁶ of PM TENURE DURATION according to component, commodity, phase, and status.

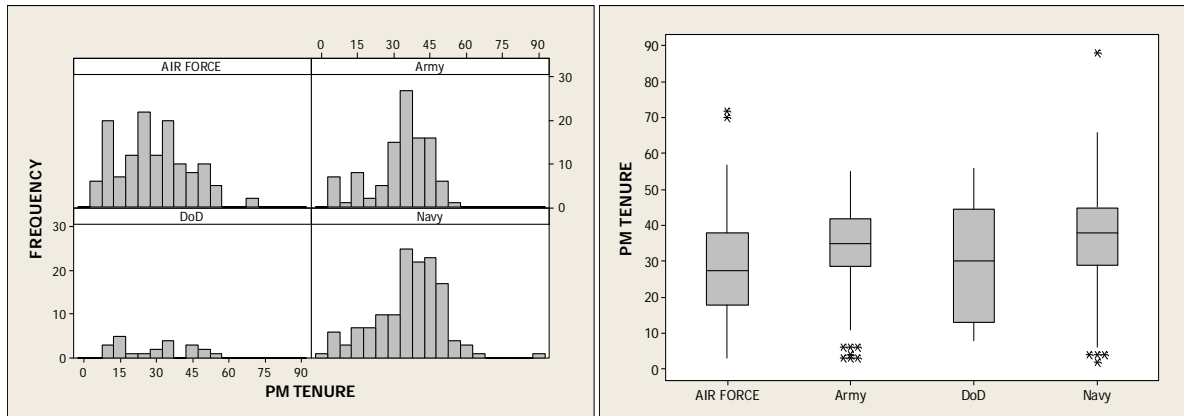


Figure 4. PM TENURE DURATION and Component

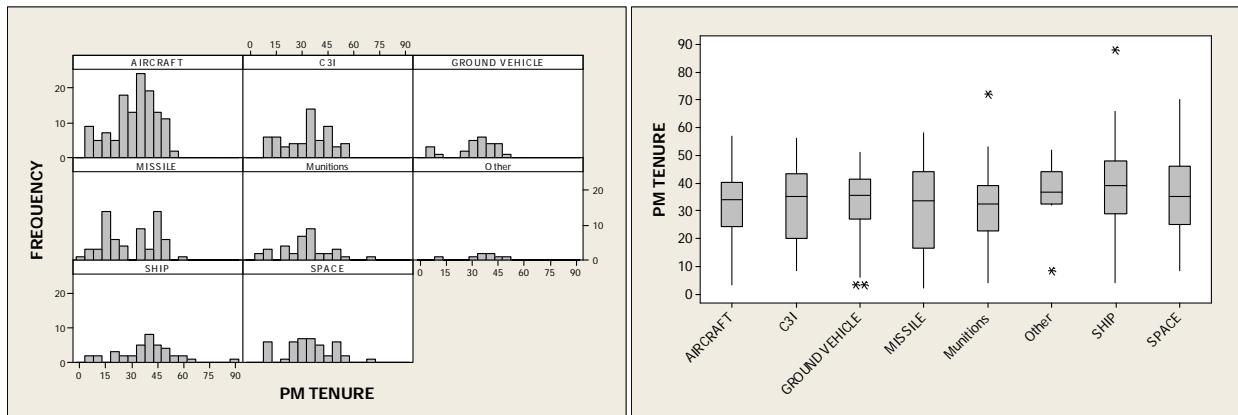


Figure 5. PM TENURE DURATION and Commodity

¹⁶ Minitab uses the quartile method for calculating box endpoints. The top of the box is the third quartile (Q3); 75% of the data values are less than or equal to this value. The bottom of the box is the first quartile (Q1); 25% of the data values are less than or equal to this value. The upper “whisker” extends to the highest data value within the upper limit (upper limit = $Q3 + 1.5(Q3 - Q1)$), and the lower whisker extends to the lowest value within the lower limit (lower limit = $Q1 - 1.5(Q3 - Q1)$). Values beyond the whiskers are outliers.

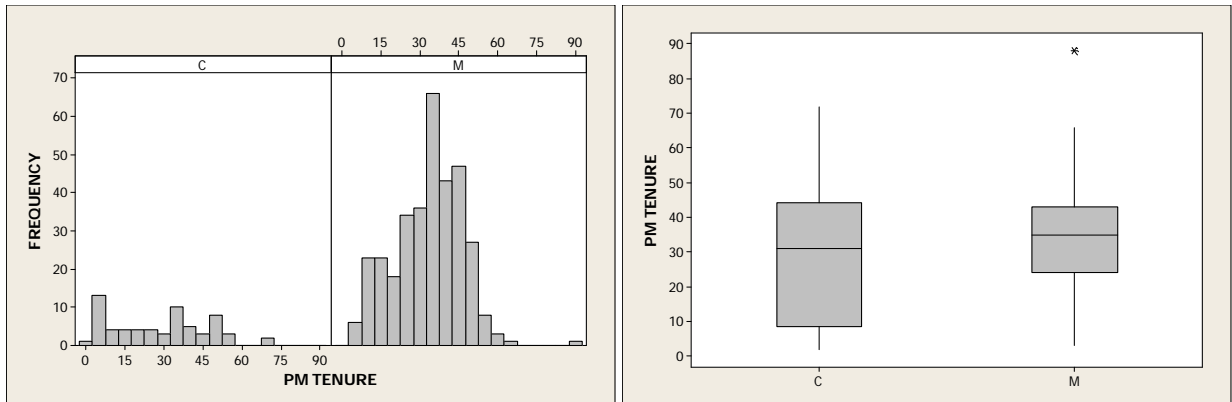


Figure 6. PM TENURE DURATION and Status (M = military; C = civilian)

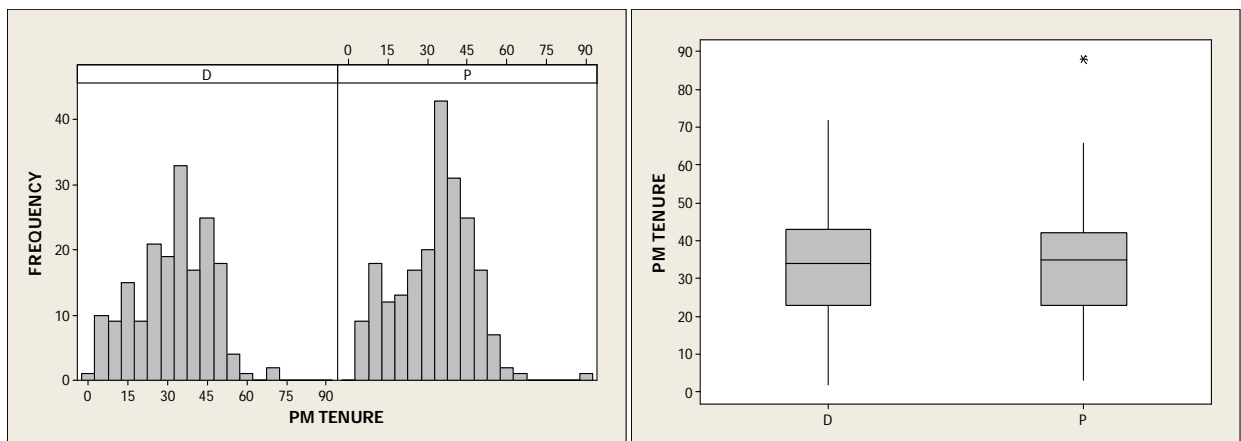


Figure 7. PM TENURE DURATION and Phase (Development or Production)

Table 5 provides a comparison of PM tenure durations between this present study and the 1990 HASC Report discussed earlier. On average, PM tenure durations have remained relatively unchanged over the past twenty years. Average tenure has increased in the Air Force and Army and, while decreasing in the Navy, average tenure remains the longest in that component.

Table 5. Comparison of PM Tenure: Present Study and the 1990 HASC Report

	PM Average Tenure (months)	
	This study	1990 HASC Report
Air Force	28.5	25
Army	33.2	29
DoD	28.8	--
Navy	36.0	41
Total	32.4	32

Discussion of PM Tenure. No significant differences are apparent regarding commodity or phase.

Figure 6 bears comment, as it indicates that tenure durations tend to be longer for military PMs. This runs counter to the idea that civilians should be preferred for PM positions, since they would (supposedly) have less frequent reassignments and longer tenure durations than military members. One possible reason for this phenomenon is that civilians might be appointed as “interim” PMs, with corresponding short tenures, pending assignments of military members. If valid, this explanation would put the recent increase in civilian PMs in a different light.

B. Dependent Variables—Graphs

This section provides graphical analyses of each the study’s dependent variables in relation to the independent and extraneous variables.

PUCV. PUCV PERIOD and PUCV DURATION are examined together because of their similarity. Table 6 provides summary statistics.



Table 6. Summary Statistics for Percent Unit Cost Variance (PUCV)

Variable	N	Mean	Std Dev	Median
PUCV PERIOD (N = 1168)	1169	-0.39	15.78	0.0
PUCV DURATION (N = 404)	405	0.23	14.42	0.02

Figure 8 shows scatter plots for PUCV PERIOD and DURATION according to reporting periods in the timeframe of interest (1997–2010). These outcomes appear to be uncorrelated with time, a phenomenon which, while not formally addressed in this study, has possible relevance to the professionalization issue. Specifically, if the DoD has invested substantial resources in PM professionalization efforts over the past twenty years, one might expect to see improved outcomes. This appears, however, not to be the case.

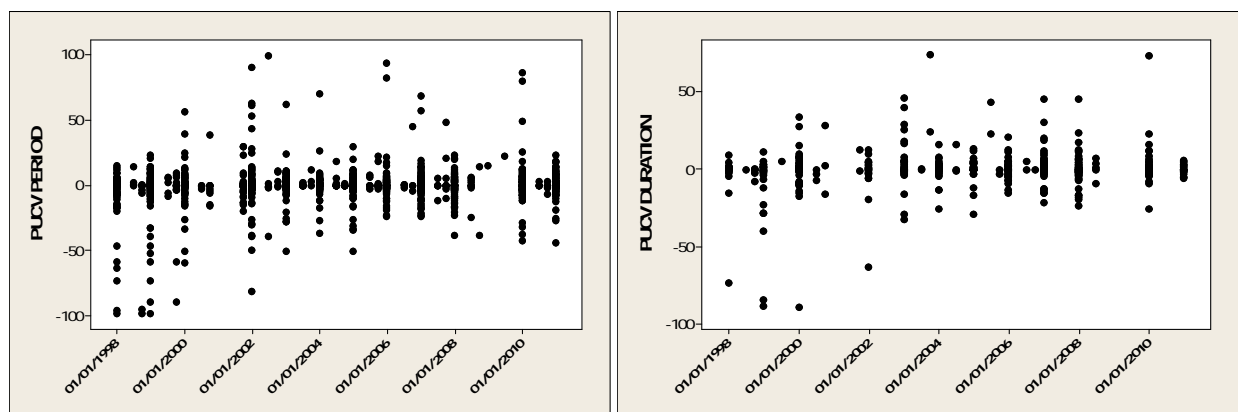


Figure 8. PUCV and Time

Figure 9 shows scatter plots for these two in relation to PM TENURE PERIOD and TENURE DURATION, respectively. Little correlation is evident.



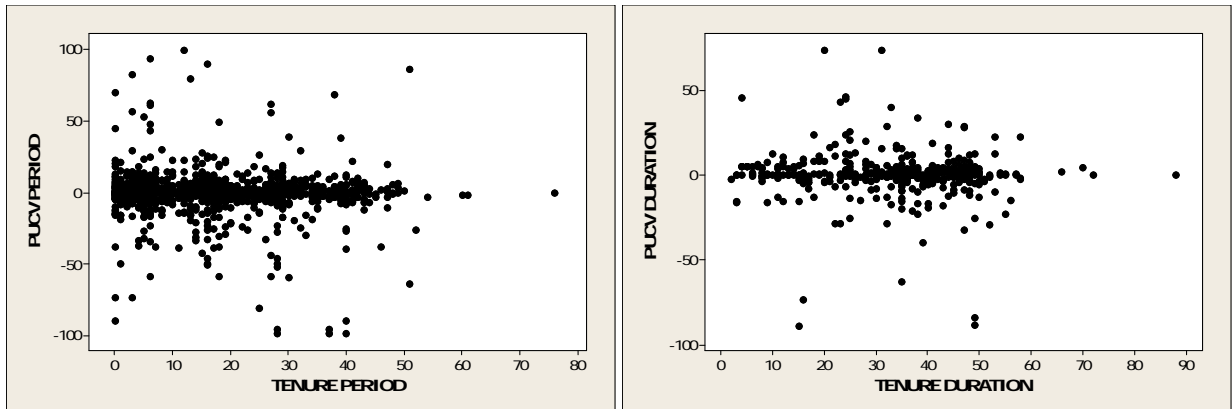


Figure 9. PUCV as a Function of PM Tenure

Figures 10 through 14 show box plots for PUCV PERIOD and PUCV DURATION in relation to component, status, commodity, phase, and PAUC Quartile. Again, none of these exhibits evident correlation.

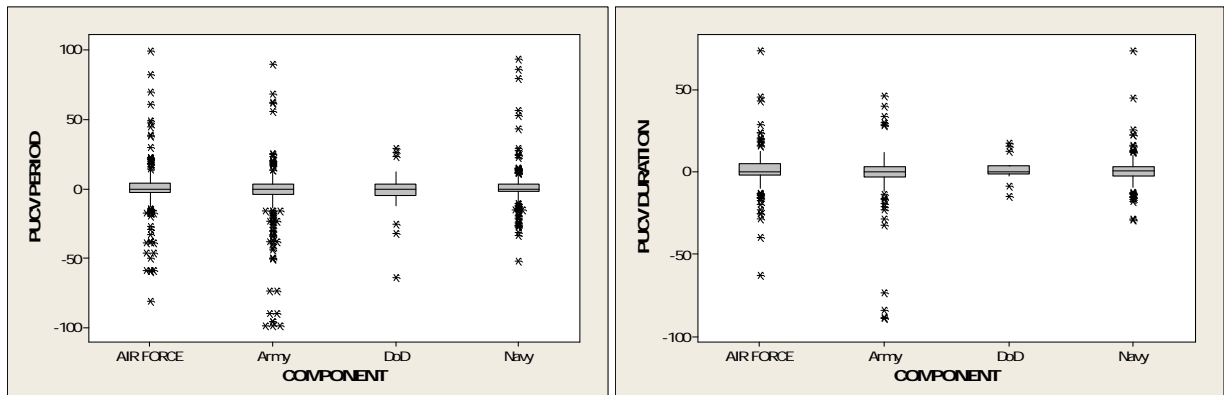


Figure 10. PUCV as a Function of Component

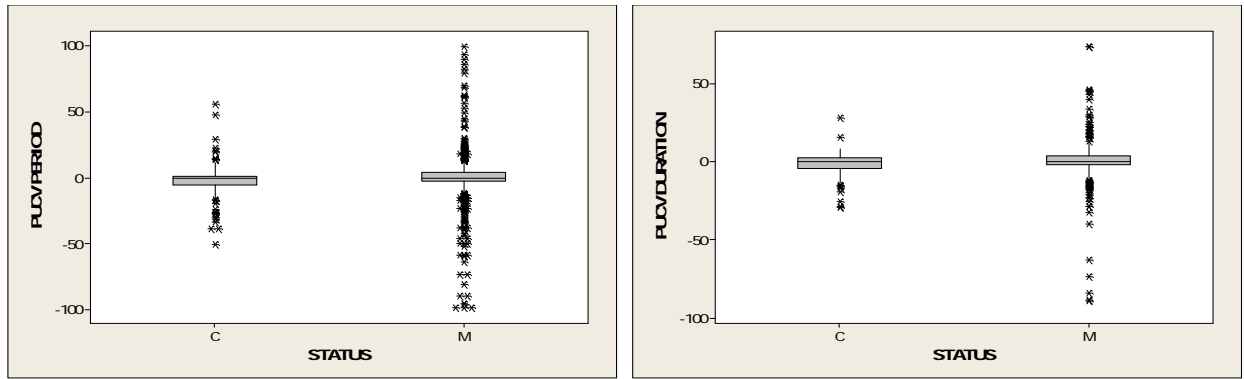


Figure 11. PUCV as a Function of Status (C = civilian; M = Military)

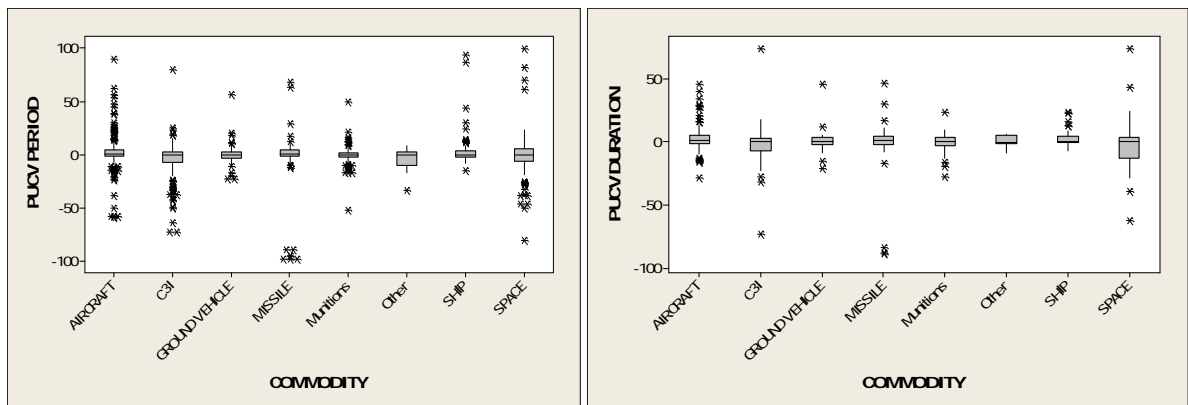


Figure 12. PUCV as a Function of Commodity

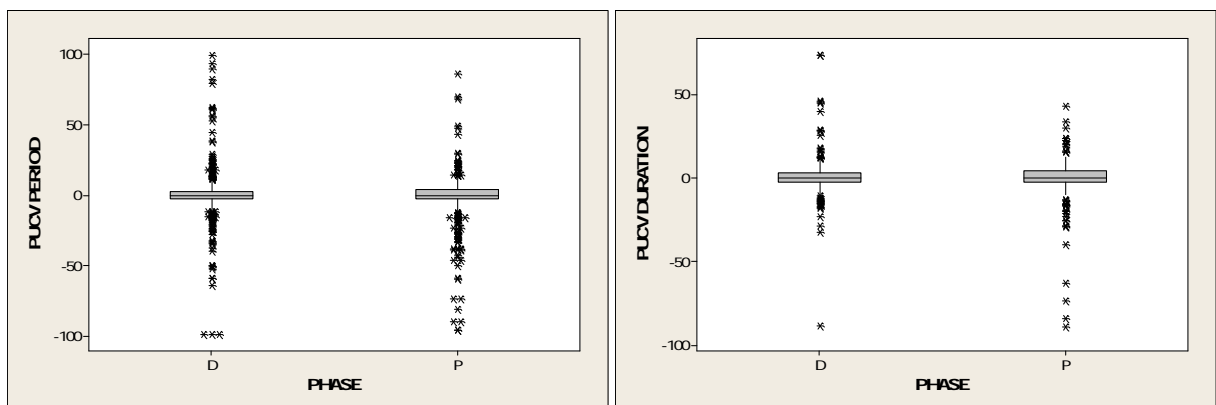


Figure 13. PUCV as a Function of Phase (D = development; P = production)



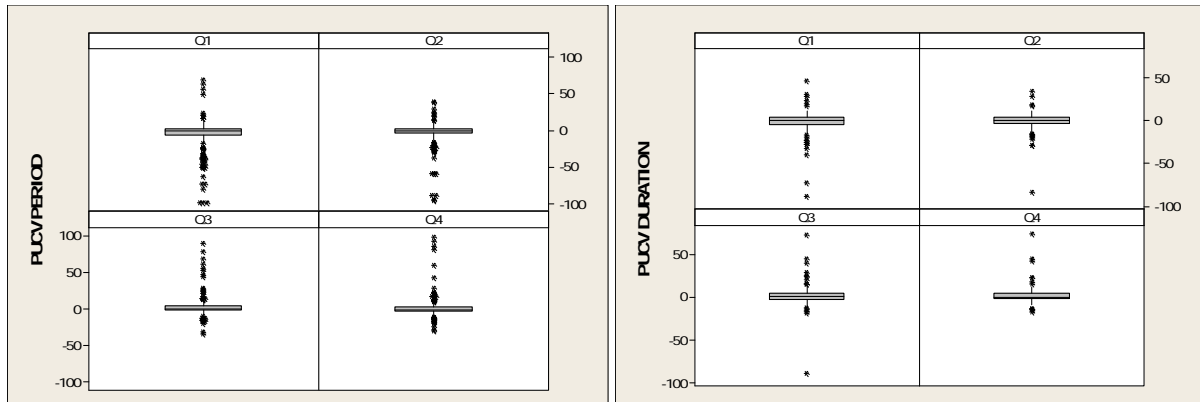


Figure 14. PUCV as a Function of PAUC Quartile

Discussion of PUCV. Regarding Figure 10, a one-way ANOVA was used to test for PUCV PERIOD differences among the four components. PUCV PERIOD differed significantly across components ($F(3, 1164) = 4.01, p < .01$). Tukey's comparisons ($p = .05$) indicate that the Army ($M = -2.87, SD = 20.5$) had significantly lower (favorable) PUCV PERIOD than both the Air Force ($M = 0.29, SD = 15.85$) and the Navy ($M = 0.95, SD = 11.22$), but the Army's PUCV PERIOD was not significantly different than the DoD's ($M = -1.29; SD = 13.54$). Comparisons of PUCV PERIOD for the DoD, Air Force, and Navy were not statistically significant.

This finding disconfirms $H3_0$ regarding a correlation between program outcomes and component, but not in the manner predicted. The research hypothesis predicted that the Air Force would have the highest levels of favorable outcomes, but the data indicate the highest levels in the Army.

Figure 11 bears comment, since it appears that the variance of PUCV is higher for military PMs than for civilian PMs. An F-test for equal variances of PUCV PERIOD confirms that the variance for military PMs (264.2) is significantly higher than that for civilians (155.9; $F = 0.59, 999, 167, p < .01$). Additionally, a two-sample T-test reveals that PUCV PERIOD for civilian PMs ($M = -2.4, SD = 12.5$) is significantly lower than for military PMs ($M = -0.1, SD = 16.3; t(271) = -2.12, p < .05$).



This finding disconfirms H_{20} regarding a correlation between program outcomes and status. As predicted by the research hypothesis, PUCV outcomes for civilian PMs are significantly more favorable than for military PMs, and they have significantly less variance.

This finding is tempered, however, by evidence presented earlier that civilians tend to be assigned to programs with lower complexity, and by evidence that PUCV is more favorable in less complex programs. A one-way ANOVA was used to test for PUCV PERIOD differences among the four PAUC quartiles. PUCV PERIOD differed significantly across quartiles ($F(3, 1164) = 17.14, p < .01$). Tukey's comparisons ($p = .05$) indicate that Q1 ($M = -4.48, SD = 19.35$) and Q2 ($M = -2.99, SD = 16.44$) had significantly lower (favorable) PUCV PERIOD than both Q3 ($M = 2.98, SD = 12.26$) and Q4 ($M = 2.21, SD = 13.20$). PUCV PERIOD differences between Q1 and Q2 were not significant, nor between Q3 and Q4. Further investigation is warranted.

Since, as noted earlier, tenure lengths for civilian PMs are in general shorter than those for military PMs, tenure duration may not be a significant factor; this will be examined subsequently via OLS regression.

PUCV NOMINAL. Instances of favorable and unfavorable PUCV are shown in Table 7.

Table 7. Counts of PUCV NOMINAL

Variable	N FAVORABLE	N UNFAVORABLE
PUCV NOMINAL PERIOD	614	554
PUCV NOMINAL DURATION	202	203

Figure 15 shows the percentage distribution of PUCV NOMINAL PERIOD according to PAUC quartile. As might be expected, programs with higher PAUC (complexity) tend to have higher levels of unfavorable outcomes.



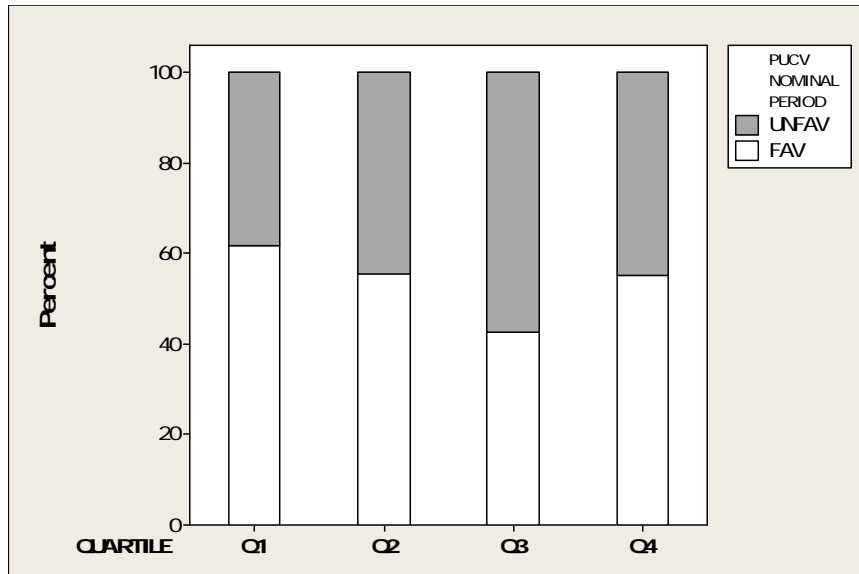


Figure 15. PUCV NOMINAL PERIOD and PAUC Quartile

Figures 16–18 depict the distribution of PUCV NOMINAL according to variables of interest. Little is remarkable about these displays, except perhaps that for aircraft programs, unfavorable PUCV NOMINAL counts exceed favorable counts (Figure 18).

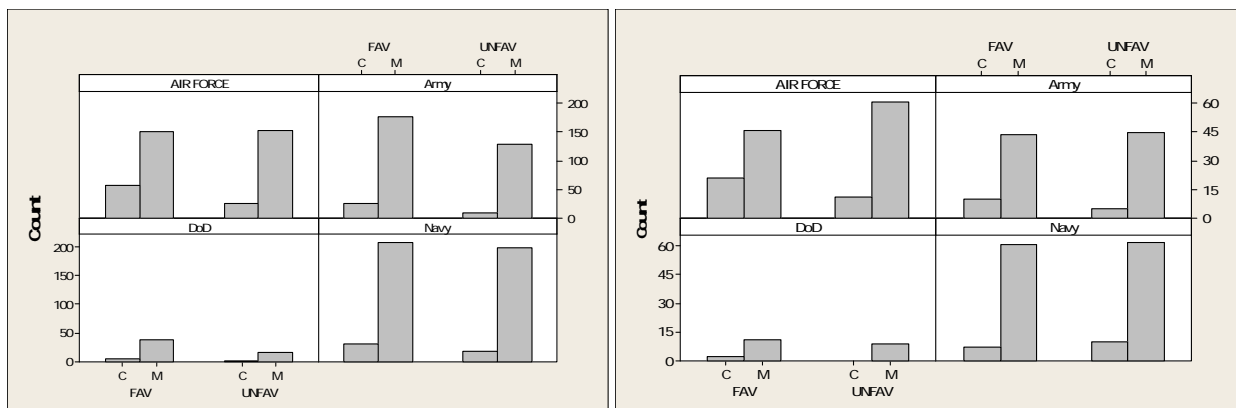


Figure 16. PUCV NOMINAL PERIOD and DURATION (Favorable and Unfavorable), Component, and Status (Military = M; Civilian = C)



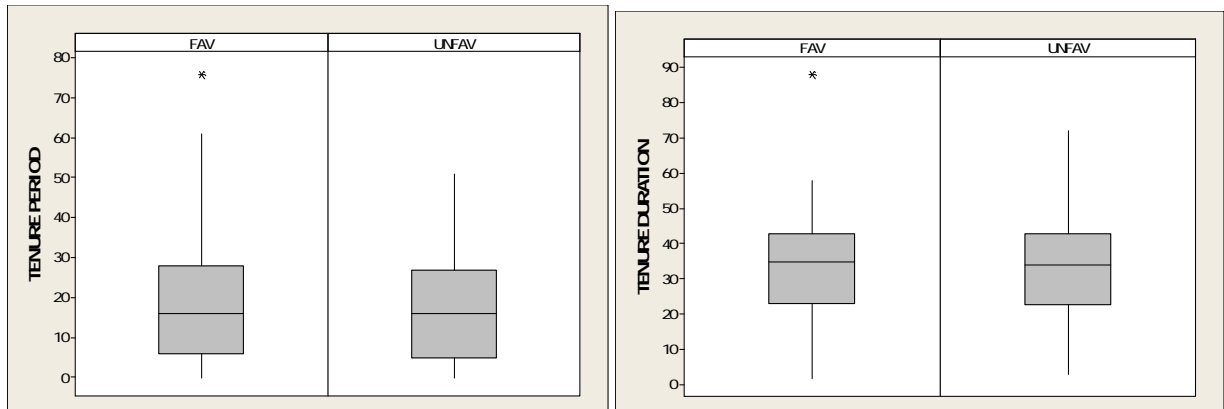


Figure 17. PUCV NOMINAL PERIOD and DURATION (Favorable and Unfavorable) and Tenure (Period and Duration)

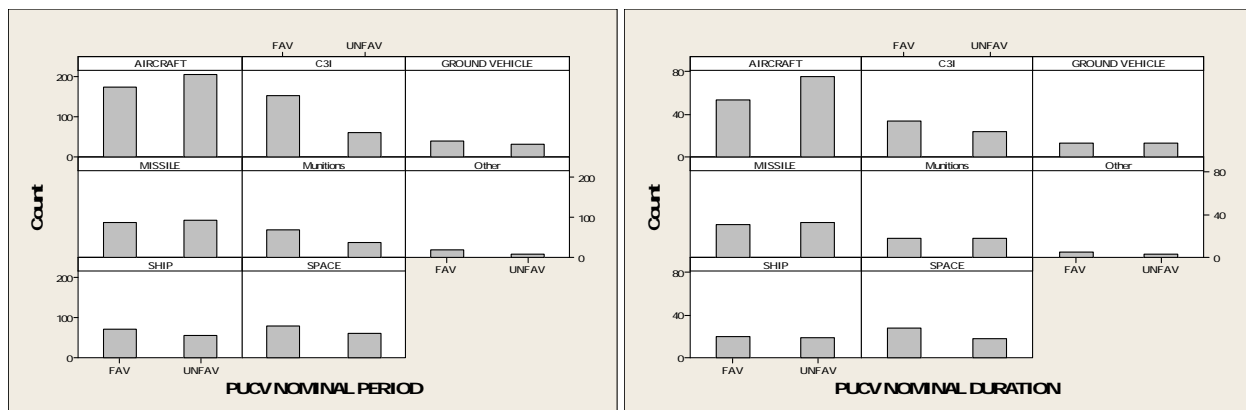


Figure 18. PUCV NOMINAL PERIOD and DURATION (Favorable and Unfavorable) and Commodity

Discussion of PUCV Nominal. Regarding Figure 16, a two-proportions test determined a significant difference in the proportions of favorable instances of PUCV NOMINAL between the civilian and military PM samples ($Z = 3.91$, $p < .01$). This disconfirms H_{20} and supports the research hypothesis that program outcomes are positively correlated with civilian PMs.

Breaches. Figure 19 depicts the distribution of numbers of SAR breaches during reporting periods from 1997–2010.¹⁷ Again, as mentioned in the discussion on PUCV, one might have expected to see a downward trend, considering recent emphasis on PM professionalization; this appears, however, not to be the case.

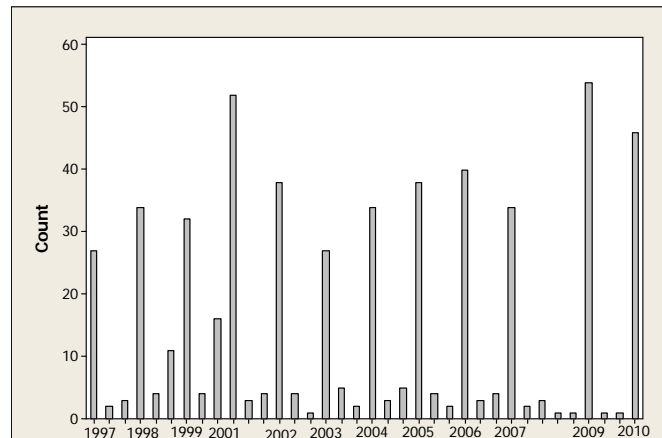


Figure 19. Counts of SAR Breaches, 1997–2010

Figures 20–23 depict the distribution of breaches during 1997–2010 according to variables of interest. These are generally unremarkable except for the case that breaches exceed non-breaches for DoD programs and for space programs (Figure 22).

¹⁷ The bars with the highest counts correspond to annual SAR submissions in December. The bars with lower counts represent exception SARs, as described earlier. Annual SARs were not submitted in either 2000 or 2008.



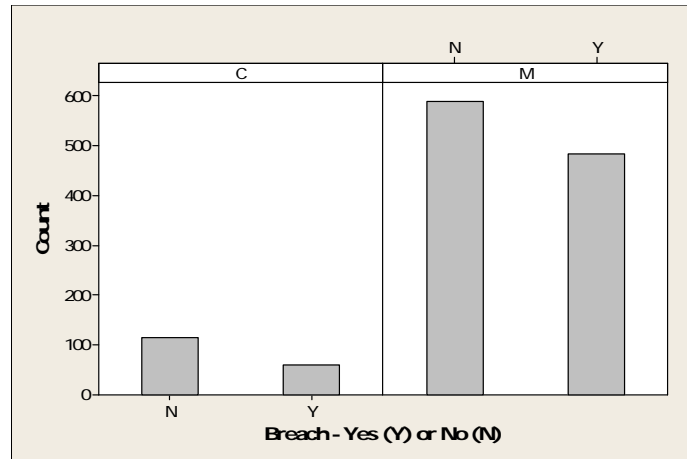


Figure 20. Counts of Breaches (Yes or No) and PM Status (Military = M or Civilian = C)

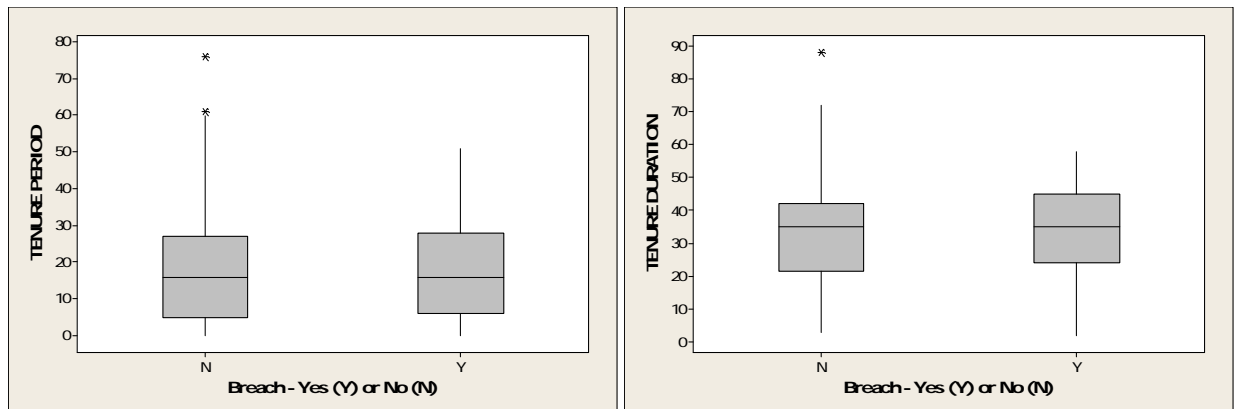


Figure 21. Breaches (Yes or No) and PM Tenure (Period and Duration)

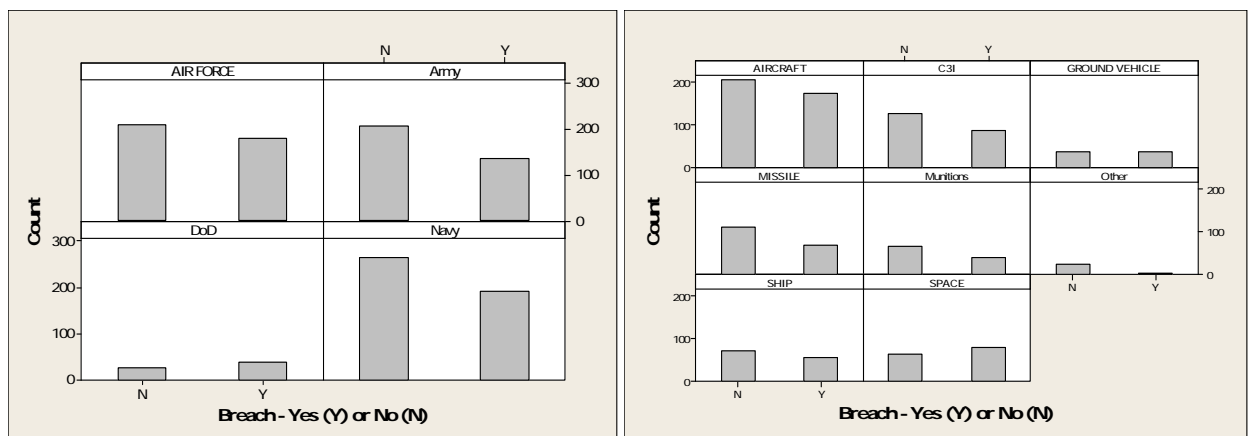


Figure 22. Breaches by Component and Commodity



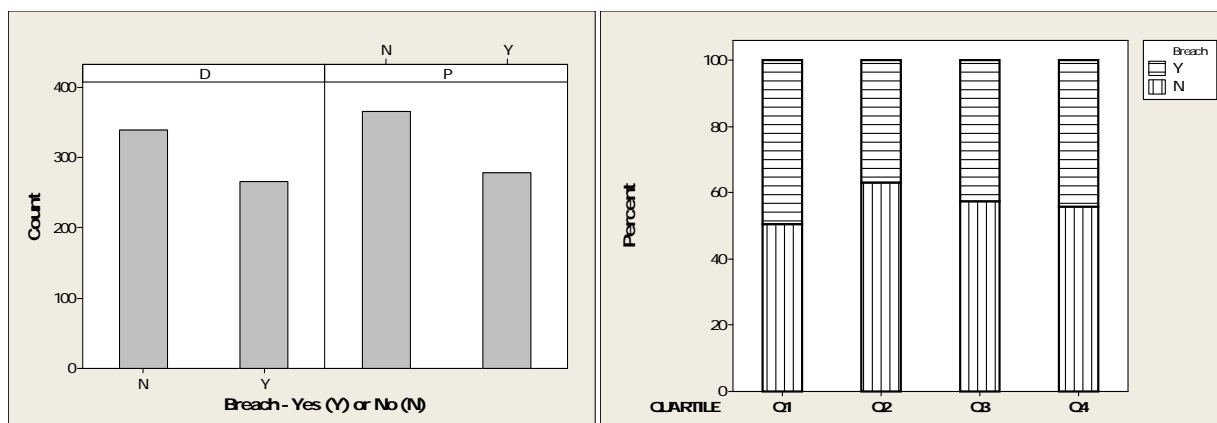


Figure 23. Breaches by Phase (D = Development; P = Production) and PAUC Quartile

Discussion of breaches. Regarding Figure 20, a two-proportions test determined a significant difference in the proportions of reported breaches between the civilian and military PM samples ($Z = -2.77, p < .01$). This disconfirms H_{20} and supports the research hypothesis that program outcomes are positively correlated with civilian PMs. When, however, the same tests were conducted within each quartile, a significant difference ($Z = -2.12, p < .01$) was found only in quartile 2 (Q2); no significant difference was found in the proportion of breaches according to status in Q1, Q3, or Q4.

Summary—Graphical analysis of dependent variables. This section has given an extensive set of depictions of relationships between the dependent and independent variables of interest. For the most part, few correlations are evident from historical SAR data.

The notable exception that emerges is the relationship between program outcomes and status: programs with a civilian PM are associated with favorable outcomes to a greater extent than those with a military PM. Because tenure durations for military PMs tend to exceed those of civilian PMs, this difference is likely due to factors other than tenure. The data indicate that military PM's manage programs with higher complexity than civilians, though the effect of program



complexity on outcomes is mixed. Further attention is given to this issue in the following section.

C. Regression Analysis

This section presents results of OLS regressions for the dependent variables representing program outcomes and the independent variables of interest. Recall that the general model for the outcome—PUCV or breach—of a program during time period t is as follows:

$$\text{Outcome}_t = f(\text{tenure}_t, \text{status}_t, \text{component}, \text{PAUC quartile}, \text{commodity}, \text{phase}_t, \text{outcome}_{t-1})$$

where component, PAUC quartile, and commodity are assumed unchanged over a program's life. (As nominal variables, status, component, commodity, and phase are made indicator variables in the regression equations.) For each outcome, the model for program i and time t is given by the following:

$$\text{PUCV PERIOD}_{it} = \alpha_{it} + \beta_1 \text{TENURE PERIOD}_{it} + \beta_2 \text{STATUS}_{it} + \beta_3 \text{COMPONENT} + \beta_4 \text{PAUC QUARTILE} + \beta_5 \text{COMMODITY} + \beta_6 \text{PHASE}_{it} + \text{PUCV PERIOD}_{it-1}$$

$$\text{PUCV DURATION}_{it} = \alpha_{it} + \beta_1 \text{TENURE DURATION}_{it} + \beta_2 \text{STATUS}_{it} + \beta_3 \text{COMPONENT} + \beta_4 \text{PAUC QUARTILE} + \beta_5 \text{COMMODITY} + \beta_6 \text{PHASE}_{it} + \text{PUCV DURATION}_{it-1}$$

$$\text{PUCV NOMINAL PERIOD}_{it} = \alpha_{it} + \beta_1 \text{TENURE PERIOD}_{it} + \beta_2 \text{STATUS}_{it} + \beta_3 \text{COMPONENT} + \beta_4 \text{PAUC QUARTILE} + \beta_5 \text{COMMODITY} + \beta_6 \text{PHASE}_{it} + \text{PUCV NOMINAL PERIOD}_{it-1}$$

$$\text{PUCV NOMINAL DURATION}_{it} = \alpha_{it} + \beta_1 \text{TENURE DURATION}_{it} + \beta_2 \text{STATUS}_{it} + \beta_3 \text{COMPONENT} + \beta_4 \text{PAUC QUARTILE} + \beta_5 \text{COMMODITY} + \beta_6 \text{PHASE}_{it} + \text{PUCV NOMINAL DURATION}_{it-1}$$

$$\text{BREACH}_{it} = \alpha_{it} + \beta_1 \text{TENURE PERIOD}_{it} + \beta_2 \text{STATUS}_{it} + \beta_3 \text{COMPONENT} + \beta_4 \text{PAUC QUARTILE} + \beta_5 \text{COMMODITY} + \beta_6 \text{PHASE}_{it} + \text{BREACH}_{it-1}$$

Linear Regression Results. Tables 8 and 9 provide unstandardized factor coefficients from progressive OLS regressions for PUCV PERIOD and PUCV DURATION, respectively.



Table 8. Regression Results for Percent Unit Cost Variance Period (PUCV PERIOD)

Predictor	Coefficient (Standard Error)						
Constant	1.065 (0.767)	-0.929 (1.356)	-0.307 (1.434)	0.261 (1.307)	0.225 (1.686)	-0.151 (1.693)	-3.98* (2.117)
TENURE PERIOD	-0.085** (0.036)	-0.086** (0.036)	-0.088** (0.036)	-0.040 (0.033)	-0.044 (0.033)	-0.045 (0.033)	-0.044 (0.033)
Status: Military (Relative to Civilian)		2.338* (1.312)	2.577* (1.324)	1.250 (1.215)	1.086 (1.238)	1.025 (1.237)	0.757 (1.233)
Component (Relative to Air Force)							
Army			-3.351*** (1.220)	-1.589 (1.128)	-1.243 (1.331)	-1.499 (1.335)	-0.637 (1.342)
DoD			-1.946 (2.391)	0.215 (2.218)	1.599 (2.443)	0.995 (2.457)	3.248 (2.538)
Navy			0.592 (1.132)	0.395 (1.036)	-0.076 (1.212)	-0.285 (1.215)	-0.866 (1.241)
PUCV PERIOD Lag				0.538*** (0.028)	0.529*** 0.029	0.526*** (0.029)	0.508*** (0.029)
Commodity (Relative to Space)							
Aircraft					0.827 (1.584)	0.517 (1.589)	-0.622 (1.761)
C3I					-1.818 (1.983)	-2.309 (1.994)	-1.888 (2.066)
Ground Vehicle					0.514 (2.393)	0.475 (2.390)	1.665 (2.509)
Missile					0.037 (1.838)	-0.173 (1.838)	1.963 (2.017)
Munitions					0.089 (1.990)	-0.144 (1.990)	3.752 (2.335)
Ship					2.054 (2.093)	2.413 (2.097)	2.140 (2.182)
Other					-0.536 (3.361)	-1.407 (3.383)	-1.311 (3.466)
Phase: Development (Relative to Production)						1.839** (0.898)	1.857** (0.900)
PAUC Quartile (Relative to Q1)							
Q2							1.978 (1.481)
Q3							6.625***



							(1.601)
Q4							4.930*** (1.747)
R-squared	.005	.008	.019	.281	.285	.288	.302
Adj. R-squared	.004	.006	.014	.277	.275	.278	.290
1. *, **, *** indicate significance at .90, .95, and .99 levels, respectively. 2. Number of observations: 998 (when the lag factor is included); 1168 (when the lag factor is omitted). 3. Variance inflation factors ranged from a maximum of 3.89 to a minimum of 1.03 ($M = 2.16$, $SD = .89$), indicating that multicollinearity was not high. 4. The Durbin Watson statistic value (2.15) indicates the absence of autocorrelation in the sample.							

Table 9. Regression Results for Percent Unit Cost Variance Duration (PUCV DURATION)

Predictor	Coefficient (Standard Error)						
Constant	2.436 (1.816)	-0.123 (2.334)	0.677 (2.404)	-1.224 (1.733)	-2.716 (2.309)	-2.733 (2.321)	-4.001 (2.755)
TENURE DURATION	-0.067 (0.051)	-0.077 (0.051)	-0.073 (0.053)	-0.034 (0.040)	-0.033 (0.040)	-0.033 (0.040)	-0.009 (0.040)
Status: Military (Relative to Civilian)		3.449* (1.983)	3.573* (1.992)	3.162** (1.417)	3.304** (1.443)	3.304** (1.445)	1.818 (1.404)
Component (Relative to Air Force)							
Army			-3.624* (1.903)	-0.637 (1.409)	-2.055 (1.630)	-2.068 (1.639)	-1.707 (1.619)
DoD			-0.351 (3.327)	1.638 (2.426)	0.130 (2.752)	0.094 (2.785)	1.639 (2.994)
Navy			-0.225 (1.791)	0.907 (1.291)	0.073 (1.504)	0.061 (1.512)	-0.381 (1.497)
PUCV DURATION Lag				0.753*** (0.037)	0.754*** (0.038)	0.754*** (0.038)	0.839*** (0.039)
Commodity (Relative to Space)							
Aircraft					1.739 (1.998)	1.715 (2.020)	-0.675 (2.181)
C3I					3.245 (2.491)	3.202 (2.543)	2.962 (2.674)
Ground Vehicle					5.689* (2.994)	5.682* (3.000)	5.710* (3.086)
Missile					1.465 (2.262)	1.445 (2.276)	2.076 (2.458)
Munitions					1.497 (2.469)	1.483 (2.477)	2.985 (2.805)
Ship					2.729	2.748	-0.047



					(2.671)	(2.683)	(2.739)
Other					2.752 (4.093)	2.715 (4.121)	0.704 (4.106)
Phase: Development (Relative to Production)						0.103 (1.160)	0.571 (1.129)
PAUC Quartile (Relative to Q1)							
Q2							1.244 (1.804)
Q3							4.303** (1.927)
Q4							4.801** (2.164)
R-squared	.004	.012	.023	.557	.563	.563	.627
Adj. R-squared	.002	.007	.011	.549	.546	.544	.607
1. *, **, *** indicate significance at .90, .95, and .99 levels, respectively. 2. Number of observations: 348 (when the lag factor is included); 400 (when the lag factor is omitted). 3. Variance inflation factors ranged from a maximum of 4.05 to a minimum of 1.07 ($M = 2.20$, $SD = .90$), indicating that multicollinearity was not high. 4. The Durbin Watson statistic value (1.93) indicates the absence of autocorrelation in the sample.							

Discussion of Results. Several points are evident from Tables 8 and 9. First, R-squared (the coefficient of determination) is twice as large for PUCV DURATION as for PUCV PERIOD, which is likely attributable to the decrease in variation when reporting PUCV only once at the end of a PM's tenure rather than reporting in each year of tenure.

As expected, the lag variable in each model and iteration is significantly related to ($p < .01$) and accounts for most of the variance in the dependent variable.

The independent variables of interest—tenure, status, and component—explain only about 2% of the variance in the outcome, a finding which is confirmatory of the null hypotheses.

Despite this last finding, the signs of the coefficients for two of the independent variables of interest—tenure and status—are in all cases in the direction predicted by the research hypotheses. That is, the negative coefficients for



duration indicate that PUCV decreases as tenure increases, and the positive coefficient for status indicates that military PMs are associated with higher PUCV and civilian PMs with lower PUCV. In only some cases, however, are these relationships significant; they are not significant in either full model.

The directions of coefficient signs of the other independent variable of interest—component—are not as predicted by the research hypotheses. Programs in the Air Force, due to its structural factors that promote PM professionalization, were predicted to have better outcomes than the other three components. The negative coefficients for the Army in all cases, however, indicate that PUCV tends to be lower in Army programs; the same can be said in some cases for Navy and DoD programs.

Regarding the extraneous independent variables, a few notable points can be made. First, the signs of coefficients for phase and PAUC quartile are in the expected direction: PUCV in the production phase is expected to be lower than in development, and PUCV is expected to increase as PAUC increases. Second, in both models, when a program is in the top two quartiles (Q3 and Q4), that relationship to PUCV is significant; thus, higher complexity is significantly related to unfavorable outcomes. Third, phase is significantly related to outcomes in one of the models (for PUCV PERIOD); thus, developmental programs are associated with unfavorable outcomes. Finally, little can be said regarding commodity, other than the obvious conclusion that it has little relationship to or explanatory power for the dependent variable.

The results are statistically secure only for a few of the factors, in the sense that most of the standard errors exceed the magnitude of their coefficients.

To summarize, these models must be judged to have very little explanatory power for the outcomes PUCV PERIOD and PUCV DURATION.



Logistic Regression Results. Tables 10 through 18 give results of binary logistic regressions for PUCV NOMINAL PERIOD (favorable or unfavorable), PUCV NOMINAL DURATION (favorable or unfavorable), and BREACH (yes or no). For each of these three dependent variables, a table of coefficients, a table of observed and expected frequencies, and a table of measures of association are shown.



Table 10. Logistic Regression Results for PUCV NOMINAL PERIOD: Coefficients

Predictor	Coefficient (Standard Error)	Odds Ratio
Constant	-1.191*** (0.363)	
TENURE DURATION	0.001 (0.001)	1.00
Status: Military (Relative to Civilian)	0.423** (0.214)	1.53
Component (Relative to Air Force)		
Army	0.131 (0.228)	1.14
DoD	0.032 (0.436)	1.03
Navy	0.012 (0.210)	1.01
PUCV NOMINAL PERIOD Lag	1.748*** (0.143)	5.74
Commodity (Relative to Space)		
Aircraft	-0.394 (0.299)	0.67
C3I	-0.807** (0.352)	0.45
Ground Vehicle	-0.445 (0.422)	0.64
Missile	0.102 (0.343)	1.11
Munitions	-0.638 (0.399)	0.53
Ship	-0.542 (0.366)	0.58
Other	-0.198 (0.579)	0.82
Phase: Development (Relative to Production)	-0.045 (0.153)	0.96
PAUC Quartile (Relative to Q1)		
Q2	0.141 (0.250)	1.15
Q3	0.670** (0.270)	1.95
Q4	0.299 (0.290)	1.35
1. *, **, *** indicate significance at .90, .95, and .99 levels, respectively. 2. Counts: Unfavorable—492 (event); Favorable—516 3. Goodness-of-Fit Test (Pearson): Chi-Square = 852.14, df = 839, p = 0.369		



Table 11. Observed and Expected Frequencies: PUCV NOMINAL PERIOD

Group										
	1	2	3	4	5	6	7	8	9	10
Unfavorable										
Observed	20	26	26	30	41	44	74	72	78	81
Expected	17.5	23.5	28.1	32.1	28.3	54.5	66.7	72.3	78.2	80.9
Favorable										
Observed	80	75	75	71	60	57	26	29	23	20
Expected	82.5	77.5	72.9	68.9	62.7	46.5	33.3	28.7	22.8	20.1

Table 12. Measures of Association: PUCV NOMINAL PERIOD and Predicted Probabilities

Pairs	Number	Percent	Summary Measures
Concordant	191721	75.5	Somers' D: 0.52
Discordant	60632	23.9	Goodman-Kruskal Gamma: 0.52
Ties	1519	0.6	Kendall's Tau-a: 0.26
Total	253872	100.0	



Table 13. Logistic Regression Results for PUCV NOMINAL DURATION: Coefficients

Predictor	Coefficient (Standard Error)	Odds Ratio
Constant	-2.124*** (0.723)	
TENURE DURATION	0.003 (0.010)	1.00
Status: Military (Relative to Civilian)	0.122 (0.357)	1.13
Component (Relative to Air Force)		
Army	-0.084 (0.424)	0.92
DoD	0.404 (0.770)	1.50
Navy	-0.356 (0.394)	0.70
PUCV DURATION Lag	2.556*** (0.289)	12.89
Commodity (Relative to Space)		
Aircraft	0.642 (0.561)	1.90
C3I	0.665 (0.687)	1.95
Ground Vehicle	0.951 (0.777)	2.59
Missile	0.717 (0.634)	2.05
Munitions	1.025 (0.725)	2.79
Ship	0.321 (0.708)	1.38
Other	-0.056 (1.088)	0.95
Phase: Development (Relative to Production)	0.150 (0.294)	1.16
PAUC Quartile (Relative to Q1)		
Q2	0.451 (0.474)	1.57
Q3	0.678 (0.506)	1.97
Q4	0.871 (0.563)	2.39
1. *, **, *** indicate significance at .90, .95, and .99 levels, respectively. 2. Counts: Unfavorable—183 (event); Favorable—151 3. Goodness-of-Fit Test (Pearson): Chi-Square = 312.450, df = 297, p = 0.258		



Table 14. Observed and Expected Frequencies: PUCV NOMINAL DURATION

	Group									
	1	2	3	4	5	6	7	8	9	10
Unfavorable										
Observed	8	9	9	12	10	21	25	30	27	32
Expected	6.6	8.7	9.4	10.4	12.5	21.0	26.9	28.7	28.5	30.3
Favorable										
Observed	25	25	24	21	24	12	8	4	6	2
Expected	26.4	25.3	23.6	22.6	21.5	12.0	6.1	5.3	4.5	3.7

Table 15. Measures of Association: PUCV NOMINAL DURATION and Predicted Probabilities

Pairs	Number	Percent	Summary Measures
Concordant	22137	80.1	Somers' D: 0.61
Discordant	5359	19.4	Goodman-Kruskal Gamma: 0.61
Ties	137	0.5	Kendall's Tau-a: 0.30
Total	27633	100.0	



Table 16. Logistic Regression Results for BREACH: Coefficients

Predictor	Coefficient (Standard Error)	Odds Ratio
Constant	-0.548 (0.383)	
TENURE PERIOD	0.002 (0.006)	1.00
Status: Military (Relative to Civilian)	0.450** (0.219)	1.57
Component (Relative to Air Force)		
Army	-0.084 (0.233)	0.92
DoD	0.484 (0.477)	1.62
Navy	-0.178 (0.215)	0.84
BREACH Lag	1.951*** (0.146)	7.03
Commodity (Relative to Space)		
Aircraft	-0.329 (0.304)	.72
C3I	-0.575 (0.362)	0.56
Ground Vehicle	-0.226 (0.433)	0.80
Missile	-0.827** (0.356)	0.44
Munitions	-1.176*** (0.406)	0.31
Ship	-0.048 (0.374)	0.95
Other	-1.244* (0.692)	0.29
Phase: Development (Relative to Production)	0.290* (0.155)	1.34
PAUC Quartile (Relative to Q1)		
Q2	-0.722*** (0.260)	0.49
Q3	-0.587** (0.279)	0.56
Q4	-0.709** (0.306)	0.49
<p>1. *, **, *** indicate significance at .90, .95, and .99 levels, respectively.</p> <p>2. Counts: Yes—474 (event); No—534</p> <p>3. Goodness-of-Fit Test (Pearson): Chi-Square = 873.171, df = 842, p = 0.222</p>		



Table 17. Observed and Expected Frequencies: BREACH

Group										
	1	2	3	4	5	6	7	8	9	10
Unfavorable										
Observed	17	16	29	22	38	49	68	80	77	78
Expected	15.4	21.9	25.2	27.8	31.8	50.7	68.8	72.7	76.4	83.4
Favorable										
Observed	83	85	72	79	63	51	33	21	24	23
Expected	84.6	79.1	75.8	73.2	69.2	49.3	32.2	28.3	24.6	17.6

Table 18. Measures of Association: BREACH and Predicted Probabilities

Pairs	Number	Percent	Summary Measures
Concordant	195659	77.3	Somers' D: 0.55
Discordant	56409	22.3	Goodman-Kruskal Gamma: 0.55
Ties	1048	0.4	Kendall's Tau-a: 0.27
Total	253116	100.0	

Discussion of Logistic Regression Results.¹⁸ Regarding the models' predictive qualities, the goodness-of-fit tests, with p-values ranging from 0.222 to 0.369, suggest insufficient evidence that the models are inadequate to fit the data. This conclusion is supported by the general similarities between the observed and expected frequencies in each model, as well as the relatively high ratios of concordant to discordant pairs. The summary measures of association (Somers' D, Goodman–Kruskal Gamma, Kendall's Tau-a) range from 0.26 to 0.61, which

¹⁸ Because these are logistic regressions, each of the estimated coefficients represents the log of the odds of an event, where odds are defined as the ratio of the event's probability of occurrence over the probability of nonoccurrence. (The "event" is an unfavorable outcome [e.g., a PUCV increase or breach]). For example, in Table 16, the coefficient of 0.450 for status (military) represents the change in the log of $P(\text{breach})/P(\text{no breach})$ when the PM is military, with other variables held constant. The estimated coefficient of 0.002 for tenure period is the change in the log of $P(\text{breach})/P(\text{no breach})$ with a one-unit (1 month) increase in duration period, with other factors held constant.

Regarding interpretation of odds ratios, those close to one indicate a minimal effect on the dependent variable. In Table 16, the coefficient of -1.244 and odds ratio of 0.29 for commodity "other" may be interpreted as follows: "Other" commodity programs tend to have fewer breaches than other commodities (i.e., the negative sign of the coefficient indicates the event's nonoccurrence), and the odds of "other" programs having a breach are 29% of the odds of the rest of the commodities having a breach.



indicates low to moderate predictive ability. Overall, it cannot be said that any of the models have either low or high predictive qualities.

Regarding the coefficients and odds ratios, the results reflect generally the same conclusions as the linear regressions above. Specifically, the effect of component is mixed, with no evidence that outcomes of Air Force programs are better than those of other components. As for the status variable, outcomes for civilian PMs are statistically better ($p < .05$) than for military PMs in two of the three models. Results for phase and PAUC quartile are mixed.

Finally, as in the OLS regressions, the factor for lag dominates other variables in its levels of significance, its odds ratios, and its contributions to the predictive power of the models. To illustrate, when the logistic regression for BREACH (yes or no) was run again with all variables except lag, the measures of association ranged from only 0.12 to 0.24, indicating this particular model's poor predictive quality.

D. Data Analysis—Conclusions

The null hypotheses may now be revisited in light of the graphical and regression analyses.¹⁹ Recall these were framed as follows: *There is no relationship between program outcomes and*

- *H1₀: duration of PM tenure,*
- *H2₀: PM status, and*
- *H3₀: program component.*

PM Tenure. In only a few regressions was PM tenure found to be significantly related to the outcome. In all regressions, the coefficient was

¹⁹ The author conducted numerous variations on these models and tests, most of which are not presented here. For example, one individual made the suggestion to examine only the best performing programs (or, alternatively, the worst performers). These excursions failed, however, to provide significant results and so are omitted.



determined to be very small, indicating little effect on the outcome for a unit change in duration. Thus, $H1_0$ should not be rejected.

PM Status. Statistical tests indicated that outcomes for programs managed by civilian PMs were better than those managed by military PMs. This difference was not related to tenure, and military PMs' programs had higher complexity than those managed by civilians. Regression results were mixed; several but not most regressions determined a significant positive correlation between favorable outcomes and civilian status. In all regressions, the sign of the coefficient indicated better outcomes with civilian PMs. Overall, however, the mixed results suggest the relationship is weak, and $H2_0$ is not rejected.

Program Component. This hypothesis was based on the presumption that outcomes of Air Force programs would be significantly better than those of other components. In almost no cases, however, was this relationship evident. In fact, outcomes of Army programs tended to be better than those of the other three components. As noted, however, this is tempered by evidence that Army programs tend to be less complex than those of the other components. Accordingly, $H3_0$ is not rejected.

Summary. On the whole, this analysis fails to reject the null hypotheses and thus fails to support the research hypothesis that PM professionalization contributes to improved program outcomes. It cannot be ruled out, then, that the conventional wisdom about PMs and their influence on program outcomes may be entirely wrong, and that the professional attributes of a PM may actually have very little to do with the success or failure of his or her program.



VII. Conclusions and Recommendations

This paper has argued that conventional wisdom portrays PM professionalism as a central factor in the success or failure of a defense acquisition program. It has also presented analysis that fails to support this view. Although such inconclusive analysis may render conclusions and recommendations problematical, it does suggest some meaningful points.

A. Conclusions

Further research is needed. Two possibilities remain: Either PM professionalism makes a significant difference, and the analysis here has failed to detect it, or it does not make a difference. In either case, more analysis with better data and models are needed. This study found no factor, other than a time lag factor, that is correlated with program outcomes. This absence of correlation between outcomes and any of this study's variables, including structural variables like commodity and phase, is unexpected. Clearly, further research is needed in order to enable reasonably reliable predictions of a program's future outcomes.²⁰

A few comments from the expert interviews indicate some alternative factors. Both Preston (2011) and Soloway (2011) suggested that the term "program manager" is a misnomer. Preston noted that defense contractors manage DoD acquisition programs, and DoD PMs manage the contractors. Soloway recalled a conversation with a PM who stated, "We're not doing program management anymore. ... We're managing people, budget, and politics. ... I don't even do what I was really trained to do ... from the technical side of program management." If valid, these comments help explain why the independent variables in this study were poor predictors of program outcomes, since none of the factors to which Preston and

²⁰ For example, Brown's (2011) work in examining program interdependencies might contribute to a better factor than PAUC to represent program complexity.



Soloway refer was included in this analysis. Accounting for these factors in future analysis, however, would entail new challenges, for example, in making them operational in a reasonable model (e.g., how to operationalize an acquisition program's political factors and the PM's involvement in those?) and in obtaining appropriate data. In any event, these interview comments suggest the need for a revised or expanded view of the traditional role of PM.

Other factors outweigh the PM's influence. Scholars of defense acquisition (see, for example, Fox & Miller, 2006; Kronenberg, 1990) have noted the high level of complexity in defense acquisition programs. Several interviewees in this study (Berteau, 2011; Etherton, 2011; Preston, 2011; Soloway, 2011) supported this view, suggesting that the range and influence of "non-PM" factors in MDAPs are large in comparison to PM-related factors. This is consistent with DoD's recent "Big A – little a" construct of acquisition consisting largely of activities that lie beyond the PM's ability to influence, and it helps explain why the best managerial efforts of even the most professional PMs would fail to have significant effects on outcomes.

This explanation is, however, incomplete. It is reasonable to argue that, given sufficient time and resources, good policy and management could be instituted to address even large numbers of factors, assuming they are amenable to policy and management (i.e., well-characterized and relatively stable across time and programs). That this has not occurred implies that these non-PM factors are idiosyncratic and unstable, that is, that every program is unique in the factors that determine its outcomes.

Every program is different. This study has implicitly assumed that MDAPs represent a homogeneous population. Likewise, approaches to PM professionalization assume that programs are sufficiently similar to allow for standardized training and for experiences in one program to be managerially useful in others. It may be argued, however, that all programs vary in their major features (e.g., requirements, technical characteristics, contractors) as well as in the major features of the environment in which they are acquired (e.g., political support,



economic circumstances, industrial capacity). Environmental instabilities cause program instabilities. Because each program faces unique and changing configurations of highly complex issues—whether operational, economic, political, or technological—each program differs in the extent to which it is open or amenable to management throughout its life.

Because the circumstances of each program are complex, unique, and unstable, so too are the reasons for success and failure. Preston (2011) described the MX missile program as follows:

It was deemed as one of the most successful programs that the Air Force had ever had. Why was that? It was because Congress supported the program, [DoD] supported the program, it got all the funding it needed, and the technology was developed in time. ... You could have the best program manager in the world [but] if the contractors can't get the technology breakthroughs that they need [or] if Congress changes its mind halfway through a program and cuts the funding ... you are going to have an unsuccessful program.

If valid, this perspective helps explain the poor predictive power of this study's models.

Past policies inhibit PM professionalism. The earlier background discussion touched on policy-makers' desires to make program management a professional career field that would attract talented candidates for membership. This presumably would entail actions such as establishing a professional body of knowledge, standards for admittance and progression, and a code of professional conduct. Such features would be the "ties that bind" members of the profession together. In attempting to hold PMs accountable for program outcomes, however, policy-makers have diverted PMs' focus away from professional considerations and toward the specific features of their individual programs. To the extent that each program is unique, PMs have little in common upon which to build a professional career field.

These conclusions have major implications for recommendations regarding PMs, as will be discussed in the following section.



B. Recommendations

With over thirty-five years of active service in the DoD, the author has no idealistic expectations regarding the likelihood of promoting and implementing significant changes where PMs are concerned. Nevertheless, with the hope that policy-makers in both the Congress and the DoD might seriously consider them, he offers the following recommendations that follow from the previous discussion.

Revise expectations of PM performance. If PMs indeed can have little to no influence over program outcomes, it is unreasonable to attempt to hold them accountable for those outcomes. Appropriate perspectives are needed as to what a PM can be expected to accomplish, along with criteria for performance evaluations (see, for example, Fox & Miller, 2006, pp. 177–196). The earlier comments by Preston (2011) and Soloway (2011) describing what a PM really manages (e.g., people, budgets, politics, contracts) indicate some possibilities for areas in which the PM could have both responsibility and accountability, for example, administration and leadership of the program management office; quality of budget submissions; oversight of contractual arrangements; and actions to enhance the program's political climate.

Promote shared program ownership and accountability. In the past, policy-makers have treated the PM position as an object for improvement: if the PM's professionalism could be improved, program outcomes would improve. This has the obvious effect of deflecting accountability from its proper place and onto an easy target—the PM. The notion of the PM as the “single point of contact” was exposed earlier as reflecting policy-makers' frustrations with having no one to blame for poor outcomes and, as indicated by the subsequent analysis, it has no correlation with those outcomes. Therefore, if program outcomes are attributable to many participants and stakeholders, policy-makers should seek to promote a shared sense of ownership for those programs, for the sake of both managerial effectiveness and accountability. Ideally, this would expand the extent of communication and collaboration in programs, as well as responsibility for them.



Promote contingency approaches for PM career management. The unique and changing nature of each acquisition program argues against a “one-size-fits-all” approach to managing PMs. It reduces emphasis on minimal qualification standards and elevates emphasis on experiential diversity. One senior career management official related the view that PMs are best prepared for their jobs through a range of diverse educational and practical experiences. This official, who chose to remain anonymous, used the metaphor of a spider web as an illustration that many different strands (career experiences) can lead to the center of the web, which represents a professionally qualified PM.

Selection for PM might be accomplished according to “best fit” rather than “best qualified,” where fit examines the extent of alignment between the unique characteristics of candidate and program, in addition to conformance with some minimal qualification standards. Selection should be accomplished at the level at which that determination of fit is best made.

While the analysis suggested a positive effect on outcomes with civilian PMs, the results were mixed. Thus, there is no strong basis for preferring one status (i.e., military or civilian) over another for PM, though it seems reasonable to ensure representation of both in the program’s management structures. Whether that balance results from a military PM with a civilian deputy or vice versa may likely be determined more by personnel management constraints rather than by any other factors.²¹

Because no significant correlation between PM tenure and outcomes was found, the past emphasis on tenure is misplaced. A contingency approach to PM

²¹ Previous discussion indicated the difficulty in making changes to the military personnel system. Regarding civilians, one senior career management official who chose to remain anonymous noted that the low numbers of civilian PMs was due to low numbers of applicants for those positions, often because civilians do not want to relocate to the locality of the PM’s office. Uniformed officers, in contrast, are inured to frequent moves.



career management would focus, rather, on ensuring that, at any given time, a proper balance of fresh perspectives and continuity is maintained.

Retain decentralized PM career management. The history of policy on PM professionalism reflects tendencies toward centralization (e.g., of policy authority) and standardization (e.g., of qualifications for assignment). In contrast, this paper's analysis and arguments support decentralized management of the PM workforce so as to facilitate contingency approaches, such as "best fit" qualification and assignment criteria.

Decentralized PM career management would not, of course, be inconsistent with the provision of centralized resources to enhance PM professionalism, such as those DoD-wide training, education, and knowledge-sharing resources provided by the DAU.

Eliminate requirements for PM waivers. Waivers militate against "best fit" assignment criteria. Waivers appear to have no functions other than as an accountability measure and to discourage assignment of PMs who do not meet minimum standards. Waiver requirements implicitly call into question the judgment of those who request and approve waivers.

Do not abandon PM professionalization. Finally, this study should not be read as an argument that investments in PM professionalization should not continue. The author has no doubt that PMs have significant influences—sometimes good and sometimes bad—over their programs, only that the traditional ways of viewing those influences are inadequate. The author often states the view that defense acquisition PMs have "the hardest job in the world" and, accordingly, they merit the best preparation possible for that job.



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- Tuition Assistance

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- Diffusion/Variability on Vendor Performance Evaluation
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- PBL (4)
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- Contractor vs. Organic Support
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