Introduction

Conventional cost estimation techniques used to support the acquisition of major weapon systems rely on data and frameworks focused on the inputs used to produce and operate the system—production costs. Consequently, most of the data collected and reported in DoD cost databases is production costs. But transaction cost economics (TCE) suggests that another set of costs—transaction costs (the costs of coordination and motivation), should also be considered in developing a cost estimate. This paper describes research efforts to measure transaction costs in Department of Defense (DoD) acquisition programs.

When DoD purchases a weapon system there are numerous transaction costs associated with source selection, periodic competition and renegotiation, contract negotiation and management, performance measurement and monitoring, and dispute resolutions. The costs are not unique to DoD transactions, but the size and complexity of the programs magnify the costs.

TCE suggests that correctly estimating the production costs of an acquisition program is necessary, but not sufficient. Traditionally, the Work Breakdown Structure (WBS) is the framework for the program cost estimate. A WBS captures the mix of inputs and activities required to produce a specific weapon system and is a product-oriented cost accounting system. The WBS does not explicitly capture transaction costs, although some coordination and motivation costs are included as part of costs captured under program management and systems engineering activities.

Transaction costs such as measurement, monitoring, management and renegotiation costs can overwhelm initial production cost estimates leading to cost overruns. One possible means to improve DoD cost estimation is to add transaction cost considerations to the current production cost focus in cost estimating methods. The first step is to identify and measure transaction costs in DoD acquisitions.

This paper summarizes the results of two research projects conducted by Diana Angelis, John Dillard, Chip Franck and Francois Melese (sponsored by the Acquisition Research Program at the Naval Postgraduate School). The research suggests how transaction costs for DoD acquisitions might be measured and discusses difficulties encountered in using data in DoD cost databases to support the measurement of transaction costs for major weapon systems.
Transaction Cost Economics

Transaction cost economics is a well-developed field of study based on the observation that markets are not frictionless and costless. The nature of the transactions will determine if a good or service is produced internally or externally. A key insight from TCE is that firms should consider both the cost of production and the cost of transactions in evaluating “make-or-buy” decisions.

Transaction costs, including coordination and motivation costs, are part of all contractual arrangements including major weapon systems acquisitions.

Coordination Costs include:

- Search and Information Costs—to identify options and acquire timely, accurate and relevant information to evaluate alternatives;
- Bargaining and Decision Costs—to choose an alternative and negotiate and write a contract; and
- Policing and Enforcement Costs—to make payments and measure, monitor, and evaluate performance.

Motivation Costs include:

- Costs to promote productive effort and incentives to encourage investment (better, faster, cheaper) and
- Costs to deter unproductive bargaining and opportunistic behavior (renegotiation).

Transaction cost economics has promising explanatory power in developing costs estimates for major DoD acquisition projects (Melese, Franck, Angelis, & Dillard, 2007). The transaction costs described above can be a major component of acquisition program cost and should be included in the cost estimating framework and cost reporting databases.

Cost Estimating Framework

The Work Breakdown Structure (WBS) provides a framework for the cost estimate and is the basis for cost reporting. The WBS is a hierarchy of system elements (hardware, software, data, facilities, and services) that contains all the cost elements of the estimate. The Program WBS is used by the Government program manager and contractor to develop and extend a Contract WBS. It contains uniform terminology, definitions, and placement in the input-oriented family tree structure. The contract WBS provides the structure for information contained in the Contractor Cost Data Reporting System and other cost performance reports and is defined by Military Handbook 881A.

While the WBS framework provides an excellent accounting system for cost estimates, it does have a few drawbacks. First, although it does capture the functional relationship between elements, it does not explicitly show the correlation between cost elements. Lack of independence between cost
elements can significantly increase the variability of the cost estimate. Second, the WBS is often product-oriented, not relationship oriented, so it can overlook transaction costs such as search and information costs, decision and contracting costs, monitoring and enforcement costs. It could be argued that these costs are implicitly considered in the cost estimates of various WBS activities, but it is more likely that they are either underestimated or ignored, resulting in overly optimistic cost estimates.

Measuring Transaction Costs in DoD

**Program Management Office Costs**

*(Angelis, Dillard, Franck and Melese, 2007)*

Our initial research efforts were based on the hypothesis that including transaction costs (and the program characteristics correlated to them) can improve cost-estimation methodology by (a) helping to explain the systematic bias observed in initial cost estimates, and (b) increasing the general explanatory power of cost estimations. More specifically, the TCE perspective suggests the traditional WBS approach may overlook two important categories: Coordination Costs and Motivation Costs. Unlike the production function approach of WBS, the TCE approach focuses on these and other key components of major weapon system acquisitions.

The system program office’s functions/activities related to monitoring, controlling, information-gathering, reporting, decision reviews, enforcement, etc., grow as oversight/governance increases with anticipated scale and risk of investments. Though program cost data may exist, it does not tell us the whole story on transaction costs. Ideally, we would want to find total program costs and contract costs. The difference consists of transaction costs (whose main components are coordination and motivation costs).

To test our hypothesis that the traditional WBS approach may overlook some important variables, we would have to compare cost estimates for systems that included significant transaction costs with those of systems that did not include significant transaction costs. The first problem, then, was to find a way to measure transaction costs in acquisition programs.

We proposed using Program Management Office (PMO) costs as a proxy measure of the amount of transaction costs present in an acquisition program. We started by examining information from the Consolidated Acquisition Reporting System (CARS)* to find evidence of transaction costs. The database included information on contract performance and program cost from a variety of reports, such as Selected Acquisition Reports (SAR) and Defense Acquisition

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*Recently, DoD created the Defense Acquisition Management Information Retrieval (DAMIR) system to identify the various data sources that the acquisition community uses to manage acquisition programs and to provide a unified manner through which to present the information. DAMIR components have replaced the need for the legacy Consolidated Acquisition Reporting System (CARS).*
Executive Summaries (DAES), as well as other reports. Unfortunately, these reports do not contain the level of detail necessary to identify transaction costs. Specifically, there was no information on the amount of resources estimated or used for the PMO.

Instead, we looked at the Budget Item Justification sheets in the OSD budget (http://www.defenselink.mil/comptroller/budgetindex.html). While there is some information on PMO costs in these documents, it is reported inconsistently or not at all (depending on the program and year). For example, the Marine Corps Advanced Amphibious Assault Vehicle (AAAV)\(^2\) reported Program Office costs in exhibit R-3 under “Support and Management Organizations” for FY97 and FY98, but discontinued reporting that line-item in subsequent years. Note also that what is included in PMO costs is not a complete picture of the resources used, since military salaries are excluded and civilian salaries may or may not be included depending on how they are funded.

The AAAV reported costs for the more general category “Support and Management” for FY97 – FY06, but the line-items included in this category varied from year to year. If we expand our proxy measure to the “Support and Management” category, we are including, in addition to Program Office costs, other support contracts, miscellaneous contracts and government labs, as well as modeling and simulation. As the program developed, this category grew to include integrated logistics support, training devices and simulators, tech data and publications development and support equipment development. Clearly, this category includes costs that should not be considered transaction costs, such as training devices and simulators and tech data and publications. More importantly, what is and is not included in the category varies over time, making the identification of transaction costs difficult on a case-by-case basis and nearly impossible on a large scale.

A more significant problem we encountered is that the information reported in CARS does not necessarily track to the information reported for the same program in the OSD budget. This problem was confirmed by OUSD(AT&L) Acquisition Resources and Analysis and is an issue they had been working on for several years and had documented in a Comparison Report that identifies potential funding disconnects between the OUSD(Comptroller) Budget Justification Materials and the OUSD(AT&L) Draft Selected Acquisition Reports.

Contributing to the difficulty of identifying program transaction costs is the fact that program managers only report information on a program’s major contracts for RDT&E, procurement, military construction, and acquisition-related operation and maintenance. According to the CARS Users’ Guide, SAR Section 15 (Contract Information) only includes the six largest, currently active contracts (excludes subcontracts) that exceed $40 million in then-year dollars. For a given reporting quarter, these are generally the same contracts reporting in Section 6 (Program Background Data) of the DAES. If a previously reported contract is

\(^2\) The name of this program changed to Expeditionary Fighting Vehicle (EFV) in FY03.
over 90% complete, it will no longer be reported. So, tracking Budget at Completion (BAC) and Estimate at Completion (EAC) at the program level involves moving targets as the individual contracts are completed and drop out of the CARS. Also, the total amount shown for the program in the OSD budget may include other contracts not reported in CARS.

Due to the data difficulties described above, we were unable to test our hypothesis using our selected proxy measure for transaction costs. In fact, it seems measuring transaction costs directly or by proxy from the existing data bases may not be possible.

**Systems Engineering Program Management Costs**  
(*Angelis, Dillard, Franck and Melese, 2008*)

TCE theory suggests that coordination and motivation problems can lead to predictably higher costs when the program is completed. Thus, in this research, we hypothesized that higher program costs are predictable from both the indicators available prior to project start and during the course of the project itself—especially the choice of governance mechanisms. We also hypothesized that higher program costs observed during and after the acquisition project are ex-post indicators of hidden or unanticipated transaction costs. The basic model for TCE variables being a component of costs is summarized in the figure below.

![Figure 1. TEC Issues in Acquisition Projects and Hypothesized Cost Manifestations](image)

Based on the indicators shown in Figure 1, we looked at two components: i) for *Indicators of High Transactions Costs*, we apply the Powell (2002) stoplight scheme (augmented by Frank, 2004), with special emphasis on asset specificity, ii) for *observable manifestations* of cost problems and governance issues *during the program*, we can consult histories of actual programs.

In previous research (Angelis, Dillard, Franck and Melese, 2007) we applied the stoplight scheme to two different acquisition projects: The Advanced Anti-Armor Weapon System—Medium (AAWS-M), later to become the Javelin and
the Army Tactical Missile System (ATACMS). For this study, we focused on ex-post indicators of transactions costs. More specifically, we examined how transaction costs might be captured in examining the outcomes of acquisition programs.

Previously we suggested using the government's Program Management Office (PMO) costs as a proxy measure of the amount of transaction costs present in an acquisition program. Our earlier research revealed that there is insufficient data on PMO costs in DoD databases. Therefore, instead of looking at the government program management office (buyer) costs, for this research we decided to look at the contractor's program management (seller) costs as a proxy for transactions costs. This effort proved to be more successful although extremely time consuming. The source documents for contractor cost were the Cost Data Summary Reports (DD form 1921, CDSR)\(^3\). While there are inconsistencies in reporting program management costs from contract to contract and contractor to contractor, the category itself is reported for every contract, and because it is based on the WBS, the reporting category is consistent within a contract.

Different contractors report program management costs in somewhat different ways. For example, some contractors separate program management into Integrated Logistics Support (ILS) and non-ILS. Some report System Engineering and Program Management as two separate categories, while others report them in one category—Systems Engineering/Program Management (SEPM). These inconsistencies make it difficult but not impossible to compare program management costs across programs.

For this study we used SEPM as the proxy for transactions costs. It is worth noting that Systems Engineering might be more indicative of complexity problems associated with transactions costs, while Program Management might be more indicative of the broader category of coordination costs. Unfortunately, it is not always possible to separate the data into these two categories.

A ratio of SEPM costs to total program cost (per the CDSRs) was calculated for each program. The hypothesis was that a higher ratio could be an ex-post indicator of higher transactions costs. To offer a preliminary test of this hypothesis, we developed two case studies (Javelin and ATACMS)\(^4\).

The research question was whether the ex-post indicator (the SEPM ratio) would be higher for the Javelin than ATACMS. Several ex-post indicators suggested transaction costs might be higher for the Javelin when compared to ATACMS. One was the number of CDSRs filed for each program that reflects “complexity,” namely the number of contracts required to develop and procure the weapon system. There were 20 filed for Javelin and only 9 filed for ATACMS. This was not unexpected, as there were up to three separate sources

\(^3\) Obtained from the Defense Cost and Resource Center (DCARC)

\(^4\) Both cases studies are described in detail in Angelis, Dillard, Franck & Melese (2007).
for the initial Javelin development, while only one source was used for the ATACMS. Clearly, higher transaction costs could be expected for the Javelin.

Another ex-post indicator was the type of contracts used for the programs. The Javelin used mostly Cost Plus contracts, indicating that the parties anticipated more uncertainty (risk) in the transactions. The ATACMS on the other hand used mostly Firm Fixed Price contracts, typical for lower risk and better defined transactions.

As expected, the SEPM indicator for the Javelin was higher than for the ATACMS. The Javelin had an SEPM ratio of .1629 while the ATACMS ratio was .0858. This supports the hypothesis that programs with more complex, risky relationships (as evidenced by the ex-ante indicators) will have higher transaction costs as evidenced by the ex-post SEPM ratio indicator. What was not clear from this research is whether the SEPM ratio reflects management’s efforts to control those transaction costs or if they are merely caused by the riskier relationships.

Conclusion

Our research sought to measure coordination and motivation costs by examining existing DoD cost databases for evidence of program management office (PMO) costs (a proxy measure of transaction costs paid by the buyer) and the contractor’s program management costs (a proxy measure of transaction costs paid by the seller).

Initial efforts revealed that current DoD cost databases do not contain direct measures of transaction costs. We attempted to use the cost of the PMO as a proxy for transaction costs, but the information collected and recorded in DoD cost databases does not support this approach either. Data in Selected Acquisition Reports (SAR) and Defense Acquisition Executive Summaries (DAES) do not contain the level of detail necessary to identify transaction costs. Specifically, there was no information on the amount of resources estimated or used for the PMO.

Contributing to the difficulty of identifying program transaction costs is the fact that program managers only report information on a program’s major contracts at any given point in time, not all contracts. In addition, Budget Item Justification sheets in the OSD budget may contain some information on PMO costs, but it is reported inconsistently or not at all (depending on the program and year).

Turning to the seller’s perspective, we found that it is possible to get an approximate measure of contractor system engineering and program management costs as recorded in the Cost Data Summary Reports. Unfortunately, extracting the information is extremely time consuming and the data is not consistent.

In general, the information collected for cost databases in DoD needs to be standardized. For a given category, the data collected should be consistent over time and across categories. If there are necessary changes in the data
categories, there should be a mapping from the old categories to the new categories. Differences between databases should be reconciled to provide better quality information to decision makers and cost analysts.

Our research suggests that measuring transaction costs in DoD acquisition may improve cost estimating for major weapon systems. Current data collection and reporting practices do not support measuring these costs either directly or indirectly. Measuring and reporting transaction costs may lead to more complete cost estimates and provide DoD with important information about the effectiveness and efficiency of the acquisition process.
References


