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Implementing the Defense Business Operations Fund: The Case of the Military Airlift Command

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PREFACE

The Logistics Management Institute (LMI) prepared this report as part of its Independent Research and Development program. In it, we present an approach for implementing the Defense Business Operations Fund (DBOF) in business areas with multiple, sometimes conflicting, outputs. We also demonstrate the potential of that approach by applying it to the Military Airlift Command (now reorganized as the Air Mobility Command).

Our primary objective in developing this methodology is to give managers of complex Defense business areas a tool to improve the efficiency of their operations without adversely affecting the quality of their peacetime support and readiness to meet national emergencies. We also seek to contribute to the exchange of ideas on implementing DBOF concepts.

The author wishes to acknowledge the cooperation of the Military Airlift Command, especially Bob O'Mara and Mike Nettemeir from the Air Service Industrial Fund, in the conduct of this study; and to thank Tom Heard, John Browne, and others at LMI for their special contributions.

LMI

Executive Summary

IMPLEMENTING THE DEFENSE BUSINESS OPERATIONS FUND: THE CASE OF THE MILITARY AIRLIFT COMMAND

The Department of Defense Comptroller has replaced DoD's industrial and stock funds with a single Defense Business Operations Fund (DBOF). Like the industrial and stock funds, DBOF will be used to establish budgets for the activities providing the services or products; stabilize prices and workloads; and, through the buyer-seller relationship, offer incentives to keep costs low and quality of services high. In addition, the DoD Comptroller will be using DBOF to raise cost-consciousness throughout the DoD by including more costs in customer prices, developing operating-budget constraints for each business activity, and monitoring the cost of those activities more aggressively.

Although the DoD Comptroller has issued general guidelines for implementing DBOF, numerous DoD Components are experiencing difficulty applying them. Many of their problems occur in the definition of business areas and the selection of output measures for those areas. Current DBOF guidelines state that DoD Components can group only activities that provide similar services into business areas. Many Defense activities, however, believe they are being encouraged to form composite business areas whose multiple outputs are represented by a single measure of workload. As an example, the Military Airlift Command (MAC) conducts readiness training of its pilots, loadmasters, and aerial port personnel; transports cargo and passengers; flies special missions; and supports military exercises. And, it employs various workload measures to monitor its performance in carrying out those responsibilities. Nonetheless, MAC's primary business area is now considered readiness training and its single workload measure is readiness flying hours. The use of readiness flying hours, however, ignores the significant contribution that cargo and passenger movements make to MAC's overall cost and performance. It also is leading to major problems in formulating budgets and assessing unit-cost performance, both of which are fundamental to DBOF's success.

In this Independent Research and Development project, we developed an approach for implementing DBOF in business areas that provide a variety of services and employ several workload measures, much like that found in MAC. Our approach consists of several discrete steps:

- Identify, with the aid of correlation analysis, operating areas with inter-related outputs and combine them into a composite business area.
- Develop, using principal components techniques, a single workload index that represents all outputs of the composite business area.
- Prepare an operating budget for the business area using regression analysis, workload index, and costs.
- Construct pricing formulas, using workload shares to allocate the cost of the business area among all customer services.
- Derive, using the cost-workload equation and workload index, unit-cost curves for gauging business area efficiency.

We also assessed the validity of our approach by applying it to MAC's operations. The results were highly encouraging. According to the correlation analysis, MAC has two business areas: readiness training, which consists of cargo and passenger movements and all readiness flights, and special missions. We then developed a workload index and operating budget for the readiness training business area. The latter shows that approximately 40 percent of MAC's costs are fixed regardless of workload, an important finding in a period of decreasing workload. In pricing out MAC's services, we found that our formulas yielded reasonable results: 52.6 cents per cargo-ton mile in FY90 (the actual rate was 52.8 cents) and 11 cents per passenger mile (MAC charged 9 cents). An examination of MAC's unit-cost efficiency shows that since FY87 its workload has decreased by 40 percent, while its average cost has increased by 29 percent.

When we reviewed these results with MAC management, the feedback was highly positive – the two business areas are organizationally logical, the derived prices for its services are representative, and the unit-cost relationship reveals a unique insight into MAC operations. More important, the direct linkage we established between workload, budgets, customer prices, and unit cost is a powerful management tool, one that does not exist today.

We believe that our approach for implementing DBOF in complex business areas is an improvement over current guidelines because it brings together all costs and workloads into a comprehensive framework, which is an essential ingredient for effectively formulating budgets and assessing efficiency. Consequently, we recommend that the DoD Comptroller endorse our approach for implementing DBOF, formally incorporate it into general guidelines, and prepare a detailed implementation guide to aid DoD Components in applying DBOF concepts. We believe that these actions will enhance DBOF implementation throughout DoD.

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IMPLEMENTING THE DEFENSE BUSINESS OPERATIONS FUND: THE CASE OF THE MILITARY AIRLIFT COMMAND

INTRODUCTION

The Department of Defense Comptroller has established the Defense Business Operations Fund (DBOF) to replace two types of revolving funds – industrial funds and stock funds – that DoD Components use to manage some of their operations as businesses.[1] The DBOF and the revolving funds have several similarities: they are both used to formulate budgets, to stabilize customer prices, and through the buyer-seller relationship, to provide incentives to keep costs low and quality of services high. They also have some important differences, as Table 1 shows, with the primary difference being the emphasis that DBOF places on controlling costs.

The DBOF strives to control costs in three ways. First, it is a single revolving fund under control of the DoD Comptroller, not several funds managed by various DoD Components. Second, the receipt of customer orders provides the manager of industrial or stock funds the authority to perform a service and expend funds. In contrast, DBOF publishes a funding document that specifies an "operating budget" for each business area within every providing activity. No DoD Component may exceed any of its operating budgets without prior approval from the DoD Comptroller. (The DoD Comptroller establishes all operating budgets after scrutinizing trends in unit-cost efficiency, evaluating workload forecasts, and formulating cost-cutting goals.) Third, DBOF requires that customer prices reflect full costs. Prices are to be based upon not only direct costs and depreciation of equipment as they were in industrial and stock funds but also depreciation of other assets.[2] Further, unlike the current revolving funds, DBOF requires that customer prices in each business area be raised or lowered in the upcoming budget year to fully

[1]Defense Management Report Decision No. 971, *DoD Financial Systems*, 2 February 1991, established DBOF. According to the DoD Comptroller, the DBOF concept is evolving and, consequently, he has not yet detailed the policy conclusions in a DoD directive.

[2]Although DBOF includes mobilization/surge costs in some customer prices, this practice may not continue. In a recent report submitted to Congress (*Defense Business Operations Fund: Implementation Plan Report*, 1 January 1992), the DoD Comptroller indicated that future prices of peacetime services will exclude readiness costs; those costs will be funded through direct appropriations.

TABLE 1

COMPARISON OF INDUSTRIAL/STOCK FUNDS AND DBOF

Feature	Industrial/stock funds	DBOF
Cash management	Separate treasury accounts for each Military Department and Defense agency	Single fund administered by DoD Comptroller
Spending authority	Obligation authority by function	Operating budgets for each business area
Customer pricing	Direct costs Depreciation of equipment	Direct costs Depreciation of equipment, buildings, facilities, and structures Prior-year profit or loss Unit-cost derivation
DoD Comptroller oversight	Budget formulation; general review of price and workload data Productivity goals Special studies on spending	Budget formulation; detailed review of price and workload data; new reports Unit-cost goals Spending execution monitored quarterly

offset any loss or gain in the current year. The raising of cost-consciousness throughout DoD appears to be the primary purpose of these pricing practices.

IMPLEMENTING DBOF AT DEFENSE ACTIVITIES

The DoD Comptroller considers a DBOF activity to be the lowest industrial-type organization that a DoD Component manages as a single entity. He further defines a business area as "... an aggregation of DBOF activities ... that produce similar products [or services] and are under the management control of the same higher level organization and/or individual."[3]

By defining business areas in this manner, the DoD Comptroller assumes that DBOF activities creating similar products or providing like services would be

[3]DoD Comptroller, *Defense Business Operations Fund Financial Policy*, 27 September 1991.

combined into relatively homogeneous business areas with nearly identical outputs. But that has not been DoD's experience. Many of the DBOF business areas provide a range of products or services, often with dissimilar or conflicting output measures.

In those situations, a DoD Component may choose one of three approaches to implementing DBOF:

- It can use a single output measure to represent the business area's outputs.
- It can subdivide the business area into separate activities with distinct outputs.
- It can develop a composite output measure for the entire business area.

The use of a single output measure for a business area providing dissimilar products or services may seem to answer management's needs. In practice, however, it often results in the selection of a measure that either misrepresents the actual performance of the business area or fails to accurately reflect the full effects of management actions.

While subdividing a business area into uniform DBOF activities may satisfy the requirement for similar output measures, it also could lead to the creation of many small but interrelated business areas. In those situations, a management change to improve the performance of one business area could adversely affect the operation, efficiency, or readiness of another, without the management of either business area knowing the specific nature of the relationship.

The development of a composite output measure for a business area that generates a variety of products and services overcomes the above difficulties. However, it raises several highly challenging technical questions, including:

- How can DoD Components construct composite output measures that accurately represent the totality of a business area's products or services?
- How can DoD Components use composite output measures for developing operating budgets and gauging the efficiency of business areas?
- How can DoD Components use composite output measures to establish prices for the products or services of business areas when those products or services jointly generate costs?

In the following section, we outline an approach for answering these and other technical questions associated with using composite output measures in the implementation of DBOF at Defense activities. We then follow with a detailed description of how the Military Airlift Command (MAC) might apply that approach to implementing DBOF within its business areas. We conclude with a brief discussion of additional applications of composite output measures in other areas of logistics.

AN APPROACH FOR DEVELOPING COMPOSITE OUTPUT MEASURES

For those business areas that provide a variety of products and services, the development of composite output measures is a straightforward exercise comprising four major steps:

- Define discrete business areas.
- Construct a workload index that includes all products and services provided by a business area.
- Develop budgets and measure efficiency using the workload index.
- Establish customer prices by allocating costs to each activity within the business area.

Each DoD Component first needs to define its business areas that are relatively independent of one another. If they are not, then management actions in one area will affect another area's performance. We consider business areas to be discrete if they consist of activities that produce either nearly identical outputs or dissimilar outputs using common processes, equipment, or facilities. Using correlation analysis techniques, we measure the degree to which the workloads and outputs of activities are linked and then group those that are interrelated into one business area.

Although use of a single output measure for such business areas would simplify DBOF implementation, it also may not be appropriate. The DoD Comptroller already recognizes these types of situations: "In some instances it is difficult to define the output and it is necessary to assign a proxy for output."[4] Building upon the Federal Government's success with using indices to describe highly complex situations, we propose that DoD Components construct a workload index for each business area

[4]DoD Comptroller, *Unit Cost Resourcing Guidance*, 15 October 1990.

employing the statistical technique of principal components.[5] That index then serves as a proxy for the business area's overall workload.

Following construction of the workload index, we then propose that DoD Components use that index to develop cost-workload index equations. Those equations have several applications. They can be used to project future operating budgets based upon estimated workloads. They also can be used to gauge the efficiency of a business area by showing how inflation-adjusted or real unit costs vary with changes in workload. For example, if the workload index persistently declines and real unit costs rise, then the capacity of the business area could be too large. In this situation, management may need to reduce capacity.

Finally, when business areas produce diverse outputs jointly and generate costs collectively, DoD Components may find it is difficult to allocate those costs to individual products and services for purposes of establishing customer prices. In the private sector, cost accountants have developed numerous algorithms to price jointly provided customer services. Drawing upon those algorithms, we allocate jointly generated costs to each product or service according to the relative importance that the workload index assigns to them.

We can now apply this approach to the complex business situation of MAC.

APPLYING THE APPROACH TO MILITARY AIRLIFT COMMAND

We begin with a brief description of MAC's operating environment, then we define its business areas. Next, we construct workload indices, develop an operating budget, price MAC's services, and measure its efficiency.

Background

The MAC has three primary missions in peacetime:

- Transport military cargo and DoD personnel
- Train pilots, crews, and aerial port personnel
- Support military exercises and special airlift requirements.

[5]Many Government programs use composite indices. For example, the U.S. Department of Commerce combines diverse economic measures into an index of leading economic indicators to help foretell turning points in overall economic activity. Also, the Bureau of Labor Statistics summarizes the price increases of various retail products in its Consumer Price Index as a means of measuring inflation in the economy.

In transporting military cargo and DoD personnel, MAC uses both regularly scheduled (frequency channel) flights and flights established to satisfy specific airlift requirements (requirement channel). It employs either military or commercial aircraft on all channel flights, with many of its flights moving both cargo and passengers. As Table 2 shows, MAC has three workload measures for its channel operations: cargo-ton miles, passenger miles, and readiness flying hours.

TABLE 2

MAC OPERATIONS AND WORKLOAD

MAC operations	Workload measure
Channel cargo	Cargo-ton miles Readiness flying hours
Channel passenger	Passenger miles Readiness flying hours
Training	Readiness flying hours
Exercises	Readiness flying hours
Special Airlift Assignment Mission	Flying hours

Note: Training includes ferrying of aircraft and other operations.

The training of MAC pilots, crews, and aerial port personnel is frequently accomplished concurrently with the military channel flights. The primary workload measure that MAC uses for its training mission is readiness flying hours.

Since the support that MAC provides to military exercises typically entails an extensive opportunity to train its aircrews and aerial port personnel, readiness flying hours is its workload measure. Special Airlift Assignment Missions (SAAMs) are primarily transportation charters so MAC uses flying hours as its workload measure.

Not only does MAC have several mission responsibilities and four measures of workload, but its readiness flying hours usually are less than the total flying hours required to satisfy its missions. This shortfall occurs because channel flights sometimes cover geographical areas that are inappropriate for readiness training. In this application, we assume that readiness flying hours equate to 80 percent of MAC's total flying hours over a 5-year period, FY86 through FY90.[6]

Defining Business Areas

As noted previously, the business area is key to implementing DBOF. It determines which activities (or operations) are grouped together for purposes of budget formulation, customer pricing, and efficiency reviews. Also, a single manager oversees each business area and is held responsible for meeting DBOF goals.

We begin to define MAC's business areas by categorizing its operations and workloads (from Table 2) into four distinct areas: (1) channel cargo-ton miles, (2) channel passenger miles, (3) readiness flying hours, and (4) SAAM flying hours. Then, we calculate the statistical correlations among the four workloads to determine their interrelationships. Table 3 presents those correlations based upon quarterly workload data from the first quarter of FY86 through the third quarter of FY90.[7] Many statisticians consider a positive association between two variables to be strong if the correlation is 0.6 or higher (on a 0-to-1 scale) and weak if it is below that level. We use the 0.6 correlation threshold to assign related operations to business areas. By so doing, business areas are then separate and distinct entities – an essential beginning point for implementing DBOF.

TABLE 3

CORRELATION MATRIX FOR MAC WORKLOAD

Workload	Channel cargo-ton miles	Channel passenger miles	Readiness flying hours	SAAM flying hours
Channel cargo-ton miles	1.0	0.8	0.6	0.3
Channel passenger miles	0.8	1.0	0.3	0.3
Readiness flying hours	0.6	0.3	1.0	0.0
SAAM flying hours	0.3	0.3	0.0	1.0

[6]Although MAC has used this 80 percent factor in recent years, it does not necessarily apply to all years.

[7]We did not use any MAC workload data from the Persian Gulf War; also, workload data subsequent to the war were not available when we performed this analysis.

According to the 0.6 correlation criterion, we find that MAC has two separate business areas: SAAMs and all others. SAAMs have relatively weak correlations with MAC's other operations (the strongest correlation, 0.3, is with cargo or passenger movements). This finding conforms with the view of MAC management that SAAMs operate virtually as an independent entity. The other business area is defined as a composite of training as well as channel cargo and passenger movements. Table 3 shows that strong associations exist between cargo-ton miles and readiness flying hours (their correlation is 0.6) and between cargo-ton and passenger miles (a correlation of 0.8).[8] The latter correlation arises from the mixing of cargo and passenger movements on some channel flights. These findings also are consistent with MAC's views on its readiness training program.

Having defined the two business areas, we next construct a workload index for each. The workload measure for SAAM (flying hours) is straightforward, but it is more complex for the other business area, and we now address that area.[9]

Constructing Workload Indices

According to the DoD Comptroller, DoD Components are encouraged to use a single workload measure as an output for each DBOF business area. However, MAC's composite business area has three, highly diverse workload dimensions (readiness training, cargo movements, and passenger movements), which may not be accurately represented with a single workload measure. If MAC selects any one of those workload measures as primary, the others – which also generate significant costs – may not be appropriately reflected in projections of operating budgets and in reviews of efficiency. In contrast, a composite measure that incorporates features of all three workloads would be much more meaningful.

[8]Readiness training and passenger movements are not closely associated with one another because commercial aircraft move more than 80 percent of the channel passengers and they (unlike MAC's organic aircraft) are not involved in readiness training.

[9]The derivation of operating budgets, prices, and efficiency measures for the SAAM business area also is straightforward.

Principal components analysis is a statistical procedure that reduces the phenomenon involving many related variables to a single summary variable. The procedures for applying this technique to MAC's composite business area are as follows:[10]

- Transform the different workload variables – readiness flying hours, cargo-ton miles, and passenger miles – into standard normal variables by first expressing them as deviations from their means and then dividing by their respective standard deviations. These steps convert each of the workload variables into pure numbers with a mean of 0 and a variance equal to 1.
- Assign weights to the standard normal variables so that their inherent variances are reflected as much as possible in the composite workload scores. To obtain a solution, constrain the square of the weights in the composite measure so that they sum to unity.

Applying these procedures to the workloads in MAC's composite business area yields the weights shown in Table 4 for the composite workload index. That index consists of each of the normalized workload variables multiplied by their respective weights. Note that cargo-ton miles has the greatest weight in the workload index (0.65), while passenger miles has the next greatest weight (0.57) and readiness flying hours has the lowest (0.50). The composite index captures 70 percent of the workload variances inherent in the three (normalized) variables – a good result for principal components analysis.

TABLE 4

COMPOSITE WORKLOAD WEIGHTS AND COST SHARES

Workload variable	Weight	Share[a] (percent)
Cargo-ton miles	0.65	43
Passengers miles	0.57	32
Readiness flying hours	0.50	25
Total	—	100

[a] Shares are workload weights squared.

[10]We actually use the first principal component as the workload index for MAC's composite business area. For a rigorous mathematical treatment of principal components, see M. G. Kendall and A. Stuart, *The Advance Theory of Statistics*, Volume 3, Griffin, London, 1966.

For illustrative purposes, Figure 1 portrays the resultant composite workload scores in index form. We transformed the third quarter of FY87, MAC's peak workload quarter in the 5-year period, to equal the value 100, and rescaled all other scores accordingly.[11] As Figure 1 shows, MAC's overall workload rose during much of FY86 and FY87, peaking in the third quarter of FY87. Thereafter, MAC's workload plummeted and, by the third quarter of FY90, it was at 60 percent of the FY87 peak level. The management of MAC has indicated that this composite index accurately portrays the workload movements of its readiness training area during this 5-year period.

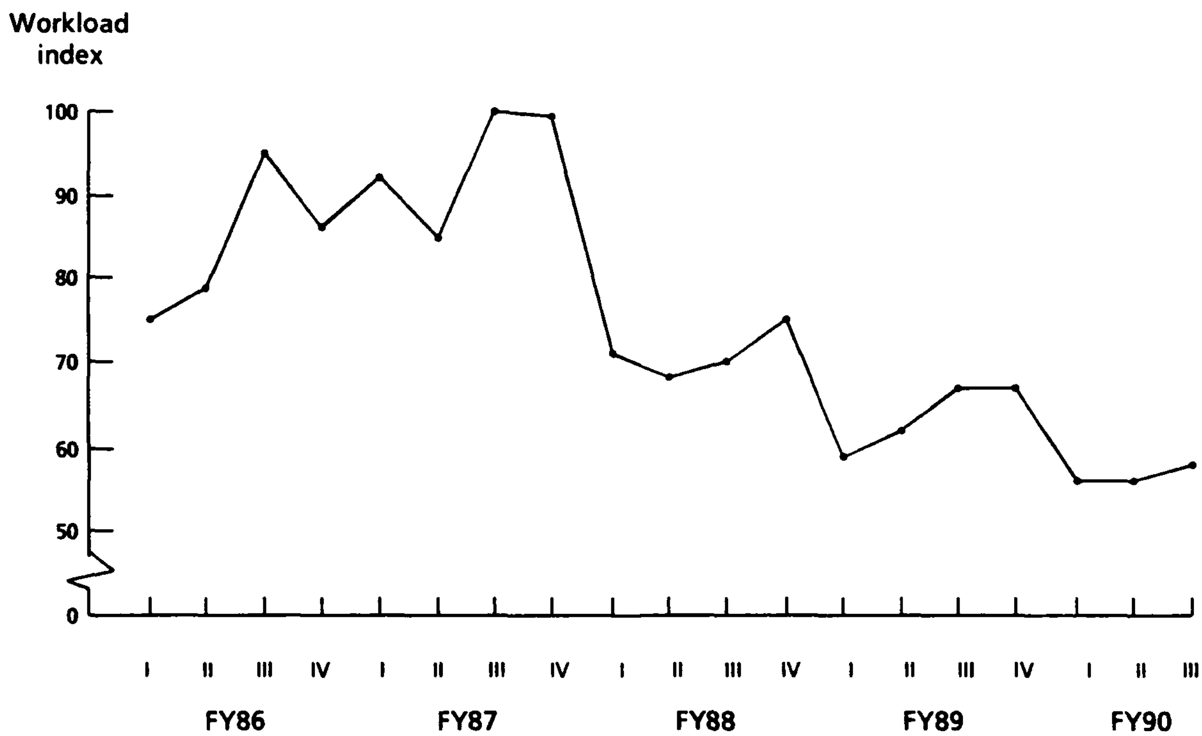

FIG. 1. MAC'S COMPOSITE WORKLOAD INDEX

We now test the utility of the composite workload index for estimating operating budgets, an important DBOF requirement.

[11]See the appendix for a discussion of the methods used to transform the raw scores to index scores and for a presentation of both data series.

Developing Operating Budgets

According to the DoD Comptroller, DoD Components need to define two distinct budgets for each business area: an operating budget and an investment budget.[12] In this application, we focus on developing the operating budget for MAC's composite business area. Specifically, we use the workload index to estimate operating costs.

We begin by examining the historical relationship between MAC's operating costs (adjusted for inflation or real costs) and the composite workload index. Using the method of least-squares regression analysis, we find that the workload index, modified for seasonality, explains much of MAC's quarterly real operating costs. In fact, with the workload index, we can estimate MAC's quarterly operating costs within 6 percent of the actual levels over the 5-year period of available data. (The appendix provides additional details on the regression analysis.)

Table 5 summarizes the effects of workload and seasonality on MAC's operating costs for its readiness training program. An increase of 10 percent in its workload index, for example, increases MAC's costs by 6.1 percent, which signifies that 61 percent of MAC's costs vary with workload. Furthermore, approximately 39 percent of MAC's costs are fixed regardless of workload, as measured by the seasonal constant effects. Thus, the fixed costs associated with MAC's infrastructure and operating capacity are not insignificant. That finding suggests that if MAC's workload continues to decline, MAC may need to adjust its fixed, as well as its variable, costs to efficiently accommodate the reduction.

The DBOF guidance also requires that DoD Components establish customer prices for each business area. Although we have seen that the workload index is useful for establishing operating budgets, it may not, by itself, be useful for pricing customer services.

Pricing Customer Services

We have already found that in its composite business area, MAC generates costs simultaneously for channel cargo, channel passenger, and readiness training, which makes it difficult to price each service individually. Nonetheless, cost accountants have extensive experience in pricing joint services or products, often

[12]These budgets are discussed more fully in DoD Comptroller, *Defense Business Operations Fund Implementation Plan Report*, 1 January 1992.

TABLE 5

COST EFFECTS OF MAC'S BUSINESS FACTORS

Factor	Hypothetical change/level	Cost effect (percent)
Workload	10 percent increase in workload index, comprising readiness flying hours, cargo-ton miles, and passenger miles	6.1 increase
Seasonality	First quarter, constant	41.0
	Second quarter, constant	45.0
	Third quarter, constant	41.4
	Fourth quarter, constant	36.4

with the aid of algorithms for allocating costs. In this application, we allocate the total cost of MAC's composite business area to the individual services on the basis of the workload shares derived during development of the composite workload index.[13] According to those shares, 43 percent of the total cost is assigned to channel cargo, 32 percent to channel passengers, and 25 percent to readiness training. Thus, MAC could use the formulas shown in Table 6 to establish prices for its channel cargo and passenger services. We have data for 5 years, and those data show that MAC billed the cost of readiness training directly to the Operations and Maintenance account; as a result, those costs were not covered by channel cargo and passenger service.

TABLE 6

MAC'S SERVICE PRICING FORMULAS

Service	Pricing formula
Channel cargo	(0.43 × total cost)/cargo-ton mile
Channel passenger	(0.32 × total cost)/passenger mile

Under the pricing formulas in Table 6, MAC's FY90 channel cargo prices would have been 52.6 cents per cargo-ton mile (MAC actually charged 52.8 cents during

[13]The appendix shows that the workload index shares are implied expenditure proportions.

that period) and its FY90 channel passenger prices would have been 11 cents per passenger mile (MAC charged 9 cents per passenger mile in FY90 and 10.7 cents in FY91). The management of MAC indicated that our estimated prices might be higher because they are based upon actual costs, whereas MAC's prices were derived from costs projected 2 years earlier as part of the normal budget cycle.

The DBOF also requires that DoD Components "provide information on their efficiency and effectiveness" in each business area.[14] However, individual customer prices, along with their implied unit costs, are not useful to measure efficiency when the business area performs a variety of workloads. In these types of situations, the unit cost of all workloads needs to be addressed simultaneously in order to assess the efficiency of a business area.

Measuring Efficiency

In MAC's case, it needs to demonstrate unit-cost efficiency for the composite business area of readiness training. To derive measures of that efficiency, we divide the estimated cost-workload equation by the workload index. Figure 2 displays the resultant unit-cost relationship, in which average variable costs are constant and average fixed costs vary inversely with workload. (See the appendix for additional technical details.)

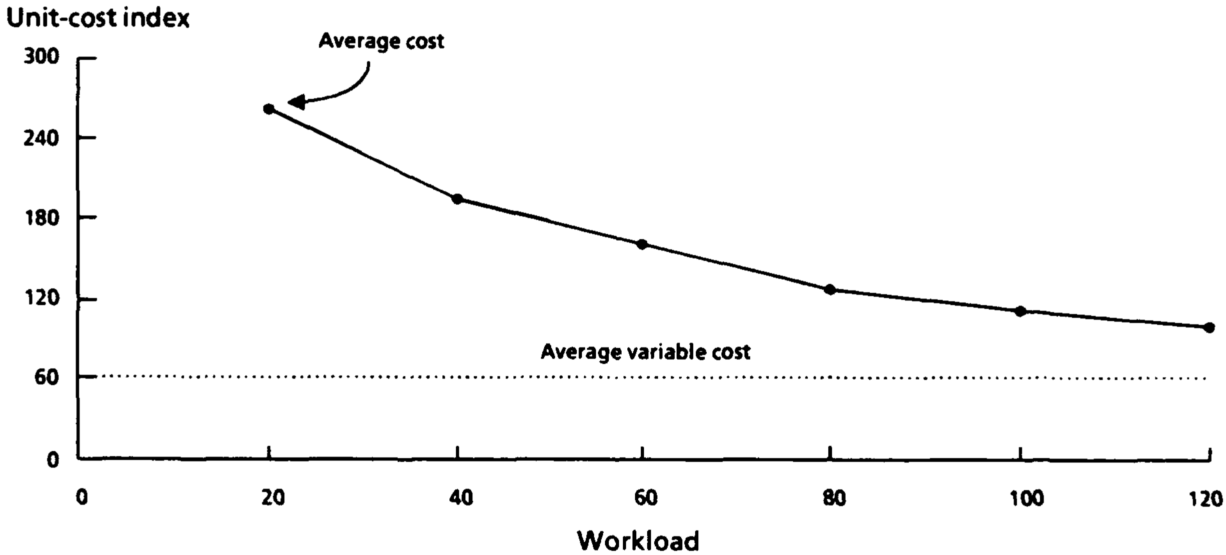

FIG. 2. MAC'S UNIT-COST EFFICIENCY

[14]DoD Comptroller, *Defense Business Operations Fund Implementation Plan Report*, 1 January 1992.

In FY87, when MAC's workload peaked during the 5-year period, MAC attained its lowest average cost (shown at the index value of 100 in Figure 2). By FY90, however, MAC's workload had fallen by more than 40 percent and its average costs had increased by 29 percent. Note that the increase in average costs was entirely attributable to the spreading of fixed costs over fewer workload units (as average variable costs are constant).

SUMMARY

This application shows that our approach for implementing DBOF in complex business areas has considerable merit. We can define meaningful business areas objectively by using statistical techniques. In addition, we can satisfy all current DBOF requirements: develop a single output measure (i.e., the workload index) that adequately represents the products or services of a complex business area, project operating budgets, develop accurate prices for customer services, and measure efficiency.

Our approach consists of several straightforward steps:

- Use correlation analysis to aid in defining business areas. If any operating area's workload has less than a 0.6 correlation with another area's workload, form two business areas. If the correlation is 0.6 or larger, merge them into a composite business area. All business areas constructed in this manner should have a logical organizational basis.
- Use principal components techniques to develop an index that represents a single summary workload for the composite business area. This step also yields the share of the business area's costs that can be attributed to each workload.
- Use regression analysis and the workload index to estimate operating budgets.
- Use workload shares to construct pricing formulas for allocating business area costs among all products and services. Those formulas provide the prices that the business area needs to charge its customers to recover costs.
- Use the cost-workload equation and workload index to derive unit-cost curves for gauging the business area's efficiency.

While some of these steps entail the use of sophisticated statistical techniques, all can be accomplished using personal computers and readily available software.

EXTENDING THE APPLICATION

The use of our approach for implementing DBOF in complex business areas is not limited to MAC. A number of other Defense organizations face similar challenges, including the following:

- *DoD's wholesale supply depots* provide a variety of services, such as receipt, storage, retrieval, and issue, that consume different amounts of resources. Significant differences also exist within those functions. For example, receipt of incoming materiel is less taxing than materiel returns from DoD activities and routine issues are easier to process than high-priority issues. The use of a single workload measure, like the total number of receipts and issues, could satisfy some of the DBOF requirements, but it may not meet the needs of depot managers who are charged with operating efficient depots and staying within assigned budgets.

- *DoD's maintenance depots* perform a wide range of repairs in support of combat vehicles, ships, missiles, aircraft, and ordnance. The extent and complexity of those repairs vary for two primary reasons: first, the uncertainty of what end items and components will enter the depots; and second, once the items enter the depot, the additional uncertainty of what repairs will be needed. The exact repairs required, if any, are typically determined by detailed inspections prior to induction into the depot, and they depend essentially upon age and usage. As a result, a single measure of maintenance and repair workload is not now available to depot managers. For the depot maintenance community to implement DBOF, it needs to develop composite workload measures for a complex business area. Such measures need to incorporate the mix, extent, and quality of repairs.[15]

- *DoD's personal property program* has several workload measures, including number of shipments, number of claims, and timeliness of service, that may be appropriate for DBOF purposes. However, the management of that program has recently launched an initiative to improve the quality of service provided military members. Among the factors that now are being more heavily weighed in evaluating carrier performance (and, therefore, that of the entire program) are timeliness, number and magnitude of damage claims, and accuracy of bills. This emphasis on quality of service has the potential to distort the value of using a traditional measure of workload to assess efficiency primarily because it may lead to a near-term increase in the overall unit-cost of service. In this situation, management needs to develop a composite measure of workload that embraces both the traditional measures and the effects of higher quality service.

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[15]For a discussion of the importance of measuring quality, see DoD Comptroller, *Defense Business Operations Fund Implementation Plan*, 1 March 1992.

In these and other situations, we believe that our approach for implementing DBOF can make a significant contribution to enhancing the overall performance of DoD's industrial-type operations. The index method overcomes the difficulties of using single workload measures when the mix of services changes (such as those routinely faced by DoD's supply and maintenance depots) and when the quality of service is a major consideration (such as in depot maintenance and personal property movements).

NEXT STEPS

Clearly, DBOF has the potential to raise the cost-consciousness of both the providers and users of industrial-type operations throughout the DoD without sacrificing essential peacetime services and wartime readiness. Nonetheless, its implementation is difficult.

The approach we put forth in this report for implementing DBOF in complex business areas shows considerable promise. It groups activities into common business areas and creates a workload index for each area. Then, it uses that index, in concert with current DBOF guidance, to formulate operating budgets, gauge efficiency, and price customer services. In spite of this promise, some DoD Components are reluctant to use the approach because they are unsure whether it fully satisfies the DoD Comptroller's DBOF requirements.

To alleviate that confusion, we recommend that the DoD Comptroller take the following actions:

- Explicitly authorize DoD Components to use this approach in implementing DBOF.
- Incorporate the concepts underlying the approach in guidelines for implementing DBOF.
- Develop a detailed guide on implementing DBOF in Defense activities.

We believe that by acting upon these recommendations, the DoD Comptroller will accelerate the implementation of DBOF throughout the DoD.

APPENDIX

TECHNICAL MATERIAL

This appendix outlines some of the statistical techniques that form the basis of our approach for implementing the Defense Business Operations Fund in complex business areas.

WORKLOAD INDICES

To express the summary workload for the Military Airlift Command's (MAC's) composite business area in more informative terms, we transformed the raw workload index to traditional index values; we set the third quarter of FY87, the peak value, equal to 100. Specifically, we multiplied each raw index value by 10 and added 75.2. Table A-1 shows the results.

TABLE A-1

RAW AND TRANSFORMED WORKLOAD INDICES

Fiscal year: quarter	Raw index	Transformed index
86:1	0.033	75.53
86:2	0.452	79.72
86:3	2.043	95.63
86:4	1.168	86.88
87:1	1.759	92.79
87:2	0.985	85.05
87:3	2.483	100.00
87:4	2.430	99.50
88:1	−0.340	71.80
88:2	−0.663	68.57
88:3	−0.430	70.90
88:4	0.074	75.94
89:1	−1.600	59.22
89:2	−1.314	62.06
89:3	−0.819	67.01
89:4	−0.756	67.64
90:1	−1.888	56.32
90:2	−1.923	55.97
90:3	−1.697	58.23

OPERATING BUDGETS

In using least-squares regression analysis to estimate the relationship between MAC's costs and the workload index, we adjusted all costs for inflation using the Department of Commerce's implicit price deflator for the economy and then expressed them in index form, matching the base period of the workload index (third quarter of FY87). We also incorporated seasonality, expressed as quarterly "dummy" variables, into the regression equation. (None of the nonlinear cost functions examined was statistically significant.)

The resulting regression equation is shown below:

$$\underset{}{\textit{Cost index}} = \underset{(7.04)}{0.61} * \textit{workload index} + \underset{(6.22)}{41.04} * Q1 + \underset{(6.96)}{45.04} * Q2 + \underset{(5.75)}{41.37} * Q3 + \underset{(4.77)}{36.38} * Q4 \qquad \text{[Eq. 1]}$$

where: Qi is the transformed workload index for quarter i and the numbers in parentheses are the t-statistics for the above coefficients.

Note that each coefficient is statistically significant at the 99 percent confidence level.

The following summary statistics apply to Equation 1:

- Adjusted R-square = 0.79 (adjusted for suppression of constant)
- Coefficient of Variation = 5.78 (costs are estimated within 6 percent)
- Durbin-Watson Statistic = 2.6 (positive auto-correlation absent).

CUSTOMER PRICES

In deriving customer prices, we needed to allocate the total cost of MAC's composite business area to each of its workloads. We accomplished this by using the shares implied by the weights in the formulation of the workload index. Note that with principal components, the square of the weights must sum to unity, as Table A-2 shows.

TABLE A-2

COMPOSITE WORKLOAD WEIGHTS AND COST SHARES

Workload variable	Weight	Share[a] (percent)
Cargo-ton miles	0.65	43
Passengers miles	0.57	32
Readiness flying hours	0.50	25
Total	—	100

[a] Shares are weights squared.

To verify that the index shares are expenditure shares, we also derived the implicit shares from Equation 1 (constants deleted):

$$\textit{Cost index} = \textit{constant} + 0.61 * \textit{workload index} \qquad \text{[Eq. 2]}$$

Rewriting Equation 2 in terms of each workload variable, we have:

$$\begin{aligned} \textit{Cost index} = \; & \textit{constant} + 0.61\ (0.65 * \textit{standardized cargo-ton miles} \\ & + 0.57 * \textit{standardized passenger miles} \\ & + 0.50 * \textit{standardized readiness flying hours}) \end{aligned} \qquad \text{[Eq. 3]}$$

Then, if we simplify this equation, the implied expenditure elasticities are 0.40 for cargo (0.61* 0.65); 0.35 for passengers (0.6 * 0.57); and 0.31 for readiness (0.6 * 0.50). Adjusting the sum of the implied expenditure elasticities to unity, we obtained the following implied expenditure shares: 0.38 for cargo, 0.33 for passengers, and 0.29 for readiness. These implied shares from the cost-workload equation are comparable to the shares formed by the workload index in Table A-2. Because the derivation of workload index shares is considered on firmer technical ground than the shares derived from the cost-workload equation, we used the shares from the workload index to allocate total costs and establish customer prices.[1]

UNIT-COST EFFICIENCY

We derived the average costs and average variable costs for MAC's composite business area from the cost-workload equation developed to project operating budgets

[1]For a technical discussion on this point, see J. Johnston, *Econometric Methods,* 2nd Edition, McGraw-Hill Book Company, New York, 1972, pages 329 – 330.

(Equation 2). Again assuming that the third quarter of FY87 equals 100, we divided Equation 1 by the workload index and multiplied both sides of the equation by 100, as shown in Equation 4:

$$\textit{Average cost index} = 100\,[\textit{constant/workload index} + 0.61] \qquad \textbf{[Eq. 4]}$$

The first term, constant/workload index, shows MAC's fixed costs spread over its workload, while the second term, 0.61, shows that the marginal cost per unit and the average variable cost are constant.

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Many DoD Components have had difficulty in implementing the Defense Business Operations Fund (DBOF). The difficulty centers on defining business areas and measuring their outputs in complex situations – e.g., diverse services or products provided jointly at varying quality levels. Using the Military Airlift Command (now reorganized as the Air Mobility Command) as a test case, we have developed a generalized method for overcoming these difficulties and enhancing the implementation of DBOF.

In this report, we present a statistical method for objectively defining complex business areas and capturing their multiple workloads and variations in a composite index. Building upon the composite workload measure, we then develop a cost-workload index equation for the complex business area with which to project its operating budget, assess its overall unit-cost efficiency, and price its individual services. These steps were readily accomplished on a personal computer with commercial software.

We propose that the DoD Comptroller broaden its DBOF guidelines and explicitly authorize DoD Components to use this approach in implementing DBOF.

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