MAXIMIZING REIMBURSEMENT OF INDIRECT COSTS: A MATHEMATICAL PROGRAMMING APPROACH

Daniel E. O'Leary

I. INTRODUCTION

One of the critical financial planning issues for governmental and not for profit organizations is how to maximize their grant revenues. An important part of that process is maximizing the reimbursement of their indirect costs from federal and state government sources.

The federal government permits organizations to obtain reimbursement from the government for implementing its programs under cost reimbursement contracts. Generally, these are contracts where the price received by the contractor is based on the actual costs incurred by the contractor. For example, universities whose faculty obtain grants from the federal government can

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obtain reimbursement for estimates of the indirect costs of supporting that research. Those costs include some items as providing the researcher with an office and other support services. As another example, cities and states can receive reimbursement for the costs that they incur while implementing federal programs.

Typically, the "allocatable" costs are allocated to the departments using a "cost allocation basis." For example, janitorial expenses are a necessary expense and, thus, may be allocated to other departments based on the number of square feet in that department, while personnel department expenses can be allocated to other departments based on the number of people in those departments. Then, based on the total allocations of these expenses a "cost allocation rate" is established for those departments or personnel actually implementing the grants, generally as a percentage of the compensation or as a percentage of total of grant expenses. As an example, universities typically charge the federal government around 25% of compensation dollars received by researchers for reimbursement of such costs, in the grants.

Historically, guidelines for reimbursement for these costs have been found in federal government documents such as *Office of Management and Budget (OMB) A-87* and *Federal Management Circular (FMC) 74-4*. Documents of this type summarize what allocation bases can be used for allocating particular costs, in order to guide these investigations and minimize the possibilities of exploitation of the system.

In particular, the Federal Acquisition Regulation (31.201–4), which became effective in 1984, provides the following explanation about when a cost can be allocated to a Government grant:

> A cost is allocable if it is assignable or chargeable to one or more cost objectives on the basis of relative benefits received or other equitable relationship. Subject to the foregoing, a cost is allocable to a Government contract if it—
>
> (a) Is incurred specifically for the contract;
>
> (b) Benefits both the contract and other work, and can be distributed to them in reasonable proportion to the benefits received; or
>
> (c) Is necessary to the overall operation of the business, although a direct relationship to any particular cost objective cannot be shown.

In the allocations of some costs there may be more than one satisfactory basis on which to allocate the costs. For example, janitorial expenses may be allocated using square feet or number of offices. It is not an easy matter simply to choose the cost that provides the largest reimbursement because there is a cascading of cost allocations from one department to another and there is a "spiderweb" effect, where a change in the allocation in one department changes the allocation in another department. In addition, there may be multiple goals to be met using cost reimbursement monies. However, there has been little research on choosing between different cost allocations. The purpose of this paper is to develop a mathematical programming model that will enable the user to choose the appropriate cost allocation basis as part of the financial planning process.

Since the cost allocation process is subject to periodic audit, it is not possible to change substantially the basis of the cost allocation plan each year to meet the needs of the organization at that point in time. Thus, choosing the initial cost allocation bases is critical. However, changes in cost allocation bases can be made, particularly if they are designed to meet the constraints discussed in paragraphs (a)–(c) of the regulation or there has been a change in the production process.

This paper proceeds as follows: Section II briefly reviews some relevant background material. Section III discusses one of the primary methods currently suggested for allocating costs. Section IV presents a means of choosing between multiple cost allocation methods. Section V discusses the goals associated with the choice of alternative cost allocation methods. Section VI summarizes the paper.

II. COST ALLOCATION PROCESSES: BACKGROUND

Conceptually, departments can be grouped into two different groups: service departments and production departments. Service departments provide support functions to other departments, whereas production departments are responsible for the production of the product or service, and ultimately the requirements of the grant. Examples of service departments include cafeterias, payroll, personnel, and executive officers.

Costs are typically broken into two different groups: direct and indirect costs. Direct costs can be directly traced to a particular production department, whereas indirect costs cannot. As a result, in an effort to attribute all costs to some production department, there is an indirect cost allocation. Typically, indirect costs include the service departments, e.g., janitorial and payroll department costs. Usually for grant purposes, the costs of service departments are allocated to production departments to determine the total costs associated with the production departments. Then the total costs associated with implementing the grant can be determined.

Cost allocation bases are used to allocate service department costs to other departments. Morse et al. (1988) provide a number of examples of typical allocation bases. For example, the attorney's office might be allocated based, for example, on estimated time spent or number of cases handled. In either case, different allocation bases are likely to yield different allocations. Thus, based on the chosen allocation, some departments would receive larger and some smaller allocations of the particular service department costs.

III. METHODS OF ALLOCATING COSTS

There are a number of methods of allocating costs (Morse et al., 1988), e.g., direct allocation and the reciprocal method. Direct allocation ignores any services performed by one department for another. It allocates the costs directly from the service department to the production departments. For example, if only 60% of the square footage in a common area belongs to production departments and 25% of that 60% belongs to a particular department, then 25% of the janitorial expense is allocated to that department.

The reciprocal method, the subject of this paper, allocates costs from service departments to service departments and production departments. Referring to the service departments as S_1 and S_2 and the production departments as P_1 and P_2, as an example, the services may be allocated as in Table 1.

Table 1. Simultaneous Allocation (%) of Costs[a]

Services provided from	*Services provided to*				
	S_1	S_2	P_1	P_2	*Total*
S_1	—	5	40	55	100
S_2	10	—	30	60	100

[a]*Source:* Morse et al. (1988).

This example can be structured as a set of linear equations. Assume that the total direct departmental costs for the service and production departments are \$20,000 for S_1, \$35,000 for S_2, \$150,000 for P_1, and \$90,000 for P_2. Let S_i and P_i, for $i = 1$ or 2, be the variable that represents the total costs at those departments. The equations can be structured as follows:

$$S_1 = 20{,}000 + 0.1S_2$$

$$S_2 = 35{,}000 + 0.05S_1$$

$$P_1 = 150{,}000 + 0.40S_1 + 0.30P_1$$

$$P_2 = 90{,}000 + 0.55S_1 + 0.60S_2$$

This set of equations can then be solved to provide the resultant allocation of service center costs.

IV. EXAMINING MULTIPLE COST ALLOCATION METHODS

In the above example, S_1 provides services to S_2, P_1, and P_2, while S_2 provides services to S_1, P_2, and P_2. In Table 1 it is assumed that there is a unique method of assigning costs and that there is no objective to the cost allocation problem. In general this is not the case. Instead, there are multiple possible bases of allocation and there are multiple goals, including maximizing reimbursement. This section examines the impact of the multiple bases of allocation and other constraints, while the next section examines the goals. Together they provide the structure necessary to solve the problem as a mathematical programming problem.

A. Allocation Bases

Frequently, there will be more than one satisfactory allocation basis for a particular cost. For example, the costs of the personnel department could be allocated based on the number of people, because that is one way to describe the amount of effort that is expended by the personnel department. Alternatively, more of the personnel department effort may be directed toward meeting the requirements of top managers, and thus total salaries may be another method of reflecting effort. As another example, classrooms may be assigned on either the basis of total number of classes in that room or total number of hours of class in that room.

Consider the examples from Table 1 with additional allocation bases to examine, illustrated in Table 2.

This example can be structured as a constraint set for a mixed integer program (e.g., Garfinkel and Nemhauser, 1972). The set of constraints associated with the first service department is as follows (other constraints would be generated in a similar manner): Let S_{ij} be the variable that represents the total cost for department i, under allocation alternative j:

$$S_1 = 20{,}000 + 0.1S_{21} + 0.05S_{22}$$

This constraint is similar to the earlier set of constraints but now reflects two different allocation strategies, denoted S_{21} and S_{22}:

$$S_1 = S_{11} + S_{12}$$

This constraint adds the amounts attributable to each of the allocation strategies into the single variable S_1.

$$S_{1B}\, D_{s_{1,1}} \geq S_{11}$$

The $D_{S_{1,1}}$ is a 0 or 1 variable depending on whether cost allocation strategy 2 or 1 is chosen, respectively. S_{1B} is a known

Table 2. Simultaneous Allocation of Costs (%)—Multiple Methods of Allocation

Services provided from		*Services provided to* S_1	S_2	P_1	P_2	Total
S_1	Method 1	—	5	40	55	100
	Method 2	—	15	35	50	100
S_2	Method 1	10	—	30	60	100
	Method 2	5	—	35	60	100

upper bound on the value of S_1. If strategy 1 is chosen, then $S_{1B}D_{S_{1,1}}$ is a nontight upper bound. However, if strategy 2 is chosen, then $D_{S_{1,1}}$ takes on a 0 value, the bound becomes 0, and thus S_{11} is 0. The following put a bound on S_{12}.

$$S_{1B}D_{S_{1,2}} \geq S_{12}$$

Similar to the discussion immediately above, this constraint aids in the choice between strategies 1 and 2, since only one of this and the previous constraint will have a bound greater than 0. The last constraint is

$$D_{S_{1,1}} + D_{S_{1,2}} = 1$$

When coupled with the following constraints, this constraint ensures that only one of the two cost allocation strategies is followed.

$$D_{S_{1,i}} = 0 \text{ or } 1 \qquad \text{for } i = 1 \text{ or } 2$$

This constraint specifies the two 0-1 variables used to denote that either cost allocation strategy 1 or 2 is used.

B. Constraints on Grant Monies

Further, there may be additional upper-bound constraints associated with reimbursement on grants. This may affect the allocation basis chosen. For example, there may be a reimbursement ceiling for a production department. If there is an upper bound of $UB(P_1)$ on department P_1 for service department costs, then a cost allocation methodology that allocates costs over and above that bound ultimately may be performing a suboptimal allocation. As a result, constraints (bounds) of the sort $UB(P_1) \geq P_1$ can be used to prevent the choice of allocation bases that would result in less than the total reimbursement of service department allocation being provided.

V. GOALS OF COST ALLOCATION

Typically, cost accounting books do not treat the cost allocation problem as a financial planning issue. Instead, they assume that there is only one method of cost allocation. As a result, there are no generally accepted goals of cost allocation for financial planning.

However, there can be a number of different goals of participants in cost allocation reimbursement programs. Likely one of the most frequently desired goals is that of maximizing total reimbursement to the organization. This generally is accomplished by maximizing the service department costs that are allocated to the particular grant-implementing departments or personnel. In terms of the example, this could mean maximizing the allocation to P_1 or P_2.

Another goal that may be used is that of minimizing the deviation from some planned goal revenue to particular departments. This latter goal occurs because of the "fund" nature of the accounting systems of nonprofit organizations such as cities, states, and universities. These organizations have different funds that permit expenditures only for certain departments. Accordingly, those departments are concerned with maximization of the reimbursement to those particular funds. In terms of the example, we could establish deviation variables d_{P1}^- (deviation under the goal for P_1) and d_{P1}^+ (deviation over the goal for P_1) [e.g., Lee (1972) and Zeleny (1982)]. The deviation goals can be built into the model as follows: Assume that the budget of department 1 is B_1. Then the following constraint will include the deviations in the model:

$$P_1 + d_{P1}^- - d_{P1}^+ = B_1$$

The deviations can then become a part of the objective function. In this case the desire might be to minimize d_{P1}^-.

A third goal could be the minimization of costs to a particular department for political reasons. If a particular department is accused of overspending by some outside source, then there may be incentive in the organization to minimize costs allocated to that department in order to minimize political costs. This goal could be established by, e.g., minimize P_1.

In addition, multiple goals could also be used. Priorities could be established on the individual subgoals and then the total set of goals could be aggregated. For example, the goal could be to minimize $C_1P_1 + C_2d_{P1}^+$, where C_i are a set of priorities assigned by the user.

VI. SUMMARY AND EXTENSIONS

Too often the choice of cost allocation bases is not treated as a financial planning problem. This paper has proposed that the impact of choosing between alternative cost allocation goals be investigated, rather than arbitrary choices being made. A mathematical programming model was proposed to accomplish this task. An example was used to illustrate the approach.

This paper elicited first the constraints of the model and then the multiple sets of objectives that could be used. Multiple-criteria objective functions and goal programming were embedded in the approach.

This approach also could be extended to other methods of cost allocation that can be described as a sequence of equations, e.g., the step-down method (e.g., Morse, 1988). Solutions from the two different methods could be compared and the cost allocation approach that best meets the goals could be chosen.

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