

Allocation of Library Funds To Different Departments of a University—An Operational Research Approach

Library governing boards are faced with many administrative questions affecting services offered. Rather than using explicit analysis of such questions, answers are implicitly based on a reluctance to change past practices. This paper describes the operational research approach to the problem of allocation of funds to different departments of a university for purchase of books and journals. A linear programming model is suggested for solving the allocation problem.

INTRODUCTION

UNIVERSITY LIBRARY FUNDS available for purchase of books and periodicals are commonly much less than the demand for such funds by different departments. Each department vigorously asserts its claim for funds to the library. A library administrator confronted with this problem may not realize that the techniques of operational research may be useful in developing a solution. Some questions raised include: What fraction of the yearly budget should be allocated to the purchase of books? To periodicals? How should this be allocated among various disciplines covered by the collection? Which books (or periodicals) within a discipline should be purchased? How and when does one decide to buy a duplicate? How

can one evaluate alternative decision procedures?

This paper discusses only an operational research approach to the allocation of funds to different departments for purchases of books and periodicals. We assume first that the funds available (M) are known in advance.

MATHEMATICAL TECHNIQUE USED FOR RESOURCE ALLOCATION

A linear programming model will be used to find the optimum allocation of funds.

ASSUMPTIONS OF LINEAR PROGRAMMING RELEVANT TO THE MODEL

(a) *Non-negativity*: Funds allocated must occur at a positive level or not at all. Negative levels are not included.

(b) *Linear objective function*: The importance " C_i " of department ' i ' is a measure of the social benefits per unit of amount spent on purchase of books

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and periodicals in that department. The objective function follows the rule of proportionality as regards funds allocated within one department, as well as the role of additivity in determining the total social benefits due to the allocated funds.

The importance of the department (C_i) is expressed as follows:

$$C_i = f(S_i, T_i, O_i) = \left(\frac{S_i + T_i}{2} \right) \times O_i, \text{ where}$$

S_i = importance which society attaches to the work of the department.

T_i = importance which the university gives to the work of the department.

O_i = importance due to the size of the department. This depends on the number of students (undergraduate/postgraduate/research) and the number of parttime/full-time students.

Any mathematical expression relating C_i with S_i , T_i and O_i can be considered. This expression was chosen because it eliminates those variables for which O_i is zero. On the other hand, it does not eliminate those cases for which either 'Si' and/or 'Ti' is zero.

FORMULATION OF FUND ALLOCATION PROBLEM:

- Let: (1) the number of departments (or subjects), for which the funds are to be allocated for purchase of books and periodicals, be 'n';
- (2) the total funds available for purchase of books be 'M';
- (3) the funds allocated for department 'i' be ' X_i ' where $i = 1, 2, 3, \dots, n$;
- (4) the importance of department 'i' be ' C_i ' ($i = 1, 2, 3, \dots, n$);
- (5) the lower limit and the upper limit of funds as furnished by department 'i' be ' L_i ' and ' U_i ';

The general formulation is:

Maximize

$$Z = \sum_{i=1}^n C_i \cdot X_i, \quad (1)$$

$$\text{where } X_i \geq L_i, \quad (2)$$

$$X_i \leq U_i, \quad (3)$$

$$\sum_{i=1}^n X_i \leq M \quad (4)$$

$$\text{and } X_i \geq 0 \quad (5)$$

GROUPED CONSTRAINTS

In actual resource allocation problems there may be other constraints, termed grouped constraints, e.g., the total funds allocated to departments 3 and 4 should not exceed U_{34} , and total of funds allocated to departments 5, 6, and 7 should not be less than L_{567} . The additional constraints will be described as:

$$X_3 + X_4 \leq U_{34}, \text{ and}$$

$$X_5 + X_6 + X_7 \geq L_{567}.$$

An original formulation, after department discussion, might require rethinking and modification of many constraints. In such cases it is essential that the problem be formulated correctly after consultations with the departments and the library administrators. The operational research (O.R.) approach to this problem will help to standardize departmental formulation of book and periodical requirements.

SOLUTION TECHNIQUE

When a number of grouped constraints are present, then the problem can become complex; depending on the number of variables and constraints, a computer may be required to solve the problem.

The most commonly employed and most efficient method for solving this problem is the Simplex Method. For a description of this method see any text on O.R. techniques. In order to use the Simplex Method, the inequality constraints must be converted into equalities. This is done by introducing slack

variables for all inequalities having (\leq) signs. In cases where inequalities are of the type (\geq) then we introduce slack and artificial variables. The introduction of artificial variables complicates and lengthens the computation work.

LOGICAL STEPS FOR CARRYING OUT THE OPERATIONAL RESEARCH PROJECT

1. Design a form for all departments to complete when submitting their estimates for purchase of books and journals. It should be divided into three categories.

(a) Books and journals that the department needs to function effectively (this is the lower limit of funds for the department).

(b) Books and journals that are desirable but not absolutely essential.

(c) Books and journals that the department would like to have if funds are available.

The department should specify the number of copies required for each book. There may be cases when a single copy of a particular book comes under category (a) but additional copies may come under category (b) or even under category (c). The total of (a) and (b) will determine the upper limit of funds required for a department. In some cases category (c) books will also be added for obtaining "U_i."

2. Check that the summation of 'L_i' for all departments does not exceed the available funds or that the summation of 'U_i' for all departments is less than the funds available. In the former case, if minimum funds required exceed funds available, then there is no other alternative (if M cannot be increased), but to ask the departments to cut down their estimates and allocate the minimum possible. In the latter case, the maximum funds required by all the departments can be allocated.

3. Determine the importance 'C_i' of

each department. The following factors should influence C_i:

(a) Social importance of the subjects taught within a department;

(b) Departmental support of other departments;

(c) Importance which the university attaches to the work of the department;

(d) Number of students (fulltime/parttime) in the department (undergraduate, postgraduate, research students);

(e) Number of staff in the department, and the number of staff actively engaged in research and consultant work.

For determination of C_i see Appendix.

4. If there are grouped constraints in the problem then apply the Simplex Method for determining optimum allocation of funds. Otherwise use the following method:

First allocate the lower limit of required funds to all the departments.

Remainder of the funds $\left(M - \sum_{i=1}^n L_i \right)$

will be allocated by selecting that department with the highest C_i and allocating the maximum permissible funds. (Difference between the upper limit and lower limit for this department.)

Pick up the next department from the remaining departments having highest C_i and allocate the maximum permissible funds to this department. Repeat this procedure until the funds are exhausted.

CONCLUDING REMARKS

Allocation problems can be answered by applying operational research techniques. For most libraries, a significant amount of funds are not being used optimally; many journals and books seldom have been read or shortage of copies exist for those books in great demand.

APPENDIX

Determination of C_i : This aspect of the project, always subject to criticism, is difficult, if not impossible, to determine. However, the problem of determining C_i is greatly simplified, if we assume that the society and the university attach equal importance to the work of each department. Even if they are biased in favor of certain departments, then it will be reflected in the size and growth of such departments. So determination of C_i is synonymous to determining O_i —the importance due to the size of a department.

Determination of O_i : For each department compile the information in the given tabular form; the numbers are easy to obtain. To determine the weights for each category, a survey can be conducted. The weights can be assumed as constant. The sum of all the total weights for a depart-

ment is the value of O_i importance due to size for that department.

TABLE 1
FOR DEPARTMENT 'I'

Category	Number	Weight Attached	Total Weight
<u>Fulltime Students</u>			
Undergraduate	Ri	Ui	Ri.Ui
Postgraduate	Pi	Vi	Pi.Vi
Research Student	Di	Wi	Di.Wi
<u>Parttime Students</u>			
Undergraduate	ri	ui	ri.ui
Postgraduate	pi	vi	pi.vi
Research	di	wi	di.wi
<u>Staff Member</u>			
Engaged in teaching	ei	ki	ei.ki
Registered for higher studies	fi	li	fi.li
Engaged in approved consultant work	gi	mi	gi.mi
			Total = O_i

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