

Modelling of Budget Allocation for University Library

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ABSTRACT

This paper suggests a simple approach to solve future budget allocation problems at Universiti Utara Malaysia's library specifically, and with minor justification, all university libraries in general. The general objective of this suggestion is to help the library to allocate its annual budget efficiently whereby the acquisitions budget is distributed to all of its clients in a manner that considers a balance between continuing commitment and new initiatives, a balance between resources to support undergraduate learning and those to support graduate work and research, and a balance between subject disciplines. In order to achieve the goals, the suggested approach starts with the construction of a mathematical model to determine the total amount of its budget that should be allocated to each of its clients. Next, based on the budget allocated to each client, the approach continues with the construction of another mathematical model to determine the budget acquisition distribution for books and journals for each client. Upon determining the amount to be allocated for books and journals, the suggested approach ends with the construction of yet another mathematical model to identify the specific books and journals to be purchased for each client.

Keywords: optimization, analytic hierarchy process, 0-1 integer programming

Introduction

Perpustakaan Sultanah Bahiyah (PSB) as a university library of Universiti Utara Malaysia (UUM) was born when the university itself existed in 1984. PSB is housed in a five-storey building situated in the heart of the campus. It is equipped with the most up-to-date facilities for the use of students and staffs. The 21,170 square meter building has a seating capacity of up to 1,000 persons including discussion and carrel rooms.

PSB provides a wide range of resources in printed and non-printed format to enable students' and staffs' access to a vast collection of information, resources, and learning materials. These include books, periodicals, newspapers, sound and video recordings, special collections, reference collections, and an expanding range of electronic resources such as CD-ROMs, computerized bibliographic databases, electronic journals, internet resources, and online information. At present PSB has more than 215,579 volumes of books and subscribes to over 700 periodical titles and over 2710 periodicals accessible via internet. Moreover, the usage of electronic resources make PSB save a lot of money on the purchase of books and printed periodicals.

Budget officers at PSB manage all matters regarding financial aspects. These officers deal with the financial transaction such as buying books and journals. The purchasing of materials is usually done if there are any requests by faculty members. For the purchase of books, the faculty members usually will

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list down all the needed books and submit the list to PSB. Most of the books are granted for purchasing unless they are out of stock, out of print or market restricted.

Meanwhile, for the purchase of printed or electronic journals, the list of journals that have been suggested by the faculty members will be brought first into the Committee of Faculty Management (JKPF) meeting for the approval. The journals are then chosen and renewed based on the needs and the demands as approved by JKPF. If there is no demand to renew any subscribed printed or electronic journals, they will then be terminated.

So far PSB manages to fulfill all requests since the annual budget allocated by UUM management to PSB is more than sufficient. However the UUM management has indicated that in the near future the budget will be reduced. When the time comes, competing demand for resources among faculties and departments will be an issue to be resolved. Furthermore the increasing of renewal cost on electronic journal and purchasing of books will make the budget becomes tighter. Thus PSB surely cannot afford the system that it is currently practicing. An impromptu plan of expenditure and improper expenditure planning will lead to over budgeting. Therefore, a fair budget allocation will be of great importance since a large amount of money can be saved if the available resources are employed efficiently, or wasted if not.

Research Objectives

The general goal of this study was to help PSB allocate its annual budget efficiently. The acquisitions budget would be distributed in a manner, which aims to balance the collection needs of all UUM's library clients:

- i. a balance between continuing commitment and new initiatives,
- ii. a balance between resources to support undergraduate learning and those to support graduate work and research, and
- iii. a balance between subject disciplines.

In order to achieve the goal, the specific objectives of the study were to firstly, construct a mathematical model to determine the total amount of PSB's budget that should be allocated to each faculty and secondly, construct a mathematical model for faculty's budget allocation in terms of acquisition of books and journals. The model must satisfy the budget allocated for every faculty and at the same time avoid overspending on the purchasing of materials.

Significance of the Study

This study provided a new budget allocation model to ensure that PSB has a better plan in the cost allocation and expenditure according to the future competing needs of faculties. The model built would help PSB to decide in prioritizing decision-making process according to required criteria.

Scope and Assumption

This study only discussed and proposed how PSB should manage the budget for books and journals. Books include all sorts of books, monographs, and audio visual materials while journals include printed journals, magazines, e-journal, e-reference, digital collection, online databases and ebooks. The expenses incurred on renovation, furniture, computer hardware and software, salary for staff, maintenance and other contingencies were not considered and assumed to be directly under the UUM Bursary Department.

Literature Review

According to Emojorho (2004), to ensure effective financial management and to avoid uncertainty or waste of financial resources, budgets and budgeting become vital. Within any large organization such as a university library, there will always be competing demands for resources. A key problem faced by such a library when funds are inadequate is to provide a fair basis of allocating these funds to the library units. In the past, smaller libraries have tended to have librarian allocate, or simply spend until the budget has all been committed; larger libraries have tended to employ client committees, or simply follow past practices (Clayton, 2001). However formula-based allocation has become increasingly popular. In these approaches the allocation is determined proportionally based on several factors such as the number of instructional units, degrees granted and the number of full time employees (Arora & Klabjan, 2002). Furthermore, Clayton (2001) stresses that a formula based budget allocation formula developed should take into account local factors which are important. The formula should also include as many relevant factors as possible so as to minimize inequity.

Several factors play an important role in the acquisition allocation operation. These include (1) the number of faculty and rank, (2) the size of students or size of student credit hours, (3) the cost of library material, (4) usage of periodicals (5) the number of degree awarded, (6) the circulation statistics and (7) number of staff. Many ensuing studies depicted in the literature have witnessed the increased use of these factors in the past few years (Crotts, 1999; Wise & Perushek, 1996, 2000; Promis, 1996; Arora & Klabjan, 2002; Kao et al., 2003; Wardiah, 2005 and Sudarsan, 2006). They have indeed shown a meaningful contribution to the enhancement of library management. Although the decision with respect to the acquisition budget allocation also involves many other issues such as priorities, strategic plans, and programs, it is believed that the suitable material utilization should be considered also.

Approaches for library budget allocation

Modeling of budget allocation has become increasingly popular – as is now evidenced by a large literature on the topic (Goyal, 1973; Cole, 1976; Wu, 2003; Kao et al., 2003; Wise and Perushek, (1996, 2000); and Sudarsan, 2006). The methods used to support the decision of the acquisition budget allocation operation mostly include statistics-based models (Anderson, Sweeney and Williams, 1994; Schad, 1978; Wu, 2003), goal-programming-based paradigms (Wise and Perushek, 1996, 2000; and linear programming models (Goyal, 1973; Cole, 1976; Wardiah, 2005).

Statistics approached such as forecasting and data mining requires a lot of data keeping and data collection processes which may not be favourable by the implementers. On the other hand, according to Wise and Perushek (1996), although linear goal programming solves for the optimal solution, in some instances the result may not be acceptable. A solution providing zero allocation to a particular subject category would likely be unsatisfactory and would necessitate appropriate changes in the model. Thus, it seems that the approach taken by Wardiah (2005) in particular is the better alternative due to its simplicity and steadiness.

In her study, Wardiah proposed Analytic Hierarchy Process (AHP), linear and integer programming methods to allocate the UiTM Perlis Library budget for academic departments. The objective of this study was to minimize regrets (how many books that could not be purchased) and to minimize deviations from each department's budget allocation target. AHP method was used to find the weight as a coefficient in linear equation for student's population, books, journals, magazines, departments and book selection based on faculty demand. In obtaining more accurate weights, the averages of three respondents were considered. The result showed the annual budget that should be allocated to each faculty and how many books and periodicals that should be bought from the request. The combination of these two approaches (AHP and optimization) shows a great deal of promise for improving our intended model development.

The Proposed Model

There are innumerable ways to allocate money in an academic library system. The purpose of an allocation formula is to ensure that money is distributed effectively to each faculty, yet it must account for certain inevitable inequalities between faculties. In order to achieve the goal, based on the model proposed by Wardiah, we improved and enhanced the model by introducing three new sub models which serve different purposes. The three models are, (1) the budget allocation for faculty, (2) the budget allocation for materials such as books and journals within the faculty and finally (3) the total budget of materials for faculty.

Model 1 - The budget allocation for faculty

The model developed is a linear mathematical model. The factors in this model were identified from previous literature. We however also included local factors believed to give significant contribution to the model. The factors are (a) number of faculty members (academic staff), (b) undergraduate students population, (c) number of postgraduate students population in faculty, (d) average age of programs, (e) number of programs in faculty, (f) number of service course slots offered and (g) number of distance learning students.

The AHP method were used to determine the priorities for each factor based on the preference scale. The weights were determined by the respondents that represent the top management of UUM such as the Vice Chancellor, Deputy Vice Chancellors, Registrar, Faculty Deans, Head of Librarian and some selected lecturers of UUM.

The budget allocation model for faculty is given below:

$$Total\ Budget = \sum_{i=1}^{13} X_i \left[W_a \left(\frac{S_{u_i}}{S_{ut}} \right) + W_b \left(\frac{S_{p_i}}{S_{pt}} \right) + W_c \left(\frac{L_i}{L_t} \right) + W_d \left(\frac{A_i}{A_t} \right) + W_e \left(\frac{P_i}{P_t} \right) + W_f \left(\frac{C_i}{C_t} \right) + W_g \left(\frac{D_i}{D_t} \right) \right] \quad (1)$$

where;

- X_i = budget allocation for faculty i
- W_i = weight for factor i , $i = a, b, c, d, e, f, g$
- S_{u_i} = number of undergraduate student in faculty i
- S_{ut} = total number of undergraduate student
- S_{p_i} = number of postgraduate student in faculty i
- S_{pt} = total number of postgraduate student
- L_i = number of academic staff in faculty i
- L_t = total number of academic staff in UUM
- A_i = average age of program in faculty i
- A_t = average age of program in UUM
- P_i = total number of program in faculty i
- P_t = total number of program in UUM
- C_i = total number of service course slot in faculty i
- C_t = total number of service course slot in UUM
- D_i = number of distance learning student in faculty i
- D_t = total number of distance learning student in UUM
- i = faculty, 1, 2, 3, ... , 13

Model 2 - The budget allocation of materials for faculty

After considering the budget allocation for faculty, the model for budget allocation of materials (books and journals) was developed. In order to develop the model, the weight preferences of books, printed journal and electronic journal were obtained from selected identified respondents including the faculty academic deputy dean, head of departments and faculty library representative.

The model is as given below:

$$\sum_{i=1}^3 \alpha_{ij} X_{ij}, \quad \forall j \quad (2)$$

where;

α_{ij} = weight for material i and faculty j

X_{ij} = budget allocated for material i and faculty j

X_j = total budget allocated for each faculty j

$i = 1$ (books), 2 (printed journals) and 3 (electronic journals)

$j = 1$ (Faculty of Economics), 2 (Faculty of Finance and Banking), 3 (Faculty of Communication and Modern Languages), 4 (Faculty of Human and Social Development), 5 (Faculty of International Studies), 6 (Faculty of Public Management and Law), 7 (Faculty of Tourism Management and Hospitality), 8 (Faculty of Business Management), 9 (Faculty of Management of Technology), 10 (Faculty of Accountancy) 11 (Faculty of Cognitive Sciences and Education), 12 (Faculty of Quantitative Science) and 13 (Faculty of Information Technology)

Model 3 - The total budget of materials for faculty

After obtaining the amount allocated for each faculty, the faculty could then decide on the purchase of books and journals relevant to the faculty. For the purpose, the following 0-1 ILP model was developed.

$$X_{ij} = \begin{cases} 1 & \text{if material type } i \text{ in type } j \text{ is bought} \\ 0 & \text{otherwise} \end{cases}$$

Objective Function:

$$\text{Max} \quad \sum_{i=1}^3 \sum_{j=1}^n \beta C_{ij} X_{ij} \quad (3)$$

Subject to:

$$\sum_{j=1}^n C_{1j} X_{1j} \leq Y_1 \quad (\text{books}) \quad (4)$$

$$\sum_{j=1}^n C_{2j} X_{2j} \leq Y_2 \quad (\text{printed journals}) \quad (5)$$

$$\sum_{j=1}^n C_{3j} X_{3j} \leq Y_3 \quad (\text{electronic journals}) \quad (6)$$

where;

β = weight for each book and journal

C_{ij} = cost for material i and type j

Y_i = total budget of materials type i

$i = 1$ (book), 2 (printed journal), 3 (electronic journal)

Therefore, the model's objective is to maximize the purchases subjected to budget allocated for books and journals. The weights for books and journals and the amount allocated for books and journals were again determined by the faculty members with the help of AHP.

Results and Discussion

Model 1 below represents the portion of budget for the thirteen faculties in UUM.

Model 1:

$$\begin{aligned} \text{Total Budget} = & 0.0475X_1 + 0.0924X_2 + 0.0498X_3 + 0.1303X_4 + 0.0345X_5 + 0.0843X_6 \\ & + 0.2010X_7 + 0.0662X_8 + 0.0330X_9 + 0.0381X_{10} + 0.0755X_{11} + 0.0890X_{12} \\ & + 0.0583X_{13} \end{aligned} \quad (7)$$

The model coefficient refers to weight or portion of money that will be allocated to each faculty. The higher value means the higher budget will be allocated to the faculty. By referring to the model of budget allocation for PSB, the highest value of the weight goes to the Faculty of Business Management. The second highest value of the weight goes to the Faculty of Public Management and Law and followed by Faculty of Communication and Modern Languages.

Meanwhile, model 2 gives the formulation for the amount to be distributed to books, printed journals and electronic journals for each faculty.

Model 2:

$$0.40X_{1,1} + 0.30X_{1,2} + 0.30X_{1,3} = X_{1T} \quad (8)$$

$$0.43X_{2,1} + 0.19X_{2,2} + 0.38X_{2,3} = X_{2T} \quad (9)$$

$$0.27X_{3,1} + 0.19X_{3,2} + 0.54X_{3,3} = X_{3T} \quad (10)$$

$$0.53X_{4,1} + 0.21X_{4,2} + 0.26X_{4,3} = X_{4T} \quad (11)$$

$$0.50X_{5,1} + 0.20X_{5,2} + 0.30X_{5,3} = X_{5T} \quad (12)$$

$$0.53X_{6,1} + 0.23X_{6,2} + 0.24X_{6,3} = X_{6T} \quad (13)$$

$$0.50X_{7,1} + 0.30X_{7,2} + 0.20X_{7,3} = X_{7T} \quad (14)$$

$$0.44X_{8,1} + 0.13X_{8,2} + 0.43X_{8,3} = X_{8T} \quad (15)$$

$$0.37X_{9,1} + 0.19X_{9,2} + 0.44X_{9,3} = X_{9T} \quad (16)$$

$$0.36X_{10,1} + 0.27X_{10,2} + 0.37X_{10,3} = X_{10T} \quad (17)$$

$$0.46X_{11,1} + 0.20X_{11,2} + 0.34X_{11,3} = X_{11T} \quad (18)$$

$$0.50X_{12,1} + 0.17X_{12,2} + 0.33X_{12,3} = X_{12T} \quad (19)$$

$$0.53X_{13,1} + 0.15X_{13,2} + 0.32X_{13,3} = X_{13T} \quad (20)$$

Collectively, the average weight for books is 0.45, printed journal is 0.21 and electronic journal is 0.34. It is most likely that most of the respondents chose books as their main reference for teaching and doing research. Between the two journals, respondents seemed to prefer electronic journals more. The values of weights for books and journals were then used in the next model, model 3.

As an illustration, the following is the 0-1 ILP model for the Faculty of Quantitative Sciences.

Model 3:

$$X_{ij} = \begin{cases} 1 & \text{if material type } i \text{ in type } j \text{ is bought} \\ 0 & \text{otherwise} \end{cases}$$

Objective Function:

$$\text{Max} \quad \sum_{i=1}^3 \sum_{j=1}^n 0.50C_{ij}X_{ij} + 0.17C_{ij}X_{ij} + 0.33C_{ij}X_{ij} \quad (21)$$

Subject to:

$$\sum_{j=1}^n C_{1j}X_{1j} \leq Y_1 \quad (\text{books})$$

$$\sum_{j=1}^n C_{2j}X_{2j} \leq Y_2 \quad (\text{printed journals})$$

$$\sum_{j=1}^n C_{3j}X_{3j} \leq Y_3 \quad (\text{electronic journals})$$

where;

C_{ij} = cost for material j and type i

Y_i = total budget of materials type i

$i = 1(\text{book}), 2(\text{printed journal}), 3(\text{electronic journal})$

Conclusion

This paper suggests a simple approach to solve future budget allocation problems at Universiti Utara Malaysia’s library specifically, and with minor justification, all university libraries in general. The general objective of this suggestion is to help the library to allocate its annual budget efficiently whereby the acquisitions budget is distributed to all of its clients in a manner that considers a balance between continuing commitment and new initiatives, a balance between resources to support undergraduate learning and those to support graduate work and research, and a balance between subject disciplines. In order to achieve the goals, the suggested approach starts with the construction of a mathematical model to determine the total amount of its budget that should be allocated to each of its clients. Next, based on the budget allocated to each client, the approach continues with the construction of another mathematical model to determine the budget acquisition distribution for books and journals for each client. Upon determining the amount to be allocated for books and journals, the suggested approach ends with the construction of yet another mathematical model to identify the specific books and journals to be purchased for each client. The proposed approach was based on the original model done by Wardiah (2005) by including more factors as suggested by various other previous researchers and Clayton (2001). Although the approach shows promise and does not require complicated computations and models, the results obtained depend on the particular group of decision makers. As we are all aware, leaderships in universities change often, thus the results and budget distribution may be affected as well.

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