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Optimization on the Budgeting Allocation with Goal Programming in Departmen Mathematic Education Universitas HKBP Nommensen

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ABSTRACT

The purpose of this research is to maximize the use of funds at the Universitas HKBP Nommensen Faculty of Training and Educational Sciences, a higher education establishment. This study intends to educate the general public on the use of goal programming challenges in achieving organizational goals, both financially and non-financially. Between 2020 and 2022, information on this faculty's budget estimates was gathered from the faculty budget. Five objectives were taken into consideration for the study in the following order of priority: personal costs, overhead costs, capital expenditures, revenue (internally generated), and the total budget from the university's budget estimates. The information gathered was utilized to create a goal programming problem, which was then addressed using the Simplex approach (using LINGO software). The optimum value of Z (Z=4.24) was found to achieve goal 1 (the personal cost goal), goal 3 (the capital expenditure goal), and goal 5 (the overall budget goal) based on the solution provided. However, it failed to satisfy goals 2 and 4, which are the goals for overhead costs and revenue, respectively. Based on the results, it was determined that in order to meet targets 2 and 4, which are related to overhead costs and revenue, respectively, the Department Mathematic Education Universitas HKBP Nommensen, needed to come within 4.24 billion Rupiah. It was also suggested that the University have an annual budget review with a minimum of 4.24 billion Rupiah in 2010 and that this review be done in a timely and appropriate manner, under the supervision of an active government budget monitoring team.

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1. INTRODUCTION

Improving the quality of education is not an easy thing, because it is not just about technical issues, but it covers a variety of complex issues, both related to the planning, funding, efficiency and effectiveness of the maintenance of the education system.To create quality education, a comprehensive and professional management of the resources available in the university is required. One of the resources that needs to be managed well in college is financial issues. In this context, finance is a vital source of funding for the university to carry out its day-to-day operational activities. A college must be able to guarantee the availability

of funds to support the practice of the tri dharma and the continuous improvement of the quality of the college. The efforts undertaken by the college in fundraising must refer to the vision, mission, character of the college as a legal institution that is not oriented towards profit/profit and does not violate the provisions of the applicable laws [1]

Private colleges are in danger of bankruptcy quite a lot. It's caused by a variety of things, one of which is untransparent and accountable financial management. Transparency and accountability must always be pursued in the financial management system by adhering to the principles of accounting including in the implementation of internal and external audits established at the college. A sound, transparent and accountable financial management is the main goal of the college. But the principle of transparency in financial management poses particular difficulties for a college. This is because it is often not in line with the budget that has been made with the operational activities of colleges that tend to be flexible. [2]

Budget allocation planning is a complex task that requires cooperation between several functional units at the University Environment. The ability in the organization's funding process to allocate the budget effectively and efficiently is essential. Despite the fact that the allocation exists at the University, it is not well structured because of some contradictory purposes [3]. A formal decision analysis capable of dealing with several conflicting objectives through the use of priorities is the Goal Programming Model. Goal programming is an extension of a linear program model that is a mathematical tool to deal with a variety of objectives that are usually conflicting. Under such conditions, it will be difficult to find a solution that can optimize conflicting objectives. Therefore, the Goal Programming model provides solutions to solve problems with conflicting objectives at the same time as existing constraints.[4]

[5] Goal Programming is a tool that has been proposed as a model and approach to the analysis of problems involving conflicting objectives. He pointed out that real-world problems always involve non-deterministic systems for conflicting issues and inconsistent with existing purposes. The main advantage of Goal Programming is its simplicity in application and ease of implementation. So, the application of Goal Programming is widely used in various fields in particular for solid waste management, accounting and financial aspects of stock management marketing, quality control, human resources, production, transportation and site selection, space studies, agriculture, telecommunications, forestry and aviation [6]. Furthermore, from existing capacity constraints, variables often emerge from uncertainty over budget, the goal programming model is able to maintain a re-planned budget by compensating for shortcomings. [7,8]

In the university funding planning process, the possible issue is First, capital and income are inadequately allocated, and without a sequence of interests. This inadequate allocation is because it does not use a strong quantitative allocation model. Second, it appears that allocated funds are not used as they should, often there is a redirection of funds use. Third, there is no active budget monitoring team so the budget is left to operate anyway. If there is an active budget surveillance team, the problem of mismanagement and improper use will be reduced. So, on this proposal will be studied how decision-making in institutions in achieving the objective of optimum utilization of funds in improvement of institutions, provide an overview related to the forecast of the budget each year and create a model of optimization of the use of budgets.

2. RESEARCH METHOD

In this study, the financial statement in the annual report of Mathematic education department from year 2019 to 2022 is investigated. A goal programming model is developed to optimize the budgeting allocation in order to achieve multiple goals. The objective of the research is to create an allocation model of the university's budget with the Goal Programming model and to make an optimal allocation of the budget with existing constraints and objectives in accordance with the requirements of the institution.

2.1 Goal Programming Formulation

The formulation for the goal programming model is as shown below

$$\text{Min } Z = \sum_{i=1}^{m}[(d_i^+ + d_i^-)] \quad (1)$$

Subject to

$$\sum_{j=1}^{m}(a_{ij}x_j - d_i^+ + d_i^-) = g_i \quad (2)$$

$$d_i^+, \ d_i^- \geq 0$$

where p_i is the pre-emptive factor associated with each competitive goal in order of preference, x_j is the decision variable for j = 1,2,3,…,m. a_{ij} ij a represents the parameter of the decision variables, d_i^- represents the negative deviation variable from underachieving ith goal, d_i^+ represents the positive deviation variable from overachieving ith goal, and g_i represents the target value or aspiration level for ith goal [9].

2.2 Goal Programming Algorithm

For solving goal programming problems, there are two algorithms. They are weights method and preemptive method. In This research preemptive method is used. The model is then optimized using one goal at a time such that the optimum value of a higher priority goal is never degraded by a lower priority goal. The preemptive model is given as

$$\text{Min } Z = \sum_{i=1}^{m}[P_i\,(d_i^+ + d_i^-)] \quad (3)$$

Subject to

$$\sum_{j=1}^{m}(a_{ij}x_j - d_i^+ + d_i^-) = g_i \quad (4)$$

$$d_i^+, \qquad d_i^- \geq 0$$

where pi is the preemptive factor/priority level assigned to each relative goal in rank order (that is $p_1 > p_2 > \ldots >$ pn). The variable used in this study is the variable amount of total budget per year and optimal income as a bound variable, while the impediment as a free variable. [10]

Data analysis in this study is carried out through stages based on the Goal Programming model: Determining the Variable Decision Making, specification of the objectives and objectives to be achieved, Sorting the priority level of objectives, Determine the relative weight, Set the minimum level of departure of the function objectives, Set the requirement of the institution as the function boundary of the purpose, Modeling the function of the goal in accordance with the preference of priority objectives.

3. RESULT AND ANALYSIS

Summary Of the Budget Estimates Over The Three Years (2019 – 2021) Table 1 gives the budget estimates summary of the Department over the period from 2019-2021, showing the personnel cost, overhead cost, capital expenditure and revenue (Internally Generated).

Table 1. Budget Estimates for three years

Item (Goal)	Tahun (dalam Milyar)			Total
	2019	2020	2021	
Personel Cost	1,19	1,57	1,67	4,43
Unforseen Expenses	0,31	0,43	0,6	1,34
Capital Expenditure	0,86	1,02	0,8	2,68
Revenue	0,32	0,53	0,73	1,58
Maximum total budget	2,68	3,55	3,8	10,3
Total	5,36	7,1	7,6	20,06

In this study, the priority of the goals is set as follows. P1 = First priority goal to maximize total asset P2 = Second priority goal to minimize total liabilities P3 = Third priority goal to maximize total equity P4 = Forth priority goal to maximize profitability P5 = Fifth priority goal to maximize earning P6 = Sixth priority goal to maximize the proportion of items' value in financial statement

The weight is assigned according to the value of items in Table 1. The decision variables are shown as follows:

x_1 : Amount in year 19/20

x_2 : Amount in year 20/21

x_3 : Amount in year 21/22

Five goals constraints are shown below:

$1{,}91x_1 + 1{,}57x_2 + 1{,}67x_3 \geq 3$ (Personal Cost Constraint)

$0{,}31x_1 + 0{,}43x_2 + 0{,}6x_3 \leq 1{,}5$ (Unforseen Expenses)

$0{,}86x_1 + 1{,}02x_2 + 0{,}8x_3 \leq 1$ (Capital Expenditure)

$0{,}32x_1 + 0{,}53x_2 + 0{,}72x_3 \geq 4$ (Revenue)

$2{,}68x_1 + 3{,}55x_2 + 3{,}8x_3 \leq 6$ (Maximum total budget)

$x_1, x_2, x_3 \geq 0$

Based on the goals identified, the goal programming model is formulated as follows:

$$Min\ Z = 8d_1^+ + 2d_2^- + 6d_3^+ + 4d_4^+ + 10d_5^-$$

Subject to:

$$1{,}91x_1 + 1{,}57x_2 + 1{,}67x_3 + d_1^- - d_1^+ = 3$$
$$0{,}31x_1 + 0{,}43x_2 + 0{,}6x_3 + d_2^- - d_2^+ = 1{,}5$$
$$0{,}86x_1 + 1{,}02x_2 + 0{,}8x_3 + d_3^- - d_3^+ = 1$$
$$0{,}32x_1 + 0{,}53x_2 + 0{,}72x_3 + d_4^- - d_4^+ = 4$$
$$2{,}68x_1 + 3{,}55x_2 + 3{,}8x_3 + d_5^- - d_5^+ = 6$$
$$x_1, x_2, x_3, d_1^+, d_2^+, d_3^+, d_4^+, d_5^+, d_1^-, d_2^-, d_3^-, d_4^-, d_5^- \geq 0$$

LINGO version 16.0 is used to solve the goal programming model [6]

Table below presents the empirical result of goal achievement based on the optimal solution obtained from LINGO software.

Table 2. The input data of analysis budget allocation

Basic Variable	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	RHS
Variable Name				d_1^+	d_2^+	d_3^+	d_4^+	d_5^+	d_1^-	d_2^-	d_3^-	d_4^-	d_5^-	
Min Z	0	0	0	8	0	6	4	0	0	2	0	0	10	
Constraint 1	1,91	1,57	1,67	1	0	0	0	0	1	0	0	0	0	- 3
Constraint 2	0,31	0,43	0,6	0	-1	0	0	0	0	1	0	0	0	- 1,5
Constraint 3	0,86	1,02	0,8	0	0	-1	0	0	0	0	1	0	0	- 1
Constraint 4	0,32	0,53	0,73	0	0	0	-1	0	0	0	0	1	0	- 4
Constraint 5	2,68	3,55	3,8	0	0	0	0	-1	0	0	0	0	1	- 6

The application of the simplex method gives the optimum solution as follows: Z = 4.24, $x_1 = 0,\ x_2 = 0\ ,\ x_3 = 1,\ d_1^+ = 0{,}08,\ d_2^+ = 0, d_3^+ = 0{,}47, d_4^+ = 0, d_5^+ = 0, d_1^- = 0, d_2^- = 0{,}39, d_{3,}^- = 0, d_4^- = 2{,}66, d_5^- = 0$

Since the optimum point is not equal to zero, this indicates that at least one of the objectives is not being met. Z is the weighted amount associated with meeting annual budget requirements. All goal were fully satisfied except goal 2 and 4 that is unforeseen Expenses and Revenue. In this case, the deviation d2 - = 0.39; shows that an overhead rate of 1.5 billion has a shortfall of 0.39 billion and d4 - = 2.66, meaning that the revenue target of 4 billion exceeds the revenue target of 2.66 billion. On the other hand, the maximum total budget target reaches the desired target of 7 billion because d5 - = 0. The Z value of 4.24 billion indicates that if targets 1, 3, and 5 are met, the university must reach the budget target of 4.24 billion to achieve target goals 2 and 4, namely overhead costs and income. Therefore, the Department's minimum budget should be 4.24 billion in the next fiscal year 2023 and should be reviewed annually.

4. CONCLUSION

This study used the goal programming approach to investigate Department Mathematic Education's budgeting system. With the exception of the overhead cost and income target, the findings showed that all of the established targets had been accomplished. The University should have a minimum budget of 4.24 billion rupiah in order to accomplish goals 2 and 4, which pertain to overhead costs and revenue. In an optimistic sense, it may be claimed that the university has not underperformed; hence, it should stick to its budget allocation formula while making more adjustments for new scientific methods.

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