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A Goal Programming Model for Optimal Allocation of University Students' Financial Assistance Funds

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ABSTRACT

University students receiving a fixed monthly allowance have to divide a limited amount of money among several essential expenses while still trying to save. This study considers that problem over a five-month academic semester using Goal Programming. Food, internet/data, transportation, personal care, study materials and savings were included in the model. The parameter values were based on questionnaire responses from 33 female students of the Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA Shah Alam. All respondents lived in on-campus hostels and received fixed monthly financial assistance. Of these students, 30 also completed a follow-up survey, which was used to capture changes in expenditure during the semester. Their mean monthly allowance was RM 475.76; for the optimisation model, this was rounded to RM 476, giving RM 2,380 for the full five-month period. The formulation incorporated expenditure bounds, monthly aspiration levels, a minimum monthly saving of RM 50 and behaviour-driven constraints. When solved in LINGO, the model returned a global optimum with an objective value of 255. The full RM 476 was allocated in every month, and the minimum savings requirement of RM 50 was maintained throughout the semester. Some preferred expenditure targets were adjusted because their combined values exceeded the available allowance. Under the equal-weight Goal Programming formulation, the model produced a feasible monthly allocation while showing how the required trade-offs were distributed across the expenditure and savings goals.

Keywords: Financial Assistance, Goal Programming, Optimisation, Student Budgeting, University Students

INTRODUCTION

University students may receive financial support from parents, scholarships, educational loans or part-time employment (Quansah et al., 2023). Once that money is available, it still has to cover several needs. Food, transportation, study materials, internet/data and personal care all draw from the same monthly

allowance, while part of the available amount may also need to be reserved for savings. More money spent in one category leaves less for the others. This becomes a particular concern for students whose allowance remains fixed from month to month. Their budgeting problem is therefore not simply about monitoring expenditure; it also involves deciding how a limited amount should be divided among competing needs. Spending requirements may also change as the semester progresses, particularly during periods such as assignment submission or examinations. Similar difficulties appear in previous studies, where limited income, increasing living costs and competing financial commitments have been associated with students' ability to manage both spending and saving (Prakoso & Apriliani, 2024; Foo et al., 2024).

A conventional budget can help students organise their spending, but it does not always show how several preferred allocations should be adjusted when the total amount desired is greater than the money available. Mathematical optimisation provides another way of treating this problem. Goal Programming (GP), which extends Linear Programming to problems involving several goals, uses aspiration levels and deviation variables to measure how far a solution falls from specified targets. Applications of GP can be found in a range of financial and budget-allocation problems where several objectives must be handled at the same time (Alam, 2022; Prathyusha et al., 2023; Lam et al., 2023; Aboud, 2025). Much of this work, however, deals with organisational or institutional planning. The monthly budgeting problem faced by an individual university student has received far less attention.

To examine this problem mathematically, the present study develops a survey-derived GP model for a five-month academic semester. A fixed monthly financial assistance amount is allocated among five essential expenditure categories and savings. Questionnaire responses are used to establish the expenditure ranges and aspiration levels, while the follow-up survey provides information on spending changes during selected periods of the semester. The emphasis is on the formulation itself and on the allocation generated by the model. All five expenditure goals are treated equally in the implemented objective, whereas under-achievement of the savings target is penalised. The solution is therefore interpreted as an optimal feasible compromise under the stated constraints, not as an indication that one expenditure category is more important than another.

THE PROPOSED METHOD

Data and Case Setting

Primary data were collected using a preliminary questionnaire distributed through Google Forms. The study considered female students from the Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA Shah Alam, who lived in on-campus hostels and received a fixed monthly allowance during the academic semester. Thirty-three (33) valid responses satisfied the screening criteria. The questionnaire recorded the source and amount of monthly financial assistance, essential expenditure categories, preferred expenditure ranges and savings behaviour. A follow-up questionnaire was completed by 30 of the original respondents to identify periods in which expenditure was expected to increase and the categories affected. Questionnaires were used as a quantitative data-collection method (Taherdoost, 2022).

Monthly allowance was reported in ranges, so the midpoint of each range was used to estimate the group mean. With frequencies of 3, 12, 9, 4 and 5 in the five allowance ranges, the estimated mean was RM 475.76. This was rounded to RM 476 for the optimisation model, giving a five-month semester budget

of RM 2,380. The expenditure categories retained in the model were Food, Internet/Data, Transportation, Personal Care and Study Materials, together with Savings. Healthcare was excluded because it was not reported as a regular monthly expenditure by most respondents. The minimum monthly savings requirement was RM 50. The study assumes that the total assistance is fixed at the beginning of the semester, is distributed equally across the five months, and is allocated only among the modelled components. Expenditure preferences and the follow-up spending patterns are treated as representative for the semester, while major price changes are not modelled.

Sets, Parameters and Decision Variables

Let I = {1, 2, 3, 4, 5, 6} denote the allocation components, where 1 = Food, 2 = Internet/Data, 3 = Transportation, 4 = Personal Care, 5 = Study Materials and 6 = Savings. Let J = {1, 2, 3, 4, 5} denote the five monthly periods. This index order follows the implemented LINGO model and is used consistently throughout the paper. The main parameters are A, the monthly allowance; T, the total semester budget; m_i and u_i, the minimum and maximum expenditure bounds for categories i = 1, ..., 5; S_{min}, the minimum monthly savings requirement; and g_{ij}, the aspiration level for component i in month j. The decision variable x_{ij} is the amount allocated to component i in month j. For each goal, d_{ij}^- and d_{ij}^+ denote the under- and over-achievement deviations, respectively.

Table 1

Expenditure Bounds and Monthly Aspiration Levels Used in the Model

Component	Bounds (RM)	Month 1	Month 2	Month 3	Month 4	Month 5
Food	250-299	250	250	250	275	250
Internet/Data	25-49	25	25	25	40	40
Transportation	25-99	50	50	70	70	50
Personal Care	75-99	75	75	90	75	75
Study Materials	25-99	25	25	25	75	25
Savings	≥ 50	100	80	70	50	50

Table 1 gives the final parameter values used in the optimisation. The expenditure bounds were obtained from the preliminary questionnaire. The month-specific aspiration levels were based on the questionnaire findings and adjusted using the expenditure changes reported in the follow-up survey.

Goal constraints and objective function

For each expenditure category, the allocation is linked to its monthly aspiration level through the standard GP balance equation shown in Equation 1.

$$x_{ij} + d_{ij}^- - d_{ij}^+ = g_{ij}, \quad i = 1, \dots, 5;\ j = 1, \dots, 5 \tag{1}$$

Savings are represented using the same goal structure:

$$x_{6j} + d_{6j}^{-} - d_{6j}^{+} = g_{6j}, \quad j = 1, \dots, 5 \tag{2}$$

The implemented model assigns equal importance to the five expenditure goals. Both under- and over-achievement of an expenditure aspiration are included in the objective, whereas only under-achievement of the savings aspiration is penalised. Savings above its aspiration level are therefore not treated as undesirable. The objective used in LINGO is given by Equation 3.

$$\min Z = \sum_{j=1}^{5} \sum_{i=1}^{5} \left(d_{ij}^{-} + d_{ij}^{+}\right) + \sum_{j=1}^{5} d_{6j}^{-} \tag{3}$$

Hard and behaviour-driven constraints

Every month, all available financial assistance is allocated across the six components:

$$\sum_{i=1}^{6} x_{ij} = A\,, \quad j = 1, \dots, 5 \tag{4}$$

The total allocation over the five-month semester is constrained to the available semester budget:

$$\sum_{j=1}^{5} \sum_{i=1}^{6} x_{ij} = T, \quad T = 2380 \tag{5}$$

For the five expenditure categories, allocations must remain within the survey-derived ranges, while monthly savings must satisfy the minimum requirement:

$$m_i \leq x_{ij} \leq u_i, \quad i = 1, \dots, 5;\ j = 1, \dots, 5 \tag{6}$$

$$x_{6j} \geq S_{min} = 50, \quad j = 1, \dots, 5 \tag{7}$$

The follow-up questionnaire identified increases in selected categories during the mid-semester, assignment-submission and examination periods. These patterns were represented through the following behavioural constraints. For Month 3, Transportation and Personal Care cannot fall below their Month 2 allocations. For Month 4, Food, Internet/Data, Transportation and Study Materials cannot fall below their Month 3 allocations. For Month 5, Internet/Data cannot fall below its Month 4 allocation.

$$x_{33} \geq x_{32}, x_{43} \geq x_{42};\ \ x_{14} \geq x_{13}, x_{24} \geq x_{23}, x_{34} \geq x_{33}, x_{54} \geq x_{53};\ \ x_{25} \geq x_{24} \tag{8}$$

All monetary allocation variables are non-negative integers. Deviation variables are non-negative:

$$x_{ij} \in \mathbb{Z}_{+}, \quad d_{ij}^{-} \geq 0, \quad d_{ij}^{+} \geq 0 \tag{9}$$

The complete model was implemented in LINGO. The target values, bounds, budget constraints, behaviour-driven constraints and integer requirements were entered directly into the solver. The solution reported below follows this implemented formulation, including the equal-weight absolute deviations for expenditure goals and the under-achievement deviation for savings.

RESULTS AND DISCUSSION

Optimal Monthly Allocation

The preferred allocations exceeded the available RM 476 monthly budget in every month. The combined targets were RM 525, RM 505, RM 530, RM 585 and RM 490 from Month 1 to Month 5, respectively. The gap was therefore present throughout the semester and was largest in Month 4, when the target total reached RM 585. Exact satisfaction of every aspiration was not possible under the fixed monthly budget. LINGO returned a global optimal solution with an objective value of 255 after six solver iterations. All monthly budget, semester budget, expenditure-range, minimum-savings, behavioural and domain constraints were satisfied.

Table 2

Preferred and Optimal Monthly Allocations

Component	Bounds (RM)	Month 1		Month 2		Month 3		Month 4		Month 5	
		T	O	T	O	T	O	T	O	T	O
Food	250-299	250	250	250	250	250	250	275	275	250	250
Internet/Data	25-49	25	25	25	25	25	25	40	25	40	26
Transportation	25-99	50	25	50	25	70	26	70	26	50	50
Personal Care	75-99	75	75	75	75	90	80	75	75	75	75
Study Materials	25-99	25	25	25	25	25	25	75	25	25	25
Savings	≥ 50	100	76	80	76	70	70	50	50	50	50
Monthly total		525	476	505	476	530	476	585	476	490	476

Note: T = aspiration target (in RM); O=optimal allocation (in RM).

Food matched its aspiration level in all five months. Internet/Data met its target in Months 1-3 but was below target by RM 15 in Month 4 and RM 14 in Month 5. Transportation was reduced below its preferred level in the first four months, with allocations of RM 25, RM 25, RM 26 and RM 26 against targets of RM 50, RM 50, RM 70 and RM 70. Personal Care required only one adjustment, from RM 90 to RM 80 in Month 3. Study materials matched its target except in Month 4, when the RM 75 aspiration was reduced to RM 25. Savings remained above the hard minimum of RM 50 throughout the semester; the aspiration was not fully met in Months 1 and 2 but was achieved from Month 3 onward.

The Month 4 result illustrates the role of the GP compromise most clearly. The follow-up survey increased the aspiration levels for food, internet/data, transportation and study materials, but the budget remained RM 476. The model retained the Food target of RM 275 and the Personal Care allocation of RM 75, while internet/data, transportation and study materials were reduced to RM 25, RM 26 and RM

25. Savings was maintained at RM 50. These values satisfy the hard restrictions and the behaviour-driven inequalities even though several aspiration levels cannot be reached simultaneously.

Deviation Analysis

Under the implemented objective, d^- measures a shortfall and d^+ measures an amount above the aspiration level. No positive deviation occurred in the reported solution. The non-zero deviations are therefore all shortfalls and are listed in Table 3. The sum of these deviations is RM 255, which is the objective value returned by LINGO.

Table 3

Non-zero Deviations in the Optimal Solution

Component	Month	Target (RM)	Optimal (RM)	d^- (RM)
Internet/Data	4	40	25	15
Internet/Data	5	40	26	14
Transportation	1	50	25	25
Transportation	2	50	25	25
Transportation	3	70	26	44
Transportation	4	70	26	44
Personal Care	3	90	80	10
Study Materials	4	75	25	50
Savings	1	100	76	24
Savings	2	80	76	4

These shortfalls should be read against the equal-weight objective. The formulation does not assign food or any other expenditure category a higher numerical priority. Instead, it minimises the total absolute deviation from the five expenditure aspirations while also penalising savings shortfalls. The reported allocation is therefore one optimal solution produced within the feasible region created by the bounds and behavioural constraints. Transportation carries the largest repeated shortfalls in the reported solution, while Food has none. That pattern reflects the combination of the available ranges, monthly targets and solver solution; it should not be interpreted as an explicit priority ranking built into the model.

The objective value can also be interpreted in terms of the overall resource shortage. Over the five-month period, the aspiration levels sum to RM 2,635, while only RM 2,380 is available. This leaves a shortfall of RM 255, which is the same as the total deviation obtained in the optimal solution because none of the allocations exceeds its corresponding aspiration level. The model therefore does not eliminate the shortage. Instead, it distributes that shortage across the expenditure and savings goals while still satisfying the expenditure bounds, the minimum monthly savings requirement and the semester-related behavioural constraints.

Feasibility and relation to the research problem

The solver result confirms mathematical feasibility under the stated assumptions. Each monthly allocation totals RM 476 and the semester allocation totals RM 2,380. Food remains within RM 250-RM 299, Internet/Data within RM 25-RM 49, Transportation within RM 25-RM 99, Personal Care within RM 75-RM 99 and Study Materials within RM 25-RM 99. Savings never falls below RM 50. The required month-to-month inequalities are also met: Transportation and Personal Care do not decrease from Month 2 to Month 3; Food, Internet/Data, Transportation and Study Materials do not decrease from Month 3 to Month 4 where required by the model; and Internet/Data does not decrease from Month 4 to Month 5.

The findings are consistent with the role of GP in earlier budgeting studies, where the method is used to balance several targets under a limited resource constraint (Prathyusha et al., 2023; Lam et al., 2023; Aboud, 2025). The present application differs in scale and context. Its parameters come from student-reported expenditure ranges, savings preferences and semester spending changes rather than an organisational budget. The model therefore converts those reported preferences into an explicit allocation system that can show which targets must be relaxed when the monthly allowance is insufficient.

The interpretation remains bounded by the study design. The data came from 33 female FSKM students living in UiTM Shah Alam hostels, with 30 respondents in the follow-up survey. The resulting parameter values should not be treated as representative of male students, other faculties or other universities. Only five expenditure categories and savings are modelled, and major price changes are not represented. The equal-weight structure can also admit alternative optimal allocations with the same total deviation when shortfalls can be redistributed without violating the constraints. For this reason, the LINGO output is reported as an optimal feasible allocation rather than a unique prescription for student spending.

CONCLUSION

This study developed a Goal Programming model for distributing a fixed monthly financial assistance amount among five essential expenditure categories and savings over a five-month semester. The model used expenditure ranges, savings requirements and aspiration levels obtained from the survey, together with semester-related spending conditions identified in the follow-up survey. With RM 476 available each month, or RM 2,380 for the semester, LINGO obtained a global optimal solution with an objective value of 255. All hard constraints were satisfied. Savings remained at or above RM 50 each month, while some preferred expenditure levels had to be reduced because the total monthly aspirations were higher than the available allowance.

The model makes these adjustments explicit. Rather than considering each expenditure item separately, it shows how a limited allowance can be distributed across competing needs within the same mathematical formulation. The findings, however, are specific to the sampled students and to the assumptions used in constructing the model. A larger and more varied sample would allow the formulation to be examined under different spending patterns. Other expenditure categories, such as accommodation, healthcare or emergency expenses, could also be included. Future extensions may consider weighted or priority-based goals when some financial needs are regarded as more important

than others. With further validation using individual-level financial data, the model could also be adapted for use in a web-based or mobile budgeting application.

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