

An Application of Linear Programming for Efficient Resource Allocation Case Study of University Education

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Abstract: The goal of this article is to submitting linear programming methods and the solution of them for optimizing one of the IAU university financial instruction in Dezfool city branch for 18000 students. In this method the goal is to maximize the number of students who are using allocation loan from students convenience fund with after graduating rate of return according to section and educational courses. This problem with attention to financial resource providing and optimizing usage of them in the IAU university has much more importance rather than previous. So for solving this problem, we utilized operation research techniques and according to gathered data, the decision making was recognized systematically and linear programming model was formed after model solving and execution it in 2 semesters and comparing the results with previous semester, defined that selecting these choices with previous ones are the best, so the credit of them was approved, so we could defined the max number of students who are using allocation loan from convenience fund with after graduating rate of return, according to levels and educational branches, by the way, AHP technique has been used for making the model realistic in the objective function coefficients.

Key words: Mathematical programming, linear programming, Optimizing allocation.

INTRODUCTION

Operation research contains, finding the best solution for management problems. The specific way is that, it has the same solution in scientific problems. So OR is quantity of management and the base of this science is quantitative factors. OR is science of management, mathematical optimizing and statistical determination and it is such a skilled system that have grown since word wide battle 2. All of them engaged with quantity methods for solving determination, designing and controlling industrial and economical operation (Templeman, A.B., 1991).

Many private and governmental organization has economized at the level of millions with successful usage of this mathematical programming.

Risk Lawrence has investigated on sales important in IBM company at the way of OR, the first solution is making analytical models for recognition of sales opportunities. After that execution, for more than 1300 people made available situation (Lawrence, R. *et al.*, 2010).

Erika Klampf has investigated determination in working environment at critical situation at the way of OR in Ford company and has proclaimed that with usage of A.H.P method incomes increased near 1.5 billion dollars (Klampf, E. *et al.*, 2009).

Taylor and Huxley, with integers programming, could making scheduling of soldiers rounding in the San Francisco Police Department (SFPD), that with his programming, they could improved the average of answering to the fellow-citizen aiding requests near %20, that caused formal appreciation of police services increases. This programming suggested a solution that for %25 than previous, the police rounding be available at the reach of more people. In the other words if it was supposed that to reach this %25 at the previous method, they had to added 200 officers and this is equal with \$ 11,000,000 salary for them. So with this new method, police officers rounding were scheduled that could economize \$11,000,000 per year (Taylor, P.E., S.J. Huxley, 1989).

Dewitt and his assistants designed a model for Texaco refinery in order to decision making about of regular lead-on fuel, regular fuel, super fuel. They could save near 30 million dollars with combination model for the refinery (Dewitt, C.W. *et al.*, 1989).

Powell and his assistants in The Commercial Transport Division of North American Van Lines dispatches thousands of trucks from customer origin to customer destination each week under high levels of demand uncertainty. Working closely with upper management, the project team developed a new type of network model for assigning drivers to loads. The model, LOADMAP, combines real-time information about drivers and loads with an elaborate forecast of future loads and truck activities to maximize profits and service. It provided management with a new understanding of the economics of truckload operations; integrated load evaluation, pricing, marketing and load solicitation with truck and load assignment; and increased profits by an estimated \$2.5 million annually, while providing a higher level of service (Powell, W.B. *et al.*, 1988).

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Sullivan, Secrest (1985) for production design in butter making, linear programming used to how the process decision making for butter making of buttermilk, raw, fresh curd cheese and cream for Creamy, cheese packaging, Sour Cream and Cream. Using the above model, that cause butter making annual profits of U.S. \$ 48,000 increase (Sullivan, R.S., S.C. Secrest, 1985).

Waddle (1983) in the Phillips Petroleum Company to answer this question, "a passenger or truck, a few years before replacement, can be used in a factory?" Equipment replacement models used. The equipment replacement models, estimates done, make annual savings of \$ 90,000 for the Phillips Petroleum Company were (Waddell, R., 1983).

Methodology:

In this article, in order to optimize the allocation of financial resources through instructions communicated by the Central Organization of IAU University, after defining the relevant variables, based on the provisions of these guidelines was prepared by linear programming model and also with the aim of being more realistic model, the coefficients objective function in question, with Poll of Experts and the unit through powerful tools and methods to determine the function of AHP were targeted.

The Analytic Hierarchy Process:

To make a decision in an organised way to generate priorities we need to decompose the decision into the following steps.

- Define the problem and determine the kind of knowledge sought.
- Structure the decision hierarchy from the top with the goal of the decision, then the objectives from a broad perspective, through the intermediate levels (criteria on which subsequent elements depend) to the lowest level (which usually is a set of the alternatives).
- Construct a set of pair wise comparison matrices. Each element in an upper level is used to compare the elements in the level immediately below with respect to it.4 Use the priorities obtained from the comparisons to weigh the priorities in the level immediately below. Do this for every element. Then for each element in the level below add its weighed values and obtain its overall or global priority. Continue this process of weighing and adding until the final priorities of the alternatives in the bottom most level are obtained.

To make comparisons, we need a scale of numbers that indicates how many times more important or dominant one element is over another element with respect to the criterion or property with respect to which they are compared.

Problem:

Providing and optimization model based on long-term loan granting guidelines issued by the Central Organization of IAU University academic units required to pay the loan allocated to students based on credit limits are the following categories:

First group: loan to pay for postgraduate students, 30 percent of the quota allocation and loan fees of 30 -75 percent of education year (2008-2009) does not exceed.

Second group: for loan payments undergraduate students, 30 percent of the quota allocation and loan fees of 30-60 percent of education year (2008-2009) does not exceed.

Third group: for loan payments to students associate levels and 40 percent of the quota allocated loan amount of 30 -45 percent of education year (2008-2009) does not exceed.

Variables Problem:

According to the above issue, the required variables in Table 1 is defined as:

Table 1: Definition of variables.

| | |
|--|----------|
| The number of students in level (i) and Branch (j) | x_{ij} |
| Master level | $i = 1$ |
| Undergraduate level | $i = 2$ |
| Postgraduate level | $i = 3$ |
| Humanities branch | $j = 1$ |
| non-humanities branch | $j = 2$ |

Goal model, the maximum number of students to the borrower considering that non-humanities students than humanities terms of both number and amount of fees is therefore more variable in the function coefficients by AHP method In determining the objective function was predicted. Matrix of paired comparisons to determine the objective function coefficients, which is set by expert opinions in Table 2 are observed.

Table 2: Coefficients of the objective function of the AHP method.

| | Humanities branch | Non-Humanities Branch |
|---------------------|-------------------|-----------------------|
| Master level | 0.77 | 0.23 |
| Undergraduate level | 0.77 | 0.23 |
| Postgraduate level | 0.77 | 0.23 |

Ultimately the objective function is:

$$\text{Max } Z = 0.23x_{11} + 0.77x_{12} + 0.23x_{21} + 0.77x_{22} + 0.23x_{31} + 0.77x_{32}$$

Total credit restrictions expected for students up to 5,500,000,000 Rials, Dezfool Unit Season is the following:

$$5581903x_{11} + 5581903x_{12} + 1793515x_{21} + 2491291x_{22} + 1474953x_{31} + 1604066x_{32} \leq 5500000000$$

Percentage limits loan payments fees for the different level are summarized in Table 3 include:

Table 3: Payments of loans to students.

| level | | |
|-----------|---------------|--------------|
| master | Undergraduate | Postgraduate |
| % 30-% 45 | % 30-% 75 | % 30-% 60 |
| Tuition | Tuition | Tuition |

$$0.3(4270275x_{21} + 5931647x_{22}) \leq 1793515x_{21} + 2491291x_{22} \leq 0.6(4270275x_{21} + 5931647x_{22})$$

$$0.3(3986360x_{31} + 4335316x_{32}) \leq 1474953x_{31} + 1604066x_{32} \leq 0.6(3986360x_{31} + 4335316x_{32})$$

Credit limit at any level in Table 4 are summarized:

Table 4: Maximum loan payments to students from the total credit allocation.

| level | | |
|------------|---------------|--------------|
| Master | Undergraduate | Postgraduate |
| % 30 total | % 30 total | % 40 total |

$$5581903x_{11} + 5581903x_{12} \leq 0.3 \times 5500000000 = 1650000000$$

$$1793515x_{21} + 2491291x_{22} \leq 0.3 \times 5500000000 = 1650000000$$

$$1474953x_{31} + 1604066x_{32} \leq 0.4 \times 5500000000 = 2200000000$$

The average fees paid by students at the education year (2008-2009) different degree per second semester for unit Rial consists of :

| | |
|-------------------|-------------------|
| $M_{11}=11786391$ | $M_{12}=11786391$ |
| $M_{21}=4270275$ | $M_{22}=5931647$ |
| $M_{31}=3986360$ | $M_{32}=4335316$ |

They explained to determine the loan amount in each branch of level, the average geometric mean minimum and maximum percentages in the declaration and guidelines calculated by multiplying the average fees is for example the geometric mean of 30% And 60% for loans up to undergraduate students is 42%. Therefore, the rate loans to students in other humanities fields is equal 249129 Rials = $M_{22} * \%42$.

The Final Model Consists of:

Problem Statement:

Let x_{ij} be the number of students who study in level $i = 1, \dots, n$ and different majors $j = 1, \dots, m$ and c_{ij} is the relative importance of x_{ij} . Therefore, the objective function of the proposed model is as follows,

$$\max \sum_{i=1}^n c_i x_{ij}$$

There are different constraints associated with our proposed model. The first constraint determines the amount of available budget for resource allocation which is as follows:

$$\text{Max } Z = 0.23x_{11} + 0.77x_{12} + 0.23x_{21} + 0.77x_{22} + 0.23x_{31} + 0.77x_{32}$$

Subject to:

$$5581903x_{11} + 5581903x_{12} + 1793515x_{21} + 2491291x_{22} + 1474953x_{31} + 1604066x_{32} \leq 5500000000$$

$$0.3(11876391x_{11} + 11876391x_{12}) \leq 5581903x_{11} + 5581903x_{12} \leq 0.75(11876391x_{11} + 11876391x_{12})$$

$$0.3(4270275x_{21} + 5931647x_{22}) \leq 1793515x_{21} + 2491291x_{22} \leq 0.6(4270275x_{21} + 5931647x_{22})$$

$$0.3(3986360x_{31} + 4335316x_{32}) \leq 1474953x_{31} + 1604066x_{32} \leq 0.6(3986360x_{31} + 4335316x_{32})$$

$$5581903x_{11} + 5581903x_{12} \leq 1650000000$$

$$1793515x_{21} + 2491291x_{22} \leq 1650000000$$

$$1474953x_{31} + 1604066x_{32} \leq 2200000000$$

$$x_{ij} \geq 0, i = 1,2,3, j = 1,2$$

Solving model and the final results: After solving the model through software winqsb optimal model following values were obtained.

| | | | | | | |
|---------------------|-----------------------|---------------------|-----------------------|-----------------------|-----------------------|-----------------|
| X ₁₁ =12 | X ₂₁ = 253 | X ₃₁ =15 | X ₁₂ = 282 | X ₂₂ = 480 | x ₃₂ =1357 | Z = 5496214000R |
|---------------------|-----------------------|---------------------|-----------------------|-----------------------|-----------------------|-----------------|

Conclusion:

Considering the results, which are observed in three levels and the number of branches x₁₁,x₃₁,x₂₂ and a loan, applicant's loan request answers have been responsive and three senior non-level of humanities, human sciences and non-expert technician humanities more than the number of loan applicants wanted to give loans that have been able to respectively 282, 253 people in 1357 and the loan can be paid.

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