International Journal of Engineering, Science and Mathematics
Vol. 10 Issue 3, March 2021,
ISSN: 2320-0294 Impact Factor: 6.765
Journal Homepage: http://www.ijesm.co.in, Email: ijesmj@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

THE APPLICATION OF LINEAR PROGRAMMING IN PROFIT MAXIMIZATION

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ABSTRACT

Linear programming if one does not first do any preparatory research on the subject of operations research. This is more precisely due to the fact that linear programming is one of the methodologies that is used in this field of study the majority of the time. To be more specific, operation research, sometimes known as OR for short, is a scientific approach of decision-making that seeks to determine the most effective way to construct and operate a system when resources are limited, as stated by Oyekan (2015). Within certain application domains, the study of operation research results in the production of a collection of algorithms that may be used to solve problems and make decisions in a more efficient manner. The use of OR is widespread in the fields of business, engineering, and public administration at the moment. In addition, the use of OR in the decision-making processes of the industrial and service sectors receives a significant amount of attention and consideration now. During World War II, the British military began employing scientists to investigate a variety of issues that were occurring inside the military. An application of the linear programming model, which is a quantitative instrument for decision-making, is necessary in the garment industry in order to achieve the highest possible level of product mix effectiveness.

Keywords: *Linear, research, administration.*

INTRODUCTION

It is difficult to offer a detailed explanation of linear programming if one does not first do any preparatory research on the subject of operations research. This is more precisely due to the fact that linear programming is one of the methodologies that is used in this field of study the majority of the time. To be more specific, operation research, sometimes known as OR for short, is a scientific approach of decision-making that seeks to determine the most effective way to construct and operate a system when resources are limited, as stated by Oyekan (2015).

Within certain application domains, the study of operation research results in the production of a collection of algorithms that may be used to solve problems and make decisions in a more efficient manner. The use of OR is widespread in the fields of business, engineering, and public administration at the moment. In addition, the use of OR in the decision-making processes of the industrial and service sectors receives a significant amount of attention and consideration now. During World War II, the British military began employing scientists to investigate a variety of issues that were occurring inside the military. These issues included a wide range of issues. Throughout the course of the academic field known as operations research, this particular occurrence is often recognized as the defining event in its history. It is possible that the concept of effectively allocating and making use of limited resources was presented to the general public for the very first time during the event that is known as the Second World War. Nowadays, it is more customary to refer to the application of mathematics and the scientific method to military operations as "Management Science and Management Science." This is because of the similarities between the two terms. When it was first established, this field was known as "Operations Research." The terms "management science" and "operations research" are, in fact, interchangeable, despite the fact that the former is often classified as being under the latter.

By assigning drivers in accordance with the LP model, transportation cooperatives have the potential to reduce the number of drivers that are necessary for each shift throughout the day. This implies that the expenditures of reserved drivers will be reduced. An application of the linear programming model, which is a quantitative instrument for decision-making, is necessary in the garment industry in order to achieve the highest possible level of product mix effectiveness. A number of different approaches may be used to overcome issues that arise with linear programming. The Big M and dual simplex operations are two examples of these methods, which have the potential to not only save a considerable amount of time but also reduce the number of repetitions being performed. In order to determine the most effective method for the distribution of raw materials in the bakery industry, the linear programming simplex technique was used. This was done in order to provide a variety of bread sizes. It was discovered that intercept values may be employed to ascertain the equality criteria that need to be achieved between the inequality constraints in order to produce optimal solutions while addressing linear programming issues.

The characteristics of linear programming issues

The following is a list of the two that are noticed the most often:

1. The problem with which the specific product combination is occurring
2. Blending is the second problem that has to be addressed.

The product-mix problem is characterized by the presence of two or more things, which are also referred to as candidates or activities, that are designed to compete with one another for the limited resources. It is difficult to determine which items should be included in the production plan and how much of each product should be produced or sold in order to achieve the highest possible rates of profit, market share, or sales revenue. Blending presents a number of challenges, one of which is the selection of the optimal mix of components to use in order to produce a certain quantity of a product while adhering to stringent requirements. For the purpose of achieving the ideal combination, the essential components are brought together in the most cost-effective manner feasible.

Creating a Model for Linear Programming

Taking the Initial Step After doing a thorough analysis of the situation, you will be able to determine which of the available choices is the most crucial to choose. Considering that each of the three items—1, 2, and 3—are permitted to have varying quantities, the most important decision that has to be made in this scenario is determining what the proper extents are for each of the products respectively.

Regarding the third phase, I was curious as to whether or not you would be able to provide a mathematical formula that is based on variables and that covers all of the different possibilities. The term "feasible alternatives" refers to those options that are logical from a physical, financial, and economic point of view within the framework of this discussion. In the context of the example that was just described, viable alternatives are sets of values that are proportional to x1, x2, and x3, respectively.

In what

$$x1, x2 \text{ and } x3 \geq 0.$$

taken into consideration the fact that poor outcomes are not just unappealing but also useless. This constitutes the fourth motion. It is essential to offer a quantitative explanation of the objective function, and it is recommended that this explanation be accomplished in the form of a linear function of the variables. For the time being, the objective is to generate the most possible revenues.

$$\text{i.e., } Z = 4x1 + 3x2 + 6x3$$

This is the fifth step. Please provide an explanation of the factors that are affecting or restricting the conditions involved. Frequently, they are the consequence of restrictions that have been imposed on the resources that are accessible or the requirements that have to be satisfied. Furthermore, in order to provide a description of these constraints in terms of variables, it is possible to simultaneously characterize them as linear equations or inequalities.

Within the context of this particular circumstance, the capabilities of the machine are limited, and these constraints may be formally expressed as

$$2x1 + 3x2 + 2x3 \leq 440$$

$$4x1 + 0x2 + 3x3 \leq 470$$

$$2x1 + 5x2 + 0x3 \leq 430$$

Simplex approach

In 1947, George B. Dantzig developed the Simplex approach as a consequence of his studies at the Pentagon, which he had previously completed while serving in the United States Military during World War II. As a direct consequence of this, the strategy took shape. In order to find solutions to problems, the linear programming field makes use of a method known as the simplex approach. Utilizing this method allows for the resolution of the vast majority of problems that may be addressed by employing linear programming. His work has evolved to encompass dynamic planning in addition to dynamic scheduling and planning, with a particular emphasis on dynamic planning in situations where there is a significant degree of uncertainty. Since the 1940s, this method has been widely accepted as the most satisfactory technique to the resolution of linear complications.

There are computer software applications that are both very advanced and extremely efficient, and they are available for your convenience. Leonid Khaciyan was the first person to provide the ellipsoid approach, which allows the linear program to be expressed as a polynomial function of the data amount. This methodology was originally given in 1979. Through the process of passing through a series of steps, it has the capacity to solve any linear issue. As a consequence of this, the ellipsoid technique is superior than the simplex methodology in simulated instances when the simplex methodology provides very poor results.

OBJECTIVE OF THE STUDY

1. To get started, have a look at the many different applications of linear programming.
2. To do research on the many tools that are accessible for the development of a linear programming model.

REVIEW OF LITERATURE

Adenike Olubiyi (2021) The process of optimization is something that almost all firms and enterprises in today's world participate in on a regular basis, according to the use of linear programming was the objective of this research project, with the purpose of maximizing the profit that could be obtained from the utilization of raw resources in the production of water. Optimization techniques are often used as the foundation for management decisions in countries that have undergone industrialization. We centered our case study on Vic Libo Ventures (VILA), a business that is situated in Zango, Lokoja, which is located in the state of Kogi. The selection criteria that are taken into consideration in this research are the three different water sizes that VicliboVenturs produces: a pack of fifty ounces, a pack of seventy-five ounces, and a sachet bag of water. The individual doing the study was primarily interested in the three raw resources that are used in the manufacturing process. These resources are the production cost, production time, and demand or sales. The researcher was also very worried about the amount of each raw material that was required for each variable, which was the size of the water.

Meghana Singh P (2023) In this research, we investigate whether or not it is possible for a bakery to increase its profits by the strategic use of linear programming. Taking into consideration the challenges that bakeries face, such as a wide range of product possibilities and changing demand, the purpose of this study is to investigate the use of LPP approaches in order to enhance production and resource allocation. In order to determine which combination of baked goods is the most profitable, the purpose of this research is to define linear objective functions and constraints in a manner that is consistent with scientific principles. In order to do this, a variety of factors, including the needs of the market, the capacity of the production facility, and the availability of the ingredients, are taken into consideration. Case studies that are both practical and anchored in reality highlight how LPP assists decision makers in making informed judgements that eventually result in enhanced operational efficiency and better levels of profitability. The findings provide valuable information on the efficacy of LPP as a tool for decision-making in the baking industry, which is characterized by intense competition and fast change.

U.U. M. Aliyu (2021) Gusau Sweet Factory Limited will use the linear programming approach, which is the primary focus of this article, to identify the optimal product mix for the company in order to achieve the highest possible level of profitability. Specific information on the quantity of each of the three primary raw materials called for in the production of the sweets, including the toffee. It was possible to determine the cost, selling price, and profit of each product, including lollipops and sweets, by using the financial data made available by the corporation. This included the cost of the information for each individual product. In order to effectively solve the issue, which was formulated as a linear programming problem (LPP), the modified simplex technique was used throughout the process. In light of the results, it is recommended that the company create lollipops and toffee on a daily basis in order for the company to achieve the highest possible degree of profitability.

Yuewei Wang (2023) that the purpose of this study is to investigate a milk tea firm by using the principles of industrial profit optimization. An example of a linear programming model is used to estimate the optimal production structure as well as the number of raw materials that should be purchased. During the first stage, the only sales advantage that is included into the goal function is optimized using the goal function. The value of this advantage is being increased. The idea is developed further in the second section of the article, which takes into account the concerns of the staff members. Additionally, it is predicted that this model will be susceptible to other constraints. The model makes an effort to take into consideration the greatest potential raw material cost, despite the fact that different members of the staff have differing degrees of expertise brewing tea and that the amount of time it takes to create each individual's drinking experience is different. The real data will serve as the foundation for the construction of the model, and the results of the model will be compared to the findings that were calculated. Conclusions drawn from the study shed light on the significance of the model as well as the potential for its further development.

RESEARCH METHODOLOGY

Gaussian-entry symmetric circulant matrices

Within the scope of this part, we will speak briefly about a new conclusion about the linear eigenvalue statistics with regard to SCn. Adhikari and Saha reported the following discovery on the fluctuations of the linear eigenvalue statistics of the SCn with Gaussian entries and monomial test functions in 3.1.1. This result was produced by assessing the data. Secondly, the premise that Given that Mn is an independent real standard normal matrix with n × n symmetry, it is crucial to remark that it comprises circulant components.

Assume that $\{p_n\}$ is a sequence of positive integers such that $p_n = o(\log n/ \log\log n)$. Then, as $n \to \infty$,

$$\frac{\mathrm{Tr}(M_n^{p_n}) - \mathrm{E}(\mathrm{Tr}(M_n^{p_n}))}{\sqrt{\mathrm{Var}(\mathrm{Tr}(M_n^{p_n}))}} \text{ converges in total variation norm to } N(0,1).$$

This is the second class that we have. As the basis for the evidence that supports this conclusion, the Poincare inequality that is exposed in and Stein's techniques serve as supporting evidence. In the next portion, the result is increased to include the entries of the matrix; however, in order to enable this extension, the convergence technique is revised. Through the use of an erroneous definition of convergence, we demonstrate that fluctuation is a product of convergence process.

Apply LPP model in the irrigation plan

However, despite the fact that water is becoming more essential, the supply is not sufficient to fulfil the demand. The contemporary world suffers from a major deficiency in terms of the availability of water. For this reason, the development of scientific techniques is very necessary in order to make the most efficient use of the water resources that are now accessible. The development of a unique linear programming model that takes into account a large number of specialised and specialised aspects that may have an effect on the feasibility and economics of agricultural water system design was the primary objective of this research project. This model illustrates a target job that, in addition to raising overall income, chooses the frequency with which water is available. When it is taken into consideration that the labour that is created as a consequence of water consumption is already present and conveniently accessible for specific harvests, the link between water usage and yield production becomes more transparent.

Model Creation

As a result of growing a specific crop while taking into account certain limitations, such as the total amount of water that is available and the amount of land that can be used for farming, the method that is used to establish the aim function results in an increase in total income, which is also referred to as revenue maximisation. This method is also known as revenue maximisation, which is another acronym. On the other hand, total revenue per region is determined as a direct consequence of production, in contrast to expenditures, which are considered to be a fixed component. Within the context of the variable component, the value of this component is established by the total amount of irrigation that is carried out during the season.

This is how the gross income is shown below:

$$IB = \sum p_i * x_i * y_i(W)$$

Were,

IB = the total amount of money that is generated in a certain region by n crops;

pi = the sum that is being charged for the agricultural commodity,

yi (W) = a correlation between the amount of agricultural production and the amount of irrigation depth in

kg.ha*l;

xi = places that have been planted with crop I and have been irrigated with it; and areas that have been measured in hectares.

i = The number that corresponds to the crop, which might range from one ton.

At each and every stage of the process, water is the only variable that is taken into consideration, and the methodological union is given with the production expenses.:

$$C\, p_i = C_i - C_w * w_i$$

Were,

C p = costs of production for the farm;

C_w = The price of irrigation using water

Wi = the crop's (seasonal) irrigation depth, measured in millimetres; and

Ci = costs associated with cultivating the crop, which are not even remotely connected to the overall irrigation.

DATA ANALYSIS

By using the technique that was discussed before, it is possible to put into action any form of irrigation strategy. It is possible that the large coefficient is due to the fact that the model that was recommended is based on data that was acquired from the supervision report of a certain time period of agricultural activity.

The primary objective is to ascertain which technique of crop irrigation is now the most effective and feasible when taking into consideration the whole region that has the potential to be used for agricultural growth. It is anticipated that this would result in an increase in the total amount of money generated by the project. In addition to the criteria that are mentioned in the plan, some examples of the components that comprise the constraints are the total amount of land and water that is available, the agricultural market, and other needs.

A breakdown of the most prevalent crops that are cultivated in the surrounding regions is included in Table 4.1 for the purpose of facilitating comprehension of the findings of this study. These crops were the focus of a significant amount of attention. During the process of formulating their answer, they take into consideration the cost of the confiscated item, the sawing season, the cost of water, and the production requirements. According to the monthly occupation blueprint, almost ninety percent of the individuals who live in the regional area that is the focus of the effort are employed mostly in the agricultural sector. This is the Table 1.

Table 1. Characteristics of the crops under investigation

Crops	***Showing Season***
Soy-based beans	July
Melon	February
Watermelon	July
Wheat	October
Pulses	July
Tomato	May
Onion	February
Banana	**##**
Corn	July
Corn	October
Sugarcane	**##**

In accordance with the parameters of the project, a total of 1,724 settlers will be given access to 9820 hectares of land that requires irrigation. There are now 7,241 hectares of land that have been investigated by settlers utilising the crops that were advised before. The land that is still available is being used to grow a variety of crops, one of which being mangoes that have just been given their roots.

1. It should be noted that the following factors restrict the amount of land that may be cultivated:

2. In the month of July, a minimum area of 714 hectares must be planted with soybeans in order to harvest them for the purpose of eating them inside the country.

3. The month of February saw the planting of 2,854 hectares of land, which included (b) a few watermelons (a share). This was done because of the market possibilities.

4. If watermelon that is produced in the month of October is to be considered market justifiable, then there must be a minimum of 2,854 hectares of agricultural land included in the calculation.

5. As a result of the market, the total area of the project must be at least 4,281 hectares in order to produce a watermelon harvest on an annual basis.

An estimate of the quantity of water that the crops need for the duration of the growing harvest season was derived from the production functions. This time period included the whole growing season. On the basis of the total irrigation depth and the maximum monthly evaporation for each crop, it was anticipated that this monthly need would be necessary.

Formulation of Mathematical

There has been consideration given to the schedules of the bus drivers working for a company that operates seven days a week. There are five shifts set to take place each and every day. The information that was obtained from the private company is now included into Table 2 with its inclusion. At the very least, there is a need for two hundred nine drivers each and every single day. Through the use of the LP method, it has been possible to identify drivers who are dedicated to their shift.

Table 2. Turning the Tables

Shifts	**No. of drivers**
1st shift (6am – 8pm)	59
2nd shift (8am – 8pm)	55
3rd shift (2pm – 10pm)	59
4th shift (9pm [Day 1] – 6am [Day 2])	06
5th shift (1pm [Day 1] – 2pm [Day 2])	92

On the first day of the fourth shift, the drivers' shift will begin at nine o'clock at night and continue until six o'clock the next day or the day after that. This shift will continue till the next day. The drivers will work the fifth shift, beginning at one o'clock on the first day and ending at two o'clock on the second or following day. This shift will begin on the first day. The drivers who are allocated to work the fifth shift will be given the opportunity to work on a variety of days throughout the week.

The following is a list of the assignments that have been bestowed onto the drivers for each of the seven shifts, provided that these assignments do not clash with one another. This is the Table 3.

Table 3. Driver assignment for the shifts that don't overlap

	1st day	2nd day	3rd day	4th day	5th day	6th day	7th day
x_1	*	*	*	-	-	-	-
x_2	-	*	*	*	*	-	-
x_3	-	-	-	*	*	*	-
x_4	-	-	-	-	-	*	*
x_5	*	*	*	*	*	*	*

The primary objective of the problem framing will be to bring about a reduction in the overall number of drivers.

When it comes to scheduling drivers for a private transportation business that operates seven days a week, it is important to take into account the information that displays in Table 4 Each and every driver is required to work for a total of six consecutive days, with each day consisting of four shifts.

Table 4. Details obtained from a commercial airline

Days	**Number of drivers**				
	Shifts				
		1	**2**	**3**	**4**
Monday	99	29	19	29	19
Tuesday	79	24	14	24	14
Wednesday	89	24	19	24	19
Thursday	84	29	14	29	09
Friday	94	29	14	34	14
Saturday	109	24	24	39	19
Sunday	69	9	24	24	09

On the basis of this, the number of drivers who begin working on ith (Monday through Sunday) will be determined. Let us have a look at the distribution of the drivers, which is shown in the table 5. is the absolute value.

Table 5. Driver assignment

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
y_1	*	*	*	*	*	*	-
y_2	-	*	*	*	*	*	*
y_3	*	-	*	*	*	*	*
y_4	*	*	-	*	*	*	*
y_5	*	*	*	-	*	*	*
y_6	*	*	*	*	-	*	*
y7	*	*	*	*	*	-	*

Bringing down the total number of drivers is the major objective of the scenario that is now being played out.

In order to solve the problem utilising the LP technique, it is more difficult to do so when there are more aspects that need to be taken into consideration. In order to arrive at the solution for model 2, a computational approach was used using the MATLAB application. In order to tackle each and every one of the subproblems, you may make use of these wonderful answers.

Table 6. Apart from providing the solution to the seven subproblems, Model 2

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
z_1	14	12.4	12.4	15.3	14	12	6.33
Z_2	14	12.4	12.4	15.3	16	20.98	18.67
Z_3	14	12.4	12.4	14.5	16	18	6.33
Z_4	14	12.4	12.4	14.5	14	11.98	3.67
Yi	29	9.7	22.53	15.72	18.87	13.3	0

CONCLUSION

The expression "linear programming problem" is rapidly becoming the most well-known catchphrase in the modern corporate sector, which is characterized by a high degree of dynamism and constant change. In an effort to gain a competitive advantage, contemporary structured organisations are concentrating a greater portion of their attention on this particular industry, which is a strategy that has been shown to be successful. There are already a number of academics that have produced works that contribute to the theoretical development of the subject matter that is being discussed via Industries. The authors of these works are recognised authorities in their respective disciplines. There have been a great number of academics who have made contributions that have made these attempts possible. The objective of this research is to attain the goal of providing a comprehensive assessment of the process that is used in structured settings and organisations for the purpose of creating linear programming models. In addition, this research investigates the ways in which these models shift in response to the influence of moderators, as well as the strategies that businesses use in order to exercise control over and improve their decision-making processes. The purpose of this chapter is to offer a summary of the findings of the research as well as a breakdown of the implications that these findings have. In addition to being beneficial for the development of theoretical frameworks, the use of these findings has consequences for practical applications as well. There have been responses from a diverse variety of business sectors, including the agricultural, industrial, and service industries, among others.

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