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OPTIMIZE PROFIT IN PRODUCING GOODS OF INDUSTRIES USING MATLAB SOFTWARE

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Abstract

In this paper, simplex method and its application is discussed and we also calculate profit of Dessert Bar Handmade Bakery by using MATLAB software. The graphical method and simplex method are still improving in order to get the optimum solution. Simplex method is the fundamental technique for numerical solutions of the linear programming problem. Consistent advertising by some established manufacturers have made these products very popular which would help the new entrants provided the product quality is comparable and prices are competitive. Dessert Bar Handmade Bakery is concerned with the rate of productivity which can be related to the efficiency of the production system. It could equally be seen as a ratio to measure how well an organization (or individual, industry, country) converts input resources (labor, materials, machines, etc.) into goods and services. The aim of this study is to use simplex method to optimize profit of any producing goods of industries. The solution of this study is resulted from MATLAB software.

Keyword: first keyword, Second keyword, Third keyword (Most relevant to your abstract)

1.INTRODUCTION

Linear Programming (LP) is an optimization method applicable for the solution problems, in which the objective function and the constraints appear as linear functions of the decision variables.

Most real life problems when formulated as an LP Model have more than two variables and therefore need a more efficient method to suggest an optimal solution for such problems. George B. Dantzing devised the simplex method of the solution in 1947.[3]

Nowadays, almost all industries are faced with many challenges in producing goods (furniture, clothes, medical products, food and soft drinks etc.) at minimum cost and maximum profit. Many businesses encounter difficulties in optimum allocation of scarce resources. This problem can be solved by using simplex method and MATLAB software. By using this software, the employers can reduce time consumed and can calculate the profit of each product systematically.[1]

2. LINEAR PROGRAMMING SYSTEM

2.1. Definition of Linear Programming

Linear Programming (LP) is a mathematical technique for maximizing or minimizing a linear function of several functions of several variables, such as output or cost. The simplex method is classical method for solving linear programs. The use of simplex method to solve an LP problem requires that the problem is converted into its standard form. The standard form of the LP problems should have the following characteristics.[6]

2.2. Design of Linear Programming

Linear Programming is the following steps

1. All the constraints should be described as equations by adding artificial variables.
2. The right hand side of each constraint should be made non-negative. If it is not, this should be done by multiplying both sides of the resulting constraints by1.
3. The objective function should be the maximization type.

The standard form of the LP problems is described as:

Optimize (Maximize or Minimize)

$Z = k_1x_1 + k_2x_2 + \cdots + k_nx_n + 0s_1 + 0s_2 + \cdots + 0s_n$
Subject to the linear constraints:
$a_{11}x_1 + a_{12}x_2 + \cdots + a_{1n}x_n + s_1 = b_1$
$a_{21}x_1 + a_{22}x_2 + \cdots + a_{2n}x_n + s_2 = b_2$
. . . .
. . . .
. . . .
$a_{m1}x_1 + a_{m2}x_2 + \cdots + a_{mn}x_n + s_m = b_m$
$x_1, x_2, x_3, \ldots, x_n, s_1, s_2, s_3, \ldots, s_m \geq 0.$ [8]

2.2.1. Matric form design

In matrix notations the standard form is described as:
Optimize (Maximize or Minimize)
$Z = kx + 0s$
Subject to the linear constraints:
$Ax + s = b$ and $x, s \geq 0$ where
$k = (k_1, k_2, k_3, \ldots, k_n)$ is the row vector;
$s = (s_1, s_2, s_3, \ldots, s_m)$ *is column vector and*
$x = (x_1, x_2, x_3, \ldots, x_n)^T$
$b = (b_1, b_2, b_3, \ldots, b_m)$

$$A = \begin{bmatrix} a_{11} & a_{12} & \ldots a_{1n} \\ a_{21} & a_{22} & \ldots a_{2n} \\ a_{m1} & a_{m2} & \ldots a_{mn} \end{bmatrix}$$

is the m x n matrix of the coefficients of variables. This final solution is termed the optimal solution of the LP problem.

In general standard form to display all properties required of a LP problem. This consists of a linear objective function f(x) such that, if in general $k_1, k_2, k_3, \ldots, k_n$ are real numbers, then the function f of real variables $x_1, x_2, x_3, \ldots, x_n$ can be defined as:

$$f(x) = k_1x_1 + k_2x_2 + \cdots + k_nx_n = \sum_{j=1}^{n} k_jx_j$$

Other properties include a linear constraint (which is one that is either a linear equation or linear inequality) and a non-negativity constraint. These can be written in mathematical notations as:
$\sum_{j=1}^{n} a_{ij}x_j \leq b_i \forall i \in \{1,2, \ldots, m\}$ (linear constraint) and $x_j \geq 0 \forall j \in \{1,2, \ldots n\}$

If $x_1, x_2, x_3, \ldots, x_n$ satisfy all the constraints of linear program, then the assignment of values to these variables are called a feasible solution of the linear program.[8

3.SIMPLEX METHOD

The Simplex Method or Simplex Algorithm is used for calculating the optimal solution to the linear programming problem.[7]

3.1. Example

Find maximize $z = 40x_1 + 88x_2$,
Subject to the constraints
$2x_1 + 8x_2 \leq 60$
$5x_1 + 2x_2 \leq 60$
$x_1 \geq 0$
$x_2 \geq 0.$ [4]
Solution: In matrix form,
$z - 40x_1 - 88x_2 = 0$
$2x_1 + 8x_2 + s_1 = 60$
$5x_1 + 2x_2 + s_2 = 60$
$x_1 \geq 0, x_2 \geq 0, s_1 \geq 0, s_2 \geq 0$

$$\begin{array}{c} \\ T_0 = \end{array} \begin{array}{cccccc} z & x_1 & x_2 & s_1 & s_2 & b \\ \end{array}$$

$$T_0 = \begin{bmatrix} 1 & -40 & -88 & 0 & 0 & 0 \\ 0 & 2 & 8 & 1 & 0 & 60 \\ 0 & 5 & 2 & 0 & 1 & 60 \end{bmatrix}$$

$\frac{60}{2} = 30, \; \frac{60}{5} = 12$
Third row is pivot equation .
x_1, x_2 *are nonbasic variables.*
s_1, s_2 *are basic variables.*
$x_1 = 0, x_2 = 0, s_1 = \frac{60}{1} = 60, s_2 = \frac{60}{1} = 60, \; z = 0$

$$\begin{array}{cccccc} z & x_1 & x_2 & s_1 & s_2 & b \end{array}$$

$$T_1 = \begin{bmatrix} 1 & 0 & -72 & 0 & 8 & 480 \\ 0 & 0 & 7.2 & 1 & -0.4 & 36 \\ 0 & 5 & 2 & 0 & 1 & 60 \end{bmatrix}$$

$\frac{36}{7.2} = 5, \; \frac{60}{2} = 30$
Second row is pivot equation.
x_2, s_2 *are nonbasic variables.*
x_1, s_1 *are basic variables.*
$x_1 = \frac{60}{5} = 12, \; s_1 = 0, x_3 = \frac{36}{1} = 36, \; s_2 = 0, \; z = 480$

$$\begin{array}{cccccc} z & x_1 & x_2 & s_1 & s_2 & b \end{array}$$

$$T_2 = \begin{bmatrix} 1 & 0 & 0 & 10 & 4 & 840 \\ 0 & 0 & 7.2 & 1 & -0.4 & 36 \\ 0 & 5 & 0 & -0.28 & 1.1 & 50 \end{bmatrix}$$

s_1, s_2 *are nonbasic variables*
x_1, x_2 *are basic variables*
$x_1 = \frac{50}{5} = 10, \; x_2 = \frac{36}{7.2} = 5 \; , s_1 = 0,$
$s_2 = 0, \; z = 840$
$\therefore$ maximize value is 840.

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4.MAIN EXPERIMENT

The data used in this study is based on Dessert Bar Handmade Bakery, which is situated in Bago, Myanmar. It is a household type business and it produce popular products such as Cheese Fruit Macaroni, Durian Pillows, Durian Puddings, Thai Milk Tea and various types of birthday cakes, etc. These foods have very high demand because they are the most popular products among the young people. This study was made by the records according to the demand of each product that are kept by the employer.

Table1. Cake and Juice Produced by Dessert Bar Handmade Bakery

Name of Product	Production cost per loaf(kyats)	Selling price per loaf(kyats)	Profit (kyats)
Egg Pudding	500	700	200
Durian Pillow	900	1000	100
Chocolate Pillow	800	1000	200
Milky Pudding	1100	1500	400
Thai Tea	1300	1800	500
Rainbow Crepe Cake	1500	2000	500

Figure. 1 Egg Pudding and Durian Pillow

Figure.2(a) Chocolate Pillow(b) Milky Pudding

Figure.3(a) Thai Tea (b)Rainbow Crepe Cake

Table 2. Quantities of Ten Raw Maximum Raw for Cake and Juice

Raw Mate-rials	Types of Product and their Raw Material Mix						Total Qty per month grams
	x_1	x_2	x_3	x_4	x_5	x_6	
Egg	35	8	8	35	-	250	342720
Milk	50	10	10	100	100	400	683400
Durian	-	15	-	-	-	-	15300
Choco -late Chips	-	-	15	-	-	-	15300
Evapor-ated Milk	10	-	-	10	10	-	30600
Sugar	10	5	15	30	30	120	214200
Thai Tea Leaves	-	-	-	-	15	-	15300
CoCo Powder	-	-	2.5	-	-	-	2550
Flour	-	2.5	2.5	-	-	125	132600
Food Color	-	5	-	-	-	20	25500

"Table 1" presents the six different Cake and Juice produced by Dessert Bar Handmade Bakery, their production costs, selling prices and profits. "Table 2" present the raw materials used for the production of Cake and Juice at Dessert Bar Handmade Bakery.
The combinations of the quantities of these eight raw materials (raw material mix) for cake production per loaf (in grams), and maximum quantity of each raw materials held in stock for monthly production is also reported in the table. The information is used to determine the production costs (in terms of raw materials) per loaf of Cake and Juice produced by Dessert Bar Handmade Bakery.

4.1. Construct the Linear Programming model

All the information provided in Table -1 to 2 was used to form the LP model of the maximization type for the data as started above.

$Z = 200x_1 + 100x_2 + 200x_3 + 400x_4 + 500x_5 + 500x_6$

Z is profit function that we seek to maximize,

Z stands for profit.

Subject to

$0.035x_1 + 0.008x_2 + 0.008x_3 + 0.035x_4 + 0x_5 + 0.25x_6 \leq 342.72$

$0.05x_1 + 0.01x_2 + 0.01x_3 + 0.1x_4 + 0.1x_5 + 0.4x_6 \leq 683.4$

$0x_1 + 0.015x_2 + 0x_3 + 0x_4 + 0x_5 + 0x_6 + \leq 15.3$

$0x_1 + 0x_2 + 0.015x_3 + 0x_4 + 0x_5 + 0x_6 \leq 15.3$

$0.01x_1 + 0x_2 + 0x_3 + 0.01x_4 + 0.01x_5 + 0x_6 \leq 30.6$

$0.01x_1 + 0.005x_2 + 0.005x_3 + 0.03x_4 + 0.03x_5 + 0.12x_6 \leq 214.2$

$0x_1 + 0x_2 + 0x_3 + 0x_4 + 0.015x_5 + 0x_6 \leq 15.3$

$0x_1 + 0x_2 + 0.0025x_3 + 0x_4 + 0x_5 + 0x_6 \leq 2.55$

$0x_1 + 0.0025x_2 + 0.0025x_3 + 0x_4 + 0x_5 + 0.125x_6 \leq 132.6$

$0x_1 + 0.005x_2 + 0x_3 + 0x_4 + 0x_5 + 0.02x_6 \leq 25.5$

$x_1 \geq 0, x_2 \geq 0, x_3 \geq 0, x_4 \geq 0, x_5 \geq 0, x_6 \geq 0$

4.2. Mathematics Form

$Z = 200x_1 + 100x_2 + 200x_3 + 400x_4 + 500x_5 + 500x_6 + 0s_1 + 0s_2 + 0s_3 + 0s_4 + 0s_5 + 0s_6 + 0s_7 + 0s_8 + 0s_9 + 0s_{10}$

Subject to:

Egg:

$0.035x_1 + 0.008x_2 + 0.008x_3 + 0.035x_4 + 0x_5 + 0.25x_6 + s_1 = 342.72$

Milk:

$0.05x_1 + 0.01x_2 + 0.01x_3 + 0.1x_4 + 0.1x_5 + 0.4x_6 + s_2 = 683.4$

Durian:

$0x_1 + 0.015x_2 + 0x_3 + 0x_4 + 0x_5 + 0x_6 + s_3 = 15.3$

Choco Chips:

$0x_1 + 0x_2 + 0.015x_3 + 0x_4 + 0x_5 + 0x_6 + s_4 = 15.3$

Evaporated Milk:

$0.01x_1 + 0x_2 + 0x_3 + 0.01x_4 + 0.01x_5 + 0x_6 + s_5 = 30.6$

Sugar:

$0.01x_1 + 0.005x_2 + 0.005x_3 + 0.03x_4 + 0.03x_5 + 0.12x_6 + s_6 = 214.2$

Thai Tea Leaves:

$0x_1 + 0x_2 + 0x_3 + 0x_4 + 0.015x_5 + 0x_6 + s_7 = 15.3$

Coco Powder:

$0x_1 + 0x_2 + 0.0025x_3 + 0x_4 + 0x_5 + 0x_6 + s_8 = 2.55$

Flour:

$0x_1 + 0.0025x_2 + 0.0025x_3 + 0x_4 + 0x_5 + 0.125x_6 + s_9 = 132.6$

Food Color:

$0x_1 + 0.005x_2 + 0x_3 + 0x_4 + 0x_5 + 0.02x_6 + s_{10} = 25.5$

$x_1, x_2, x_3, x_4, x_5, x_6, s_1, s_2, s_3, s_4, s_5, , s_6, s_7, s_8, s_9, s_{10} \geq 0$

5.CALCULATE WITH THE EXPERIMENTS RESULT

5.1. Calculate by using MATLAB software

5.1.1. Flow chart for MATLAB software

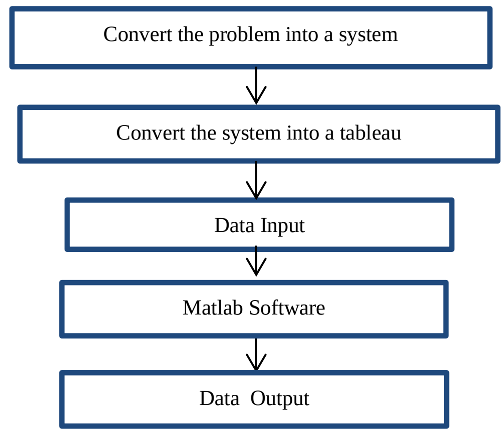

Figure.4 Steps by MATLAB software

5.1.2.The output from MATLAB software

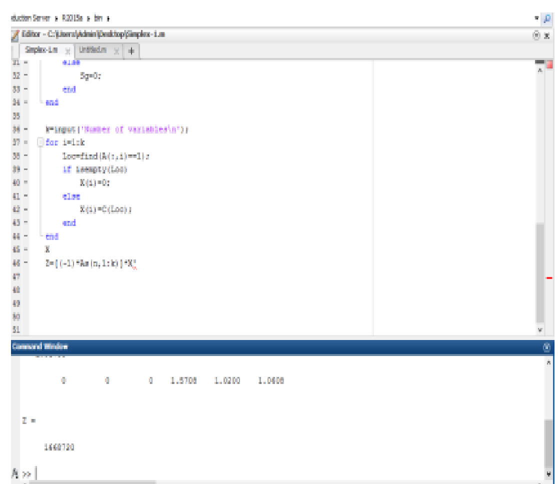

Figure.5 Result of MATLAB SOFTWARE

5.1.3. Coding of MATLAB software

```
clc; clear; close all

A=input('Enter coefficient matrix A\n');
C=input('Enter constant vector\n');
n=length(C);
if any(A(n,:)<0)
    Sg=1;
end
As=A;
for j=1:3
    [Va,La]=min(A(n,:));
    Cn=C(1:n-1)./A(1:n-1,La)';
    if any(Cn<0)
        Loc=find(Cn<0);
        Cn(Loc)=Inf;
    end
    [Vc,Lc]=min(Cn);
    A(Lc,:)=A(Lc,:)/A(Lc,La);
    C(Lc)=Vc;

    for i=1:n
        if i~=Lc
            MF=A(i,La)/A(Lc,La);
            A(i,:)=A(i,:)-MF*A(Lc,:);
            C(i)=C(i)-MF*C(Lc);
        end
    end
    if any(A(n,:)<0)
        Sg=1;
    else
        Sg=0;
    end
end
k=input('Number of variables\n');
for i=1:k
    Loc=find(A(:,i)==1);
    if isempty(Loc)
        X(i)=0;
    else
        X(i)=C(Loc);
    end
end
X
Z=[(-1)*As(n,1:k)]*X'
```

Figure.6 Coding of MATLAB software

Using the MATLAB software before we need to prepare the following components of the model.
1.Each decision variable
2.The objective function and it value
3.Each functional constraint

After running the MATLAB software, we have Objective function, $Z = 1668720$

$x_1 = 0, x_2 = 0, x_3 = 0,$
$x_4 = 1570.8, x_5 = 1020.0, x_6 = 1060.8$
$\therefore x_4, x_5, x_6$ are important variables.
$\therefore x_4, x_5, x_6$ should produce more than x_1, x_2, x_3.

5.2. Calculate by mathematical method

We calculate by mathematical method to show the flow chart of simplex method.

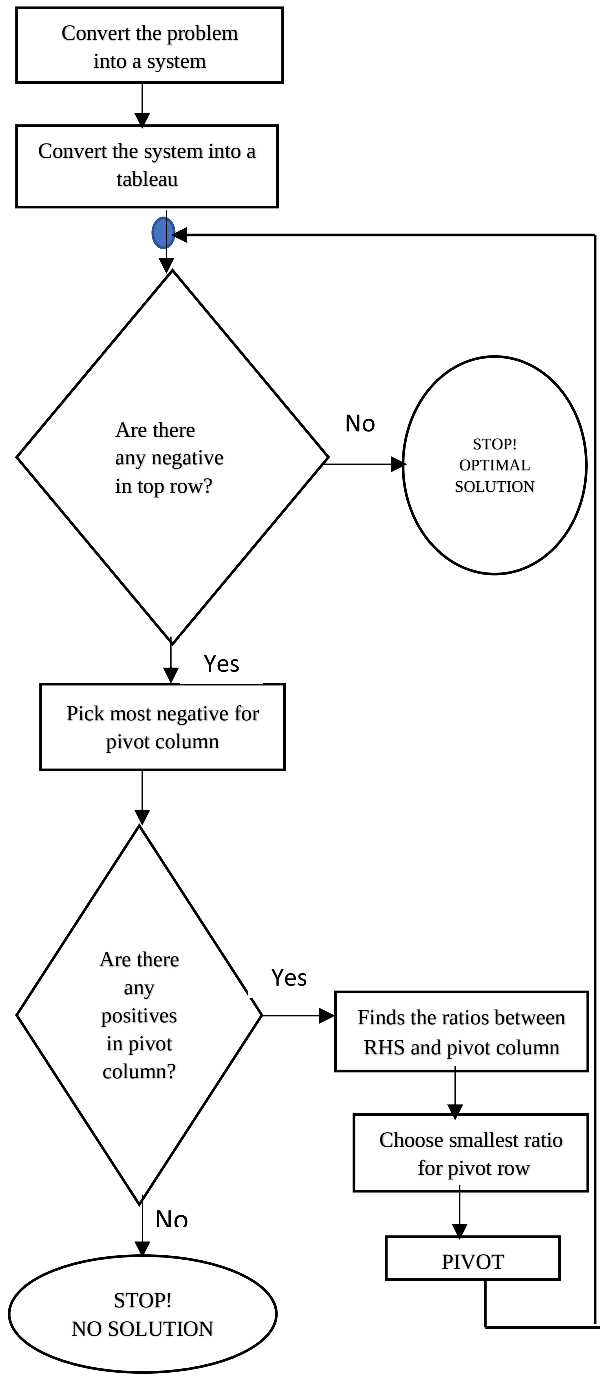

Figure.7 Flow chart for mathematical method

From the results of the LP model, it is desirable for Dessert Bar Handmade Bakery to concentrate more on $x_4(miky\ pudding), x_5(Thai\ tea)$ and $x_6(Rainbow\ Crepe\ Cake)$ production. By this total sales of about 1570.8 loves of x_4, 1020.0 loves of x_5, and 1060.8 loves of x_6 would be sold by Dessert Bar Handmade Bakery per month based on the costs of raw materials and the capacity of the oven only. Hence I found $x_4(miky\ pudding), x_5(Thai\ tea)\ and$ $x_6(Rainbow\ Crepe\ Cake)$ more produce than $x_1(egg\ pudding), x_2(Durian\ pillow) and$ $x_3(Chocolate\ pillow)$ per day. The result of this study is only based on the cost of raw material without labor and time of process.

5.CONCLUSIONS

In this paper, based on calculations using the linear programming simplex method and MATLAB software. Simplex method can solve many variables by hand or computerized. By using simplex method calculation take a lot of time and may have some error during the calculating process. On the other hand, using the MATLAB software as a program, this software will give an exact solution during a short time but need to data input exactly. We can study in this paper, the Dessert Bar Handmade Bakery use by computer is more effective for its production. The reader who read this paper will study many mathematics method and mathematics software to calculate the profits of the business. So, the other business should make this analysis to determine the optimum expected profits of their products.

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