APPLICATION OF LINEAR PROGRAMMING FOR OPTIMAL USE OF AL-AMEER FACTORY IN AL-AJAYLAT FOR THE PRODUCTION OF FOODSTUFFS

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Abstract

Linear programming is a mathematical method aims to optimize the available resources through several possible ways. This study is to highlight the role of linear programming in decision-making in Al-Ajaylat Foodstuff Factory. It focuses on solving linear programming problems in a simplified way "simplex" with the help of TORA Software.

Keywords: Linear Programming model; Simplex method; TORA Software.

Introduction

Linear programming is mathematical programming technique to optimize performance (example of profit and cost) under a set of resource constraints (machine-hours, man-hours, money, material etc.) as specified by an organization (Aregawi, 2018). It is considered one of the important topics in operations research as it is concerned with finding competitive and rapid solutions to problems. Capabilities increase of computers and software has increased linear programming importance to find solutions with amazing speed and high accuracy, regardless of the number of variables (Akpan and Iwok, 2016).

The Simplex Method is among the popular methods to solve the general Linear Programming Problem (LPP) (امبيرش ، الكواش ، زلي, 2020). In 1947, George. B. Dantzig formulated the general LPP and devised the Simplex Method for solving these LPP (Ndayiragije, 2017).

This study aims to achieve the objectives of the factory by reducing costs and maximizing the factory turnover. Reaching the optimal production rate will be achieved by using linear programming, and making appropriate decisions in the factory.

Linear Programming Model

The general linear programming model with **n** decision variables and **m** constraints can be stated in the following form

Objective Function

$$\boldsymbol{Max\ .or\ Min\ Z = c_1X_1 + c_2X_2 + \ \dots\dots.. + c_nX_n}$$

Constraints / Limitations

Subject to**:**

$$\boldsymbol{a_{11}X_1 + a_{12}X_2 + \ \dots\dots.. + a_{1n}X_n (\geq, =, \leq) b_1}$$

$$\boldsymbol{a_{21}X_2 + a_{22}X_2 + \ \dots\dots.. + a_{2n}X_n (\geq, =, \leq) b_2}$$

$$\vdots$$

$$\vdots$$

$$\boldsymbol{a_{m1}X_1 + a_{m2}X_2 + \ \dots\dots.. + a_{mn}X_n (\geq, =, \leq) b_m}$$

$\sum_{j=1}^{n} a_{ij}X_j \ (\leq, =, \geq) b_i \quad ,(i = 1,2,3,\dots..m)$ where $a_i, b_i, c_i \ \forall (i = 1,2,3,\dots..m)$ are constants.

Non-Positive Restrictions: Non-Negativity Constraint

$$\boldsymbol{X_1, X_2, \dots\dots\dots\dots, X_n \geq 0}$$

The main task of solving a linear programming problem is to find an optimal feasible solution (Hadley, 2002).

The above LPP model having **n** decision variables can be summarized in the following form:

$$\boldsymbol{Maximise\ .or\ Minimise\ Z = \sum_{j=1}^{n} c_jX_j}$$

Subject to

$$\boldsymbol{\sum_{i=1}^{m}\sum_{j=1}^{n} a_{ij}X_j \ (\leq, =, \geq) b_i \quad (i = 1, 2, \dots, m)}$$

$$\boldsymbol{X_j \geq 0, j = 1, 2, \dots, n}$$

where, c_j, a_{ij}, b_i are constants.

Data Presentation and Analysis

The data for this paper were collected from (Al-Ameer Factory in Al-Ajaylat). The data consist of total amount of raw materials (Flour, Sugar, Butter, Cocoa powder, Tahinia) available for daily production of three (Halawa Tahini, Biscuit Al-Bataal, Weffer Maryoo).

Princess Food Industries Factory

Al-Ameer Factory for Food Industries is located in the city of Al-Ajaylat, Sania Khamlej area, south of Al-Ajaylat city, 6438 meters of Al-Ajaylat round about and next to Mahmoud Mosque. This factory was established in 1995. At the beginning, it just produced Shamia product. Later, it has developed at a stable pace and it is considered one of the largest factories in the city. About 87 technician, worker, and employee are running this factory, of which 80% are Libyans.

Model Formulation

The formation of linear programming tables for each of Shamia Al-Amira, Al-Batal Biscuit "Candlestick", and Mario Wafer's "Chocolate" will be studied.

Table (1): Shamia Al-Amira Mixture and the Price of its Constituent Raw.

Raw material	Quantities inKg	The price of a kilo in dinars	The cost of the raw unit
Tahinia	260	15	3900
Sugar	300	3	900
Lecithin	1	6	6
Vanilla	0.2	19	3.8
The flavor	0.1	2	0.2
Assassen	5	35	175
Total			**4985**

Table (2): Al-Batal Biscuit, Mix "Al Shamadan" and the Price of its Constituent Raw Materials.

Raw material	Quantities in kg	The price of a kilo in dinars	The cost of the raw unit
Flour	50	3	150
Butter	39.3	11	432.3
Carbonate	0.002	7	0.014
Cocoa powder	4	11	44
Sugar	50	3	150
Hazelnut flavor	0.25	47	11.75
Total			**788.064**

Table (3): Mario Biscuits with Chocolate and the Price of its Constituent Raw Materials.

Raw material	Quantities in Kg	The price of a kilo in dinars	The cost of the raw unit
Flour	50	3	150
Butter	75	11	825
Carbonate	0.002	7	0.014
Sharetek butter	75	9	675
Sugar	208	3	624
Cocoa powder	25	9.5	237.5
Milk powder/dried milk	13	12	156
Chocolate flavor	0.025	49	1.225
Total			**2668.739**

The linear programming model for the above production

Let the quantity of Halawa Tahinia be produced $= X_1$,

Let the quantity of Biscuit Al-Bataal be produced $= X_2$,

Let the quantity as of Weffer Maryoo be produced $= X_3$,

Let Z denote the profit to be maximize.

The simplified method is defined as a mathematical method with high efficiency in extracting optimal solutions to linear programming problems in general. The possibility of manipulating information for linear programming problems on computers led to its wide spreading.

Solving linear programming problems in the simplified way "simplex"

$$\boldsymbol{Max\ \ Z = 400X_1 + 350X_2 + 300X_3}$$

Subject to:

$$\boldsymbol{260X_1 \leq 300}$$

$$\boldsymbol{50X_2 + 50X_3 \leq 120}$$

$$\boldsymbol{300X_1 + 50X_2 + 208X_3 \leq 600}$$

$$\boldsymbol{4X_2 + 25X_3 \leq 40}$$

$$\boldsymbol{39.3X_2 + 75X_3 \leq 130}$$

$$\boldsymbol{5X_1 \leq 7}$$

$$\mathbf{13X_3 \leq 20}$$

$$\mathbf{X_1 \leq 3}$$

$$\mathbf{17X_1 + 14X_2 + 16X_3 \leq 55}$$

$$\mathbf{13X_1 + 10X_2 + 12X_3 \leq 45}$$

$$\mathbf{X_1, X_2, X_3 \geq 0}$$

The values were $x_1 = 1.1538$, $x_2 = 2.4000, x_3 = 0$.

TORA Software

We will analyze the data using TORA software. From the main menu, select the Linear Programming option, enter the input values for the previously discussed problem as shown in the following Figure (1).

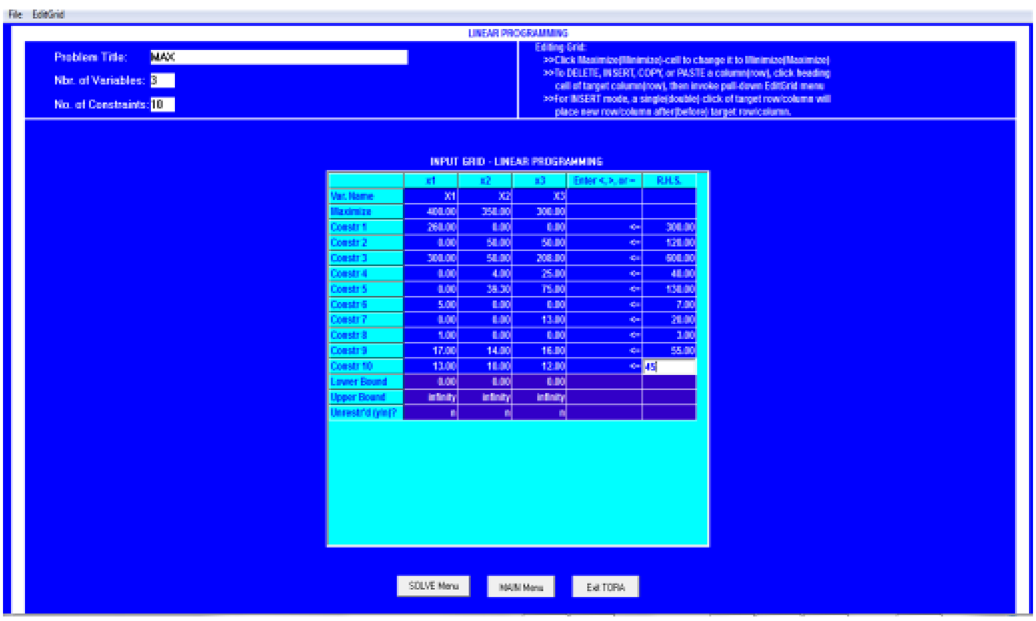

Figure (1): Solving LPP using Computer with TORA (Input Screen).

The pop-up menu also indicates that the solution has reached the optimal level. We can now see that all the values in the row of the target function z max are nonnegative indicating that the solution is optimal. The final recurrence table is shown in the following Figure (2).

LINEAR PROGRAMMING

Variable	Value	Obj Coeff	Obj Val Contrib
x1: X1	1.15	400.00	461.54
x2: X2	2.40	350.00	840.00
x3: X3	0.00	300.00	0.00

Constraint	RHS	Slack-/Surplus+
1 (<)	300.00	0.00
2 (<)	120.00	0.00
3 (<)	680.00	133.85-
4 (<)	40.00	30.40-
5 (<)	130.00	35.68-
6 (<)	7.00	1.23-
7 (<)	20.00	20.00-
8 (<)	3.00	1.85-
9 (<)	55.00	1.78-
10 (<)	45.00	6.00-

Sensitivity Analysis

Variable	Current Obj Coeff	Min Obj Coeff	Max Obj Coeff	Reduced Cost
x1: X1	400.00	0.00	infinity	0.00
x2: X2	350.00	300.00	infinity	0.00
x3: X3	300.00	-infinity	350.00	50.00

Constraint	Current RHS	Min RHS	Max RHS	Dual Price
1 (<)	300.00	0.00	327.29	1.54
2 (<)	120.00	0.00	126.37	7.00

Figure (2): Final Iteration Table (TORA, Output Screen).

The above linear programming model was solved using TORA software, in the Figure (1). which gives an optimal solution of the net profit (Shamia Al-Amira Al-Batal Biscuit “Al Shamadan” and Mario Wafer's “Chocolate”) is 1,301.5390 dinars per mixture. The factory should produce $x_1 = 1.1538$ and $x_2 = 2.4000$ valued atproduction$x_3 = 0$.

Interpretation of the Result

Based on the data collected, the above linear programming model was solved by using the simplified method and the TORA program, which gave the optimal solution. This will provide a maximum profit of 1,301.5390 dinars. The plant should produce Shamia Al-Amira, $x_1 = 1.1538$, and Albatal “Candlestick Biscuit” $x_2 = 2.4000$. And it should not produce "chocolate chip" Mario, $x_3 = 0$.) because it is no profitable.

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