OPTIMAL PRODUCTION OF BRA BLOCK FACTORY BY USING SIMPLEX METHOD

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ABSTRACT

In this paper simplex method is used to obtain the optimal solution to maximize the production profit for three different block types in BRA BLOCK FACTORY for heat insulating light construction pomic blocks productions. The three different model that we have taken to investigat the maximum profit for the factory are BB6H.10, BBS.15 and BB2H.20. As aresult we found that the first and the third types of model gives the maximum profit.
KEYWORDS : Linear Programming Problems;Integer Programming Problems; Simplex Method; Constraints; Objective Function; Variables, Slack Variable;Surplus Variables; Optimal Solution.

1. INTRODUCTION

Simplex method is the first method which was able to solve a linear programming problem developed by the American Air Force during the Second World War. It has proved in practice to perform very well in problems of small or medium size, although (Klee,V., Minty, GJ., 1972) had proven that in the worst case its behavior presents exponential complexity. Since then, a lot of research has been done to 1nd a faster (polynomial) algorithm that can solve LPs. The main branch of this research has been devoted to interior point methods (IPM). There is still much research being done in order to improve pivoting algorithms. Recently, (Paparrizos, 1991) proposed an exterior point Simplex algorithm that avoids the feasible Region; (Luh, H., Tsaih, R. , 2002) proposed using IPM to replace phase I of the Simplex; Paparrizos et al. In this research simplex method is used to find optimal solution for the problem that has taken from BRA.BLOCK FACTORY Duhok, three types of block have been chosen of PONZA model BB6H.10, BBS.15 and BB2H.20, in this paper $\mathbf{B_1}$, $\mathbf{B_2}$ and $\mathbf{B_3}$ represent the our chosen block types respectively. Furthermore, as it is clear that the linear programing problem is organized in objective function and constraints, in this paper our objective function is the percentage profit in each block types and the constraint part includes five constraints the first two one are mixing and pressing the others constraints are number of our block product in per day.

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2. Linear programming problem (Lpp) (Usha, K., Rashmi , M., 2016), (Bland R. , 1977)

A linear programming problem (LPP) is a mathematical program in which the objective function is linear in the unknowns and the constraints consist of linear inequalities.

We formulate a mathematical model for general problem of allocating resources to activities. In particular, this model is to select the values for x_1, x_2, …..,x_n as to maximize or minimize

$$z = c_1x_1 + c_2x_2 + \cdots + c_nx_n$$

Subject to constraints :

$$a_{11}x_1 + a_{12}x_2 + \cdots + a_{1n}x_n (\leq \text{ or } \geq) b_1$$
$$a_{21}x_1 + a_{22}x_2 + \cdots + a_{2n}x_n (\leq \text{ or } \geq) b_2$$
$$\vdots$$
$$a_{n1}x_1 + a_{n2}x_2 + \cdots + a_{nn}x_n (\leq \text{ or } \geq) b_n$$

and

$$x_1, x_2, \ldots . x_n \geq 0$$

Where :

Z = value of overall measure of performance.

x_j = level of activity (for $j = 1, 2, \ldots \ldots, n$)

c_j= increase in Z that would result from unit increase in level of activity j.

b_i= amount of resource i that is available for allocation

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to activities ((for $i = 1, 2, \dots \dots, m$)
a_{ij}= amount of resource I consumed by each unit of activity j.

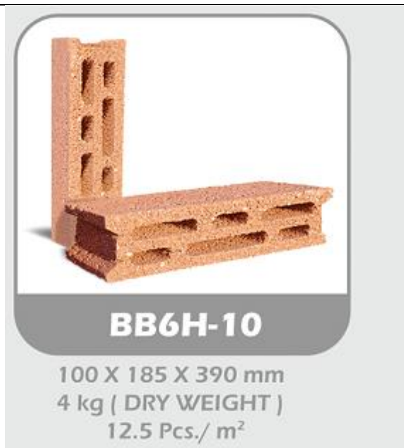
3. History of BRA Block factory

BRA plants was established on 02/02/2006 to produce the insulating volcanic light blocks, and the actual operation as on 12/01/2013 to be the largest plant of its kind in the Middle East, the production capacity of up to (100,000 pieces) a day ... and nearly (2,000,000 Piece) monthly using the technology of ADLER French company....

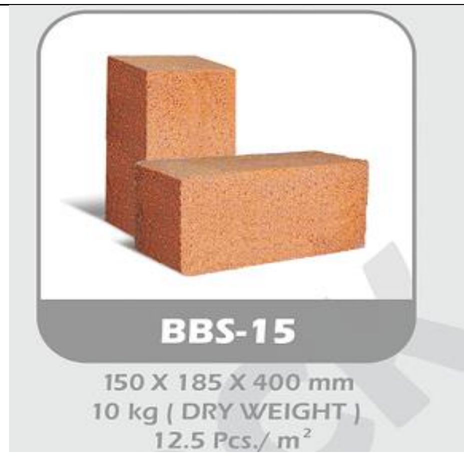
The plant produces more than (25 types) of BRA BLOCK with various dimensions, measurements according to German, European and Turkish standards and specifications for this type of products ....

The production process are 100% automatic using volcanic material 100% natural without any additives or improvers, the mode of production and drying is done based on the principle of (natural curing system) ....

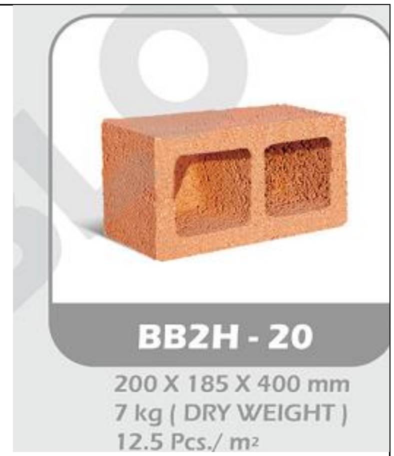
BRA BLOCK is produced from a natural volcanic stones which characterized by light weight density ranging between 600.700 kg / m 3, and high permeability to contain pores formed by natural interactions during the formation of these stones are called (PONZA) .....



Type (B_1)



Type (B_2)



Type (B_3)

4. Computational Procedure of Simplex Method (Dantzig, 1963)

Simplex method by G. Danztig in 1947. The simplex method provides an algorithm (a rule of procedure usually involving repetitive application of a prescribed operation) which is based on the fundamental theorem of linear programming.

This paper aims to find the maximum profit for three types of ponza block which denoted by B_1, B_2 and B_3 of BRA. BLOCK FACTORY. Every type needs two stages , mixing and pressing,each step needs a period of time to produce a certain type of block. For this porpuse data are collected as shown in table1 and table 2.

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4.1Types and amount of production for BRA Block

Table (1) : Available amont of production per day

Block type	**Amount available for each day**
Type (B_1) ((100*185*390 mm) , 4 kg (dry weight), 12.5 pcs./m2)	33000
Type(B_2) ((150*185*4000 mm) , 10 kg (dry weight), 12.5 pcs./m2)	24000
Type(B_3) ((200*185*4000 mm) , 7 kg (dry weight), 12.5 pcs./m2)	18000

4.2 Duration times of produce

In this stage the block is mixed and pressed in a different period of time as shown in table 2,

Table (2) : The Time needs in each stage

Types / stages	**B_1**	**B_2**	**B_3**
mixing	0.627	0.866	1.155
pressing	0.133	0.184	0.25
Available time(per hour)	25200	25200	25200

Now the factory produces 33000 of type B_1, 24000 of type B_2 and 18000 0f type B_3 per day. The profit of each product is $0.10, $.0.05 and $0.10 respectively.

Table (3) : The profit of each types in US Dollar

Block Type	**Daily Profit**
B_1	$3300
B_2	$1200
B_3	$1800

5. Formulate the research problem as a linear programming problem

A BRA BLOCK FACTORY produces three types of blocks B_1, B_2 and B_3 and the profit of each product respectively are $0.10, $.0.05 and $0.10. Each product is processes in two stages, mixing S_1 and pressing S_2, and needs 99 per second in S_1 stage and 21 per second in S_2 stage. Available time for both stages is not more than 2 minutes. The available times for both stages are not more than 7 hours per day. The limit number of products B_1, B_2 and B_3 respectively are as follows : (330000, 240000, and 180000) per day. In this research we assume that $x_1$represents the product number of type B_1, x_2 represents the product number of type B_2 and x_3 represents the product number of type B_3

Table (4) : Formula

Stages	**Type B_1**	**Type B_2**	**Type B_3**	**Availability**
Mixing S_1	0.627	0.866	1.155	25200
Pressing S_2	0.133	0.184	0.250	25200
Profit	$ 0.10	$ 0.05	$ 0.10	

The objective function for this problem is

Maximize $z_x = 0.10\ x_1 + 0.05x_2 + 0.10\ x_3$

The constraints are formulated as follows :

$$0.627x_1 + 0.866x_2 + 1.155x_3 \leq 25200$$

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$$0.133x_1 + 0.184x_2 + 0.250x_3 \leq 25200$$
$$x_1 \leq 33000$$
$$x_2 \leq 24000 \qquad (5.1)$$
$$x_3 \leq 18000$$
$$x_1, x_2, x_3 \geq 0$$

First we start to convert the problem as standard linear programming problem, thus the slack variables should add in each constraint in terms of index (i.e. s_1 in constraint one, s_2 in constraint two and so on)

Objective function :

Maximize $z_x = 0.10\,x_1 + 0.05x_2 + 0.10\,x_3 + 0s_1 + 0s_2 + 0s_3 + 0s_4 + 0s_5$

Constraints :

$$0.627x_1 + 0.866x_2 + 1.155x_3 + s_1 = 25200$$
$$0.133x_1 + 0.184x_2 + 0.250x_3 + s_2 = 25200$$
$$x_1 + s_3 = 33000$$
$$x_2 + s_4 = 24000$$
$$x_3 + s_5 = 18000$$
$$x_1, x_2, x_3, s_1, s_2, s_3, s_4, s_5 \geq 0$$

The problem can be solved by using the WinQSB program (Al-safar, 2010).

In this stage the data are tabulated as follow :

Table (5) : Table of initial data (Simplex Method)

$C_j \longrightarrow$			0.10	0.05	0.10	0	0	0	0	0	
Basic Variables	C_B	X_B	x_1	x_2	x_3	s_1	s_2	s_3	s_4	s_5	Min ratio $\frac{X_B}{X_K}$
s_1	0	25200	0.627	0.866	1.155	1	0	0	0	0	40191.38755
s_2	0	25200	0.133	0.184	0.250	0	1	0	0	0	189473.68421
s_3	0	33000	1	0	0	0	0	1	0	0	33000
s_4	0	24000	0	1	0	0	0	0	1	0	....
s_5	0	18000	0	0	1	0	0	0	0	1	....
Z	Z=0		.0.10	.0.05	.0.10	0	0	0	0	0	$\longleftarrow \quad \Delta_j$

In this step $\mathbf{s_3}$ is removed and convert to x_1

$C_j \longrightarrow$			0.10	0.05	0.10	0	0	0	0	0	
BasicVariables	c_B	x_B	x_1	x_2	x_3	s_1	s_2	s_3	s_4	s_5	Min ratio $\frac{X_B}{X_K}$
s_1	0	4509	0	0.866	1.155	1	0	.0.627	0	0	3903.8961
s_2	0	20811	0	0.184	0.250	0	1	.0.133	0	0	83244
x_1	0.10	33000	1	0	0	0	0	1	0	0	....
s_4	0	24000	0	1	0	0	0	0	1	0	....
s_5	0	18000	0	0	1	0	0	0	0	1	18000
Z	Z=3300		0	.0.05	.0.10	0	0	0.10	0	0	$\longleftarrow \quad \Delta_j$

In this step s_1 is removed and convert to x_3

$C_j \longrightarrow$			0.10	0.05	0.10	0	0	0	0	0	
Basic Variables	C_B	X_B	x_1	x_2	x_3	s_1	s_2	s_3	s_4	s_5	Min ratio $\frac{X_B}{X_K}$

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x_3	0.10	3903.8961	0	0.749783	1	0.8658	0	.0.5428571	0	0	
s_2	0	19835.0259	0	.0.0034457	0	.0.21645	1	0.002714275	0	0	
x_1	0.10	33000	1	0	0	0	0	1	0	0	
s_4	0	24000	0	1	0	0	0	0	1	0	
s_5	0	14096.1039	0	.0.749783	0	.0.8658	0	0.5428571	0	1	
Z	Z=3690.38961		0	0.0249783	0	0.08658	0	0.04571429	0	0	$\longleftarrow \Delta_j$

Finally in above table we get the optimal solution for our problem which is Z= 3690.38961 where $x_1 = 33000, x_2 = 0$ and $x_3 = 3903.8961$, here producing 33000 of type B1 and 3903.8961 of type B3 we get \$3690.38961amout of money as maximum profit. In the above problem we take three types and find the maximum profit, but in case we need to find the maximum profit for two types, we will have three cases:

Case 1

Hence for B1 and B3 we will get a result as the same as above result.

Case 2

If the products of type B2 and product of type B3

Maximize $z_x = 0.05x_2 + 0.10\,x_3$

Subject to :

$$0.866x_2 + 1.155x_3 \le 25200$$
$$0.184x_2 + 0.250x_3 \le 25200$$
$$x_2 \le 24000$$
$$x_3 \le 18000$$
$$x_2, x_3 \ge 0$$

Using the same technique as used as in solving problem (5.1) the optimal solution Z= 2054.61893764434 where $x_2 = 5092.37875288683608$ and $x_3 = 18000$ can be obtained.

Case 3

If the products of type B1 and products of type B2

Maximize $z_x = 0.10\,x_1 + 0.05x_2$

Subject to :

$$0.627x_1 + 0.866x_2 \le 25200$$
$$0.133x_1 + 0.184x_2 \le 25200$$
$$x_1 \le 33000$$
$$x_2 \le 24000$$
$$x_1, x_2 \ge 0$$

Using the same technique as used as in solving problem (5.1) the optimal solution Z= 3560.33487297921 where $x_1 = 33000$ and $x_2 = 5206.69745958429121$ can be obtained.

Table (6) : The maximum profit for defferent cases using simplix method

Products	**Production in seven hours per day**					
Type B1	33000	0	0	33000	0	33000
Type B2	0	24000	0	5206.69745958429121	5092.37875288683	0
Type B3	0	0	18000	0	18000	3903.8961
Profit \$	3300	1200	1800	3560.33487297921	2054.61893764434	3690.38961

Here we need to convert the results to be integer value in staid of rational number because in the real life the above results are not accepted, then the next step we need to use integer programming problem to meet our final aim.

6. Integer programming problem (IPP) (Schrijver, 1986)

The linear programming models that have been discussed thus far all have been continuous, in the sense that decision variables are allowed to be fractional. Often this is a realistic assumption. For instance, we might easily produce $102\frac{3}{4}$ gallons of a divisible good such as wine. It also might be reasonable to accept a solution giving an hourly production of automobiles at $58\frac{1}{2}$ if the model were based upon average hourly production, and the production had the interpretation of production rates.

At other times, however, fractional solutions are not realistic, and we must consider the optimization problem :

Maximize of objective function :

$$z = \sum_{j=1}^{n} c_j\, x_j$$

Subject to constraints :

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

$$x_j \geq 0 \qquad (j = 1,2, \dots, n)$$

x_j integer for some or all $(j = 1,2, \dots, n)$.

This problem is called the *linear integer programming problem*.

It is said to be a *mixed* integer program when some, but not all, variables are restricted to be integer, and is called a *pure* integer program when *all* decision variables must be integers. As we saw in the preceding paper, if the constraints are of a network nature, then an integer solution can be obtained by ignoring the integrality restrictions and solving the resulting linear program. In general, though, variables will be fractional in the linear.programming solution, and further measures must be taken to determine the integer.programming solution.

First, solve the problem as linear programming problem to obtain optimal solution :

The technique that used in this paper is called Technique rounding solution for solving it. The purpose of using the mentioned technique is obtaining integer number of blocks as it is known that after the calculations sometimes, we get a rational number of objects that should be integer. Therefor in this case we have to change original number to integer because otherwise in real life it does have no meaning.

Table (7) : Technique rounding solution

Type B1	33000	0	0	33000	0	33000
Type B2	0	24000	0	5206	5092	0
Type B3	0	0	18000	0	18000	3903
Profit $	3300	1200	1800	3560.30	2054.60	3690.30

Conclusion

In conclusion, after defining A BRA BLOCK FACTORY and collecting data concerning of three types of products BB6H.10, BBS.15and BB2H.20, we formulate a problem of three variables representing the block types then used Simplex method and integer programming to find the maximum profit for factory of seven hours per day. As a result, we obtain that producing 33000 of type BB6H.10 and 3903 of type BB2H.20, give the maximum profit. It means that when the factory produces the mentioned number of types BB6H.10 and BB2H.20 it will get $3690.30 as a profit per day.

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