Application of Linear Programming in Block Industry Using Two Phase Method

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Abstract

This research application of linear programming in block industry is aim to maximize the profit in block industry. Data were obtain from iwa block industry in ilorin township on two types of block, 6 inches and 9 inches, and two phase method was used to analysed the data. The optimum solution is obtain at seventh iteration with X_1=400 units(6 inches block), X_2=450 units(9 inches block) and profit of #15,200 .We there by recommended to any Block Industry to simply specialize on the production of either 6 inches or 9 inches in order to minimize the total cost and maximize the profit.

Keywords

Linear, Programming, Block Industry, Minimize,Cost, Maximize Profit

I. Introduction

Block is one of the famous products in Nigeria today that can be found at virtually every angle across the nation, because it is one of most common important Building materials used in building houses i.e. flats, rooms, bungalows, shops e.t.c.`Block is of various sizes and their price depends relatively on the sizes. The blocks are produced with sand, water, cement and man power. In the light of this, it becomes imperative to find mix products that will yield maximum profit for the block industry.

II. Methodology

A. The Linear Programming Approach

Optimize $Z = C_1X_1 + C_2X_2 + \ldots\ldots\ldots\ldots C_nX_n$ .... (i)

s.t

$$a_{11}X_1 + a_{12}X_2 + \ldots\ldots a_{1n}X_n * b_1$$
$$a_{21}X_1 + a_{22}X_2 + \ldots\ldots a_{2n}X_n * b_2$$
$$a_{31}X_1 + a_{32}X_2 + \ldots\ldots a_{3n}X_n * b_3$$
$$\text{,,} \qquad \text{,,} \qquad \text{,,}$$
$$\text{,,} \qquad \text{,,} \qquad \text{,,}$$
$$a_{m1}X_1 + a_{m2}X_2 + \ldots\ldots a_{mn}X_n * b_m$$
$$X_1, X_2, \ldots\ldots\ldots\ldots X_n \geq 0 \ \ldots\ldots\ldots\text{(iii)}$$

Where * means =, ≤, ≥ and equation.

B. Two Phase Method

This is another approach to handle the artificial variable whenever they are added to the constraints.

1. Phase I

This phase consist of finding and initial basic feasible solution to the original problem[1]. In order words, the removal of the artificial variable is taken up first for this and artificial objective function is created which is the sum of all the artificial variables [2]. The artificial objective function is then minimized using the simplex method. If the minimum value of the artificial problem is zero, then the entire artificial variable have been reduced to zero, and we have the basic feasible solution to the original problem[4]. (Note if the sum of non – negative variable is zero, then each variable must identically equal to zero). We then go to Phase Two.

2. Phase II

In this phase, the basic feasible solution found at two end of phase I is optimized with respect to original objective function[5]. In order words, your final tableau of phase I become initial tableau of Phase II after changing the objective function the simplex method is ones again applied to determine the optimal solution[3].

III. Presentation of Data

Data are collected on two Types of Block in IWA block industry which are:-6 inches and 9 inches

Table 1: Requirements for Each Product Size

Product	Material Unit (Cement)	Labour Hours	Machine Hour
6 inches of block	5	1	3
9 inches of block	2	3	2

Table 2: Total Available Resources

Resources Sources	Availability Total
Material Unit (Cement) in bags	3000
Labour Hours	1750
Machine Hour	2100
Number of 6” blocks per 5 bags of cements	200
Number of 9” blocks per 2 bags of cements	60

Table 3: The Unit Profit Made on Production of Two Types of Blocks

Product	Unit Profit (N) per block
6” blocks	20
9” blocks	16

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IV. Formulation of Linear Programming Problem

Let X_1 be the number of unit of product A (6 inches of block) X_2 be the number of unit of product B (9 inches of block) The objective is to maximize profit.The profit per unit of product A is ₦20,the profit per unit of product B is ₦16,therefore the objective function is given asMax $Z = 20X_1 + 16X_2$. In this research, product A needs 5 Material unit, Bneeds 2 Material unit and the total available Material Unit is 3000.Theconstraint is, $5X_1 + 2X_2 \leq 3000$. Similarly, products A need 1 Labour Hours, B need 3 Labour hours and the total available is 1750,The constraint is given as, $X_1 + 3X_2 \leq 1750$. Also, product A need Machine Hours and B need 2Machine hours and the total available is 2100.The constraint is $3X_1 + 2X_2 \leq 2100$.

Furthermore, product A has 200 minimum available per 5 bags of cement And product B has 60 minimum available per 2 bags of cement. Hence, the Combine LPP in given as,

A. Application of Two Phase Simplex Method

Max $z = 20x_1 + 16x_2$

Subject to
$5X_1 + 2X_2 \leq 3000$
$X_1 + 3X_2 \leq 1750$
$3X_1 + 2X_2 \leq 2100$
$X_1 \geq 200$
$X_2 \geq 60$

Convert the problem into standard form, adding the slack variables, we have,

Max $Z = 20X_1 + 16X_2$

Subject to
$5X_1 + 2X_2 + X_3 = 3000$
$X_1 + 3X_2 + X_4 = 1750$
$3X_1 + 2X_2 + X_5 = 2100$
$X_1 - X_6 + R_1 = 200$
$X_2 - X_7 + R_2 = 60$
$X_1, X_2, X_3, X_4, X_5, X_6\ X_7, R_1, R_2 \geq 0$

r_1 & $r_2 \geq 0$

1. Phase I

We shall minimize the sum of artificial variable at this phase that is

Min $r = R_1 + R_2$

$r = 200 - X_1 + X_6 + 60 - X_2 + X_7$

$r = 260 - X_1 - X_2 + X_6 + X_7$

$r + X_1 + X_2 - X_6 - X_7 = 260$

Table 4: Simplex Tabeau for Phase I

ITR	BV	X_1	X_2	X_6	X_7	X_3	X_4	X_5	R_1	R_2	X_B	MIN RATIO
0 X_1 enters R_1 leaves	**R**	**1**	**1**	**-1**	**-1**	**0**	0	0	0	0	260	
	X_3	5	2	0	0	1	0	0	0	0	3000	600
	X_4	1	3	0	0	0	1	0	0	0	1750	1750
	X_5	3	2	0	0	0	0	1	0	0	2100	700
	R_1	1	0	-1	0	0	0	0	1	0	200	200
	R_2	0	1	0	-1	0	0	0	0	1	60	
1 X_2 enters R_2 leaves	**R**	0	1	0	-1	0	0	0	-1	0	60	
	X_3	0	2	5	0	1	0	0	-5	0	2000	1000
	X_4	0	3	1	0	0	1	0	-1	0	1550	516.7
	X_5	0	2	3	0	0	0	1	-3	0	1500	750
	X_1	1	0	-1	0	0	0	0	1	0	200	
	R_2	0	1	0	-1	0	0	0	0	1	60	60
2 Optimal	**R**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-1**	**-1**	**0**	
	X_3	0	0	5	2	1	0	0	-5	-2	1880	
	X_4	0	0	1	3	0	1	0	-1	-3	1370	
	X_5	0	0	3	2	0	0	1	-3	-2	1380	
	X_1	1	0	-1	0	0	0	0	1	0	200	
	X_2	0	1	0	-1	0	0	0	0	1	60	

Since r = 0, the original problem has a feasible solution. We can then discard the artificial variables the solution to phase I

$X_3 + 5X_6 + 2X_7 = 1880$
$X_4 + X_6 + 3X_7 = 1370$
$X_5 + 3X_6 + 2X_7 = 1380$
$X_1 - X_6 = 200$
$X_2 - X_7 = 1880$

The original objective function becomes

Max $Z = 20X_1 + 16X_2$

$Z = 20(200 + X_6) + 16(60 + X_7)$
$4000 + 20X_6 + 960 + 16X_7$
$4960 + 20X_6 + 16X_7$

$Z - 20X_6 - 16X_7 = 4960$

Table 5: Simplex Tableau for Phase II

Iteration	BV	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_B	Min Ratio
	Z	**0**	**0**	**0**	**0**	**0**	**-20**	**-16**	**4960**	
0 X_6 enters X_1 leaves	X_3	0	0	1	0	0	5	2	1880	376
	X_4	0	0	0	1	0	1	3	1370	1370
	X_5	0	0	0	0	1	3	2	1380	460
	X_1	1	0	0	0	0	-1	0	200	
	X_2	0	1	0	0	0	0	-1	60	
1 X_7 enters X_5 leaves	**Z**	**0**	**0**	**4**	**0**	**0**	**0**	**-8**	**12480**	
	X_6	0	0	$^1/_5$	0	0	1	$^2/_5$	376	940
	X_4	0	0	$-^1/_5$	1	0	0	$^{13}/_5$	994	382.31
	X_5	0	0	$-^3/_5$	0	1	0	$^4/_5$	252	315
	X_1	1	0	$^1/_5$	0	0	0	$^2/_5$	576	1440
	X_2	0	1	0	0	0	0	-1	60	
2 X_3 enters X_4 leaves	Z	0	0	-2	0	10	0	0	15000	
	X_6	0	0	$^1/_2$	0	$-^1/_2$	1	0	250	500
	X_4	0	0	$^7/_4$	1	$^{13}/_4$	0	0	175	100
	X_7	0	0	$-^3/_4$	0	$^5/_4$	0	1	315	
	X_1	1	0	$^1/_2$	0	$-^1/_2$	0	0	450	900
	X_2	0	1	$-^3/_4$	0	$^5/_4$	0	0	375	
Optimal	**Z**	**0**	**0**	**0**	**57/50**	**$^{629}/_{100}$**	**0**	**0**	**15200**	

Optimal solution: X1 = 400, X2 = 450 and Z = 15200

V. Summary and Conclusion

From the analysis carried out so far one can see that the optimal solution was obtained at the seventh iterations with X1=400 units(6 inches block), X2=450 units(9 inches block) and Z=#15,200 .This implied that iwa block industry should produce 400 units of 6 inches and 450 unit of 9inches to make a profit of #15,200.

VI. Recommendation

We there by recommended to any Block Industry to simply specialize on the production of either 6 inches or 9 inches to reduce the total cost in order to maximize profit.

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