Improving Hebron Drinks Company Value through Optimization of Production Processes using Operations Research Model

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Abstract—**Production and Operations Management Organizations are continually faced with the challenge of maximizing profit while incurring cost. Poor production planning subjects the organization to promote more expenses rather than revenue. In this paper optimization of production processes was treated as a linear programming problem which resulted in the implementation of a linear programming model for Hebron Drinks, a Nigerian Beverage Industry. This work was carried out through the access of relevant literatures, primary sources of data; information analysis was carried out using the simplex method. In our aim to maximize profit and minimize cost, a linear programming model was designed taking into consideration records such as sales, costs, human resources, salaries and wages, energy and power consumption and revenue. Results were generated using a Computer Aided Software tool - (LiPS-1.11.0). Interpretations of the results from the analysis formed basis for recommendations to enhance managerial decisions. Specifically, the production capacity of Black Currant juice should increase by four units within a production period to maximize the profit of the company within the period.**

Index Terms— **Hebron drinks, Simplex Method, Operations Research, Optimization, Linear Programming, Production Processes.**

I. Introduction

BUSINESS everywhere throughout the world, including the ones in Nigeria, are persistently faced with deficiencies of generation inputs which result in low capacity use and thus low yields. Be that as it may, an economy can only grow if administration choices at the firm level outcome in supported output through either cost minimization or output maximization culminating in increases generation in the real sector of the economy.

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Subsequently firm directors are continually looking for the correct choices to meet their targets which essentially revolve on how best to increase profit. (Ezema et al., 2012). Production is the core procedure of each manufacturing organization, thus the productivity and quality of decision taken on the shop floor decides the execution of the organization's quality administration framework. At planning stage, a great production manager must have the capacity to distinguish plausible restrictions keeping in mind the end goal to build up, preceding item realization processes, the suitable preventive measures, an enhanced production process is in this way described by the accessibility of wanted yield of products in type and quantity inside the arranged time at least cost. (Berrichi et al., 2012). Most organizations are frequently faced with decisions identifying with the utilization of constrained resources which incorporates men, materials, money and the issue of decision making depends on the most proficient method to settle on which resources would be allocated to get the best outcome, which may relate to profit or cost or both. (Muazu et al., 2012). Hebron drinks is a company in Nigeria that produces various types of beverages. It started production with two products in 2004, namely the sachet and bottled water. Black currant drink was later introduced by the company. Subsequently, the carbonated drinks, yoghurt were also introduced. A pet brewing unit which specializes in the making of various sizes of bottles for the company was later built within the company. The company has 52 staff including the unskilled, who help in the production processes of the products. The following categories of inputs are used in the company's operations processes: manpower, raw materials, machine, cost, energy. The company's profitability profile shows that profit continued to vary each year, in order to ensure optimum profit for the company, optimal production level that effectively utilize the available resources have to be determined. Most beverage companies operation processes include treating the water, compounding ingredients, carbonating products, filling products and packaging. This is the case in Hebron drinks company. Hebron drinks adopt the use of standard operation procedure (SOP) to produce their products. This process document which gives detailed description on how an operator should perform his operations. The purpose of SOPs today is to guarantee that all workers are performing tasks in the same way, to get an expected output. The research is gone for how constrained resources, crude materials can be utilized to acquire maximum contribution to profit, it is likewise aimed at deciding the product that contribute to such profit. (Agarana and Ayeni, 2015; Agarana, Bishop and Odetunmibi, 2014),) Among its noteworthiness are that it is a widely applicable problem-solving model and positioned among the most scientific advances of the twentieth century. It has been applied in areas like management, financial matters, research, software engineering, and the sky is the limit from there. [Agarana and Ehigbochie, 2015; Agarana, Owoloko and Kolawole, 2016),]. The contributions of the operations processes are maximized utilizing linear programming method with a specific end goal to turn out optimal outputs. From perception, a few inquiries ring a bell with respect to why they are not utilizing linear programming for their decision making. secondly, what in truth are the potential advantages of linear programming model to the organization? Thirdly, would they be able to make higher profit by adopting the linear programming technique in determining the product mix and enhance production processes? The Mathematical model used in this paper is Linear Programming model. Linear Programming is a branch of Mathematics that deals with solving optimization problems. It consists of linear function to be minimized or maximized subject to certain constraints (Olsen, 2012). Linear programming is a mathematical model used to solve maximization or minimization problems. It is an operations research technique is widely used in finding solutions to complex managerial decision problems. Linear Programming is used in Company Management to get an optimum output.

II. PROBLEM FORMULATION

This paper sets out to optimize the operation processes of Hebron Drinks in order to improve the company's value in terms of maximizing her profitability using operations research model.

A. *The Activities*

The activities of the company include:

Activity 1 - production of Sachet water,
Activity 2 – production of Bottle Water,
Activity 3 - production of Yoghurt,
Activity 4 - production of Orange Juice,
Activity 5 - production of Apple Juice,
Activity 6 - production of Black currant Juice.

B. *Constraints*

Raw Material, Man Power, Machine Hour, Cost and Energy are the resources These resources are usually limited. These resources constitute the inputs to the operations processes. The available quantity of these resources of Hebron drinks for a period of one week was used in this paper.

C. *Resources Available for a Week*

The following are the available quantity of these resources for a week, according to the information gathered from the management of the company. Cost of maintenance of machine, power supply, cost of labour, raw materials used in production of each product, quantity of each products produced, capital outlay of each products and all other useful information are as shown in the table I.

D. *Contributions*

The contributions of the activities to the company's profit, are as follows:

C1=60%, C2=80%, C3=70%, C4=60%, C5 = 50%, C6=70%
Where,
C1 represents the percentage contribution from Sachet Water production
C2 represents the percentage contribution from Bottle water production
C3 represents the percentage contribution from yoghurt production
C4 represents the percentage contribution from Apple Juice production
C5 represents the percentage contribution from Orange juice production
C6 represents the percentage contribution from Black Currant juice production

A. *Mathematical Representation*

Let the decision variables; X1, X2, X3, X4, X5, X6, represent increase in the activities, as follows:
X1 represents increase in Sachet Water production
X2 represents increase in Bottle water production
X3 represents increase in yoghurt production

X4 represents increase in Apple Juice production
X5 represents increase in Orange juice production
X6 represents increase in Black Currant juice production

B. *Mathematical Representation*

Let the decision variables; X1, X2, X3, X4, X5, X6, represent increase in the activities, as follows:
X1 represents increase in Sachet Water production
X2 represents increase in Bottle water production
X3 represents increase in yoghurt production
X4 represents increase in Apple Juice production
X5 represents increase in Orange juice production
X6 represents increase in Black Currant juice production

The Objective function becomes:

$$Maximize\ Z = \sum_{j=1}^{6} cjxj$$

That is
Maximize Z = C1X1 + C2X2 + C3X3 + C4X4 + C5X5 +C6X6

= 60X1 + 80X2 + 70X3 + 60X4 + 50X5 +70X6

C. *Quantity of Material per Unit of Activity*

Let aij represent the amount of available of resource i per unit of activity j:

a11 = Amount of raw material needed for 1st activity
a12 = Amount of raw material needed for 2nd activity
a13 = Amount of raw material needed for3rd activity
a14 = Amount of raw material needed for 4th activity
a15 = Amount of raw material needed for 5th activity

a16 = Amount of raw material needed for 6th activity

D. Labour Hour per Unit of Activity

a21 = Manpower hour needed for 1st activity
a22 = Manpower hour needed for 2nd activity
a23 = Manpower hour needed for 3rd activity
a24 = Manpower hour needed for 4th activity
a25 = Manpower hour needed for 5th activity
a26 = Manpower hour needed for 6th activity

E. Machine Hour per Unit of Activity

a31 = Machine time needed for 1st activity
a32 = Machine time needed for 2nd activity
a33 = Machine time needed for 3rd activity
a34 = Machine time needed for 4th activity
a35 = Machine time needed for 5th activity
a36 = Machine time needed for 6th activity

F. Cost per Unit of Activity

a41 = cost needed for activity 1
a42 = cost needed for activity 2
a43 = cost needed for activity 3
a44 = cost needed for activity 4
a45 = cost needed for activity 5
a46 = cost needed for activity 6

G. Amount of Energy per Unit of Activity

a51 = unit of energy for activity 1
a52 = unit of energy for activity 2
a53 = unit of energy for activity 3
a54 = unit of energy for activity 4
a55 = unit of energy for activity 5
a56 = unit of energy for activity 6

H. The Constraints in Mathematical Form

The Constraints are as follows:

$$\sum_{i=1}^{5}\sum_{j=1}^{6} a_{ij}x_j \leq b_i$$

Where, bi represent the available resources, i=1, 2, 3,4,5
From the data gathered, the values of aij are as follows:
a11 = 50000, a12 = 80000, a13 =95000, a14 = 85000, a15 = 85000, a16 = 85000
a21 = 16, a22 = 18, a23 = 18, a24 = 10, a25 = 10, a26 = 10
a31 = 20, a32 = 25, a33 = 10, a34 = 5, a35 = 5, a36 =5
a41 =60000, a42 =60000, a43 =65000, a44 =60000, a45 = 6000, a46 = 60000
a51 = 5000, a52 = 6000, a53 = 7000, a54 = 7000, a55 = 7000, a56 = 7000

III THE MODEL

Maximise Z = 60x1 + 80x2 + 70x3 + 60x4 + 50x5 +70x6
Subject to:
50000x1 + 80000x2 + 95000x3 + 85000x4 + 85000x5 + 85000x6 ≤800000
16x1 + 18x2 + 18x3 + 10x4 + 10x5 + 10x6 ≤40
20x1 + 25x2 + 10x3 + 5x4 + 5x5 + 5x6 ≤40
60000x1 + 60000x2 + 65000x3 + 60000x4 + 60000x5 + 60000x6 ≤900000
5000x1 + 6000x2 + 7000x3 + 7000x4 + 7000x5 + 7000x6 ≤50000
xi ≥ 0 ; i =1 , 2,…,5

A. The Standardized Model

Maximise Z = 60x1 + 80x2 + 70x3 + 60x4 + 50x5 +70x6
Subject to:
50000x1 + 80000x2 + 95000x3 + 85000x4 + 85000x5 + 85000x6 + X7 =800000
16x1 + 18x2 + 18x3 + 10x4 + 10x5 + 10x6 + X8 =40
20x1 + 25x2 + 10x3 + 5x4 + 5x5 + 5x6 + X9 =40
60000x1 + 60000x2 + 65000x3 + 60000x4 + 60000x5 + 60000x6 + X10 =900000
5000x1 + 6000x2 + 7000x3 + 7000x4 + 7000x5 + 7000x6 + X11 =50000
xi ≥ 0 ; i =1 , 2,…,5

IV MODEL SOLUTION

The simplex method is applied to the Standardized model. The initial simplex tableau is in Table II.

V RESULT DISCUSION

In this study, six decision variables, x1, x2… x6 were considered. They represent increase in the activities of Hebron drinks. Five constraints were also considered, excluding the non-negativity constraint. A computer software known as (LiPS-1.11.0) was used to solve the LP problem. The following results were obtained; variable x6= 4. The other five r decision variables however have zero value. This implies that the number of black currant juice expected to be produced, within one week, should increase by 4 units in order to maximize the profit of Hebron Drinks Company. Other activities of the company should remain as they were.

VI. CONCLUSION

This paper deals with improving Hebron drinks value through optimization of its production processes to improve profitability. Simplex method of solution was used for the iteration of the linear programming model formulated. A computer software- linear programming solver (LIPs) was used to solve the final tableau. From the results obtained, to improve the company's profitability, the company's production processes should be optimized by properly imploring the limited resources, which includes: Energy, Raw materials, Manpower, Machine hour and Cost. Specifically, there must be an increase in the production of black currant. This particular product is used as Holy Communion by one of the largest churches in the world, located in the same vicinity. So its demand by the church members is always on the rise.

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Table I: Amount of available resources used per week

RESOURCE	**AMOUNT USED PER WEEK**						**AVAILABLE RESOURCE**
Raw Material	Sachet water	Bottle water	yoghurt	Orange juice	Apple juice	Black currant	
	₦50000	₦80000	₦95000	₦85000	₦85000	₦85000	₦800,000
Man Power	16hrs	18hrs	18hrs	10hrs	10hrs	10hrs	40hrs
Machine Hour	20hrs	25hrs	10hrs	5hrs	5hrs	5hrs	40hrs
Cost	₦60000	₦60000	₦65000	₦60000	₦60000	₦60000	₦900,000
Energy	₦5000	₦6000	₦7000	₦7000	₦7000	₦7000	₦50,000

Table 2: Initial Simplex Tableau

Solution variable	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	Solution quantity
X7	50000	80000	95000	85000	85000	85000	1	0	0	0	0	800000
X8	16	18	18	10	10	10	0	1	0	0	0	40
X9	20	25	10	5	5	5	0	0	1	0	0	40
X10	60000	60000	65000	60000	60000	60000	0	0	0	1	0	900000
X11	5000	6000	7000	7000	7000	7000	0	0	0	0	1	50000
z	60	80	70	60	50	70	0	0	0	0	0	

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Appendix

*** Phase II --- Start ***

Basis	X1	X2	X3	X4	X5	X6	s7	s8	s9	s10	s11	RHS
s7	50000	80000	95000	85000	85000	85000	1	0	0	0	0	800000
s8	16	18	18	10	10	10	0	1	0	0	0	40
s9	20	25	10	5	5	5	0	0	1	0	0	40
s10	60000	60000	65000	60000	60000	60000	0	0	0	1	0	900000
s11	5000	6000	7000	7000	7000	7000	0	0	0	0	1	50000
Obj.	60	80	70	60	50	70	0	0	0	0	0	0

Variable to be made basic -> X2
Ratios: RHS/Column X2 -> { 10 20/9 1.6 15 25/3 }
Variable out of the basic set -> s9

*** Phase II --- Iteration 1 ***

Basis	X1	X2	X3	X4	X5	X6	s7	s8	s9	s10	s11	RHS
s7	-14000	0	63000	69000	69000	69000	1	0	-3200	0	0	672000
s8	1.6	0	10.8	6.4	6.4	6.4	0	1	-0.72	0	0	11.2
X2	0.8	1	0.4	0.2	0.2	0.2	0	0	0.04	0	0	1.6
s10	12000	0	41000	48000	48000	48000	0	0	-2400	1	0	804000
s11	200	0	4600	5800	5800	5800	0	0	-240	0	1	40400
Obj.	-4	0	38	44	34	54	0	0	-3.2	0	0	128

Variable to be made basic -> X6
Ratios: RHS/Column X6 -> { 224/23 1.75 8 16.75 202/29 }
Variable out of the basic set -> s8

*** Phase II --- Iteration 2 ***

Basis	X1	X2	X3	X4	X5	X6	s7	s8	s9	s10	s11	RHS
s7	-31250	0	-53437.5	0	0	0	1	-10781.3	4562.5	0	0	551250
X6	0.25	0	27/16	1	1	1	0	5/32	-9/80	0	0	1.75
X2	0.75	1	1/16	0	0	0	0	-1/32	1/16	0	0	1.25
s10	0/1	0	-40000	0	0	0	0	-7500	3000	1	0	720000
s11	-1250	0	-5187.5	0	0	0	0	-906.25	412.5	0	1	30250
Obj.	-17.5	0	-425/8	-10	-20	0	0	-135/16	23/8	0	0	222.5

Variable to be made basic -> s9
Ratios: RHS/Column s9 -> { 8820/73 - 20 240 220/3 }
Variable out of the basic set -> X2

*** Phase II --- Iteration 3 ***

Basis	X1	X2	X3	X4	X5	X6	s7	s8	s9	s10	s11	RHS
s7	-86000	-73000	-58000	0	0	0	1	-8500	0	0	0	460000
X6	1.6	1.8	1.8	1	1	1	0	0.1	0	0	0	4
s9	12	16	1	0	0	0	0	-0.5	1	0	0	20
s10	-36000	-48000	-43000	0	0	0	0	-6000	0	1	0	660000
s11	-6200	-6600	-5600	0	0	0	0	-700	0	0	1	22000
Obj.	-52	-46	-56	-10	-20	0	0	-7	0	0	0	280

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