Optimization of Processing Data Time for Stephens Bread Industries Owerri, Imo State, Nigeria

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Abstract– **This research work is aimed at modeling production processes in bread industries using linear programming model as optimization model in a given bread industry (Stephens Bread) for effective and efficient production. The L.P model was deduced to be the best optimization model to be used in any bread industry since the model analytically gives a simultaneous result of profit maximization and cost minimization. Specifically, a designed simulator in a MATLAB and Graphical Users Integrated Development Environment (GUIDE) windows (BREADPROD) that are capable of detecting the exact quantity of bread to be produced and the optimization level to maintain in any bread industry was developed. The simulator was subjected to various initial input conditions in bread production processes which include mixing, matching, moulding and baking processes with three (3) different sizes of bread loaves: the giant, the long and small loaves with reference to non-basic variables – x_1, x_2, x_3 respectively. BREADPROD, the designed simulator, equally shows how realistic or unrealistic bread production could be. The application of L.P model which agreed with the designed BREADPROD simulator gave different profits for the two bread industries in this study while the optimum recommended production gave a higher profit of over one hundred percent when compared with that of Stephens Bread industries. The result of the proposed production mix used gave a production mix of 202 giant loaves, 102 long loaves and 92 small loaves representing 51%, 26% and 23% of the total production respectively as against the production mix for Stephens Bread, which gave 115 giant loaves, 40 long loaves and 110 small loaves. The giant loaf, long loaf and small loaf are 43%, 42% and 15% of the total production respectively.**

Keywords– **Modeling Production Process, Industries and Graphical Users Integrated Development Environment**

I. INTRODUCTION

In this modern day, manufacturing industries at all levels are faced with the challenges of producing goods (cars, machines, breads etc) of right quality and quantity and at right time and more especially at minimum cost (minimized cost) and maximum profit for their survival and growth. Thus, this demands an increase in productive efficiency of the industry.

The aim of this paper is to use linear programming (LP) as a mathematical model to optimize the production processes of manufacturing industries such as bread bakery industries, and to design software using a Graphical Users Integrated Development Environment (GUIDE) this will generate a quicker output and effectively control the established mathematical model.

Linear programming can be viewed as part of a great revolutionary development. It has given mankind the ability to state general goals and to lay out a path of detailed decisions to take in order to "best" achieve his goals when faced with practical situations of great complexity. The tools used for doing this work, involve expressing a real-world problem in a detailed mathematical term (model). This ability began in 1947, shortly after World War II, and has been keeping pace ever since with the extraordinary growth of computing power. So rapid has been the advance in decision science that few remember the contributions of the great pioneers that started it all. Some of their names are von Neumann, Kantorovich, Leontief, and Koopmans. In the years from the time when it was first proposed in 1947 by George B. Dantzig (in connection with the planning activities of the military), linear programming and its many extensions have come into wide use. In academic circles, scientists decision (operations researchers and management scientists), as well as numerical analysts, mathematicians, and economists have written hundreds of books and an uncountable number of articles on the subject. Curiously, in spite of its wide applicability today to everyday problems, it was unknown prior to 1947. This is not quite correct; there were some isolated exceptions. Fourier (of Fourier series fame) in 1823 and the well known Belgian mathematician de la ValléePoussin in 1911 each wrote a paper about it. Their work had much influence on Post-1947 developments.

A) Production Processes in Bread Industries

There are basically four production processes in the bread industry namely: Mixing process, Matching process, Moulding process and baking process.

Mixing Process: This process utilizes a mixing machine called the mixer which is used to mix all the required raw materials in their rightful proportion or quantity. However, the quantity of yeast used in the flour mixing process matters a lot as yeast determines the rising strength of the bread.

Matching Process: This is known as milling process as well and is regarded as the final mixing. This process is carried out using a milling machine (dough) to mix the floor to softness. The operator does the job of milling or machining. Wise to note that we have cutting and scaling operation under this process, in which the bread is cut to different sizes such as 1kg, 2kg etc.

Moulding Process: This is also referred to as moulding and planning process and the moulding machine is also called the rounder which helps different sizes of the bread cut to enter the pan. However, the pan is always buttered to prevent sticking of the bread to the pan.

Baking Process: This is the last process in the bread bakery industry. It involves the cooking or baking of the panned bread with either electric or local oven. Also, care is taken by the baker in this process to avoid the bread being burnt.

However, it is vital to state here that there is a formula for each bakery industry and that is what determines their ratio of mixture and it is regarded as their patent right thus, the mixture proportion could not be simulated in this research work.

II. FORMULATION OF THE LINEAR PROGRAMMING (L.P) MODEL

To apply the simplex/iterative method, it is necessary to state the problems in the form in which the inequalities in the constraints have been converted to equalities. Then the L.P. problems are said to be in standard forms. It is necessary to obtain the standardize form of the L.P. problem because it is not possible to perform arithmetic calculations upon an inequality. The inequalities in maximization problems are converted to equalities with the aid of slack variables to the left hand side of each inequality. The slack variable in maximizing problem represents any unused capacity in the constraint and its value can take from zero to the maximum of that constraint. Each constraint has its own separate slack variable. The inequalities in the minimization problems are converted into equalities by subtracting one surplus variable.

A) Simplex/Iterative method for Linear Programming model

i. Design the sample problem.

ii. Setup the inequalities describing the problem

iii. Convert the inequalities to equations adding slack variables.

iv. Enter the inequalities in a table for initial basic feasible solutions with all slack variables as basic variables. The table is called simplex table.

v. Compute C_j and P_j values for this solution where C_j is objective function coefficient for variable j and P_j represents the decrease in the value of the objective function that will result if one unit of variable corresponding to the column is brought into the solution.

vi. Determine the entering variable (key column) by choosing the one with the highest C_j-P_j value.

vii. Determine the key row (outgoing variable) by dividing the solution quantity values by their corresponding solution quantity values by their corresponding key column values and choosing the smallest positive quotient. This means that we compute the ratios for rows where elements in the key column are greater than zero.

viii. Identify the pivot element and compute the values of the key row by dividing all the numbers in the key row by the pivot element. Then change the product mix to the heading of the key column.

ix. Compute the values of the other non-key rows

x. Compute the P_j and C_j-P_j values for this solution.

xi. If the column value in the C_j –P_j row is positive, return to step (vi).

If there is no positive C_j-P_j, then the final solution has been reached.

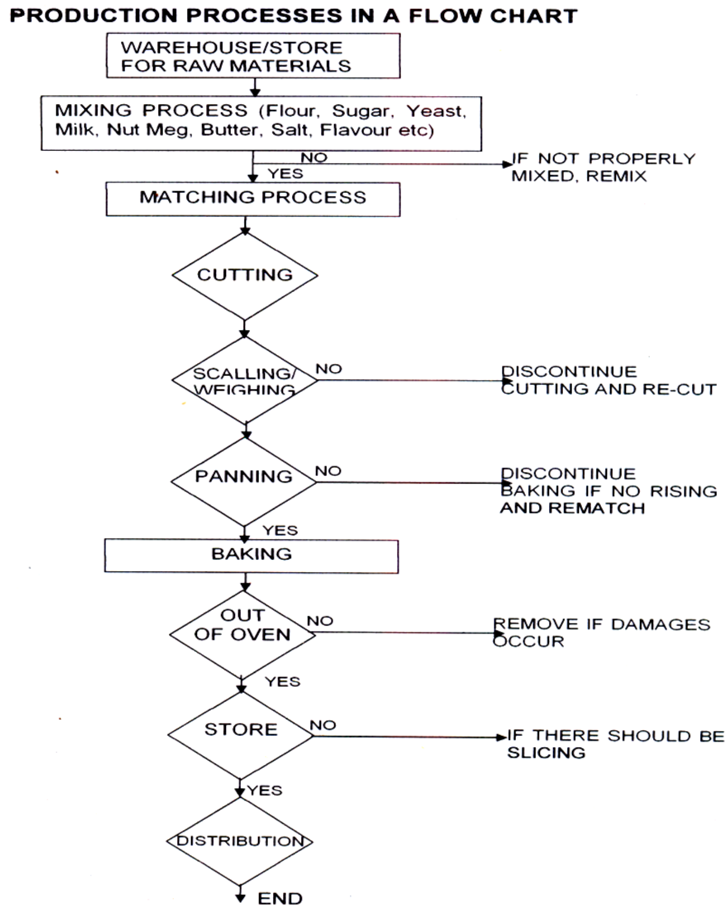


Fig. 1: Production process in a flow chart *(Source: Field Survey)*

B) Structure of Linear Programming (LP)- Model

Table 1: LP Model Structure

c_j column c_j			(C$_J$ Row) $C_1\ C_2 \cdots C_n\ 0\ 0 \cdots 0$ objective function coefficients		
₦ or Kobo	Product mix (basic variables)	Solution Quantity	$X_1\ \ X_2 \cdots Xn$ (Non- basic variables)	$S_1 S_1 \cdots S_n$ (slack variables)	variable Row (HEADINGS)
₦ 0	S_1	b_1	$a_{11}\ \ a_{12} \cdots a_{1n}$	1 0 0	CONSTRAINT COEFFICIENTS
₦ 0	S_2	b_2	$a_{21}\ \ a_{22} \cdots a_{2n}$	0 1 0	
.	.	.	. . .	. . .	
₦ 0	.	.	. . .	. . .	
₦ 0	.	.	. . .	. . .	
₦ 0	Sn	b_n	$a_{n1}\ \ a_{n2} \cdots a_{nn}$	0 0 ⋯ 1	
	P_j	current values of objective function	$P_1\ \ P_2 \ldots\ P_n$	$Ps_1\ \ Ps_2 \cdots Ps_n$	Profit or loss per unit of bread production
	$C_j - P_j$		$\underbrace{C_1\text{-}C_p\ \ C_2\text{-}P_2 \cdots C_n\text{-}P_n}_{\text{Decision variable (Real products)}}$	$\underbrace{CS_1\text{-}PS_1\ \ CS_2\text{-}PS_2 \cdots CS_n\text{-}PS_n}_{\text{Slack variable}}$	Net Profit per unit of bread production

Keys

S = Slack variable

P_j = Total gross amount of outgoing profit.

Cj - P_j= Net evaluation row

X = non-basic variable.

Source: (Dibua, 2004)

III. MATHEMATICAL PRESENTATION OF THE LINEAR PROGRAMMING MODEL

Max. P = $ax_1 + bx_2 + cx_3$ (1)

Subject to =
$$\left.\begin{array}{l} dx_1 + ex_2 + fx_3 \leq T_1 \\ gx_1 + hx_2 + ix_3 \leq T_2 \\ jx_1 + kx_2 + lx_3 \leq T_3 \\ mx_1 + nx_2 + px_3 \leq T_4 \\ (x_1, x_2, x_3 \geq 0) \end{array}\right\} \quad (2)$$

Where: x_1, x_2, x_3 are the non-basic variables; and T_1, T_2, T_3,T_4 are the total available time as defined in the applications in chapter four.

To solve the mathematical set up model shown above, slack variables are introduced to eliminate the equalities

Thus;

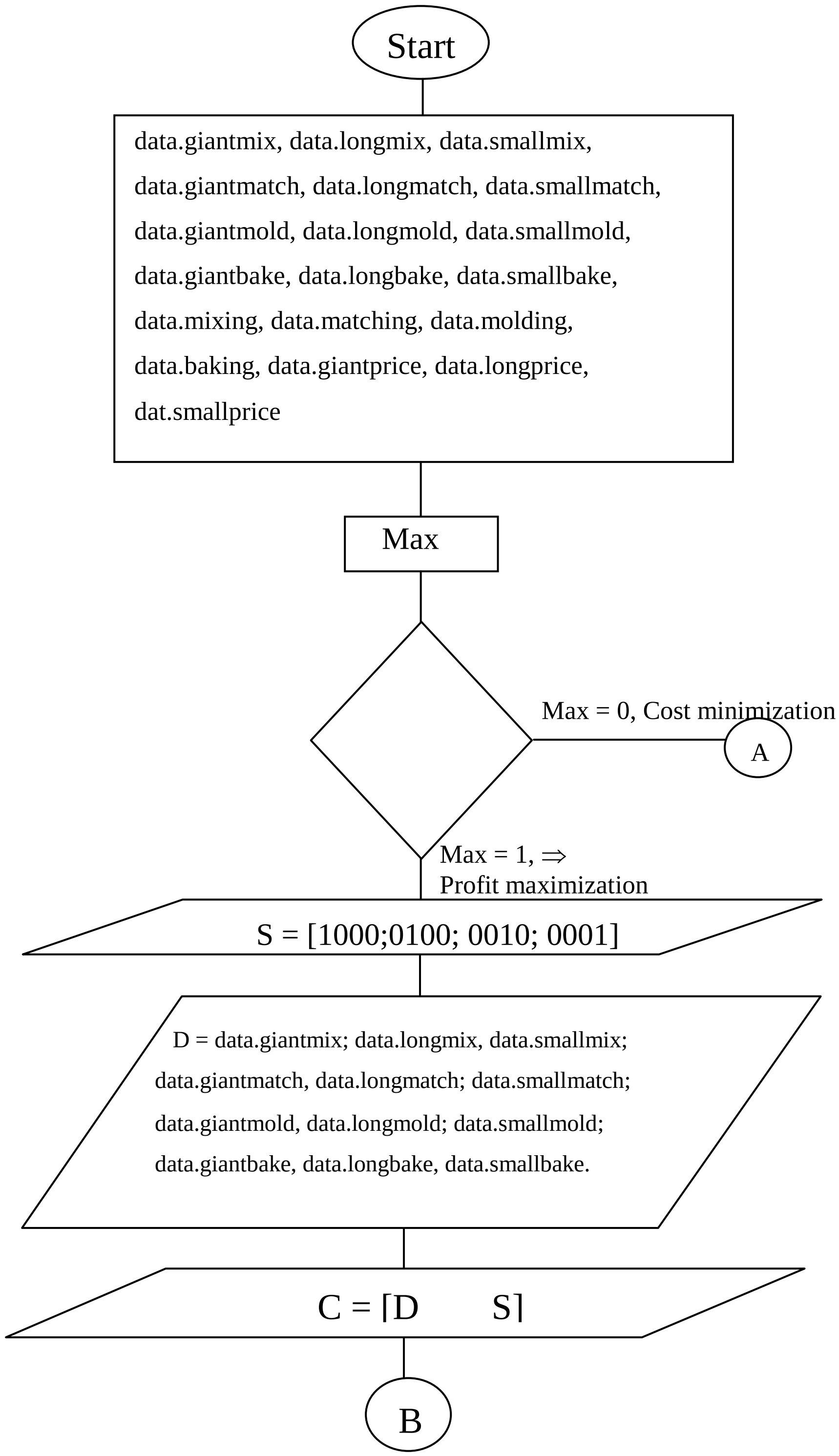
Max. P = $ax_1 + bx_2 + cx_3 + OS_1 + S_2 + OS_3 + OS_4$ (3)

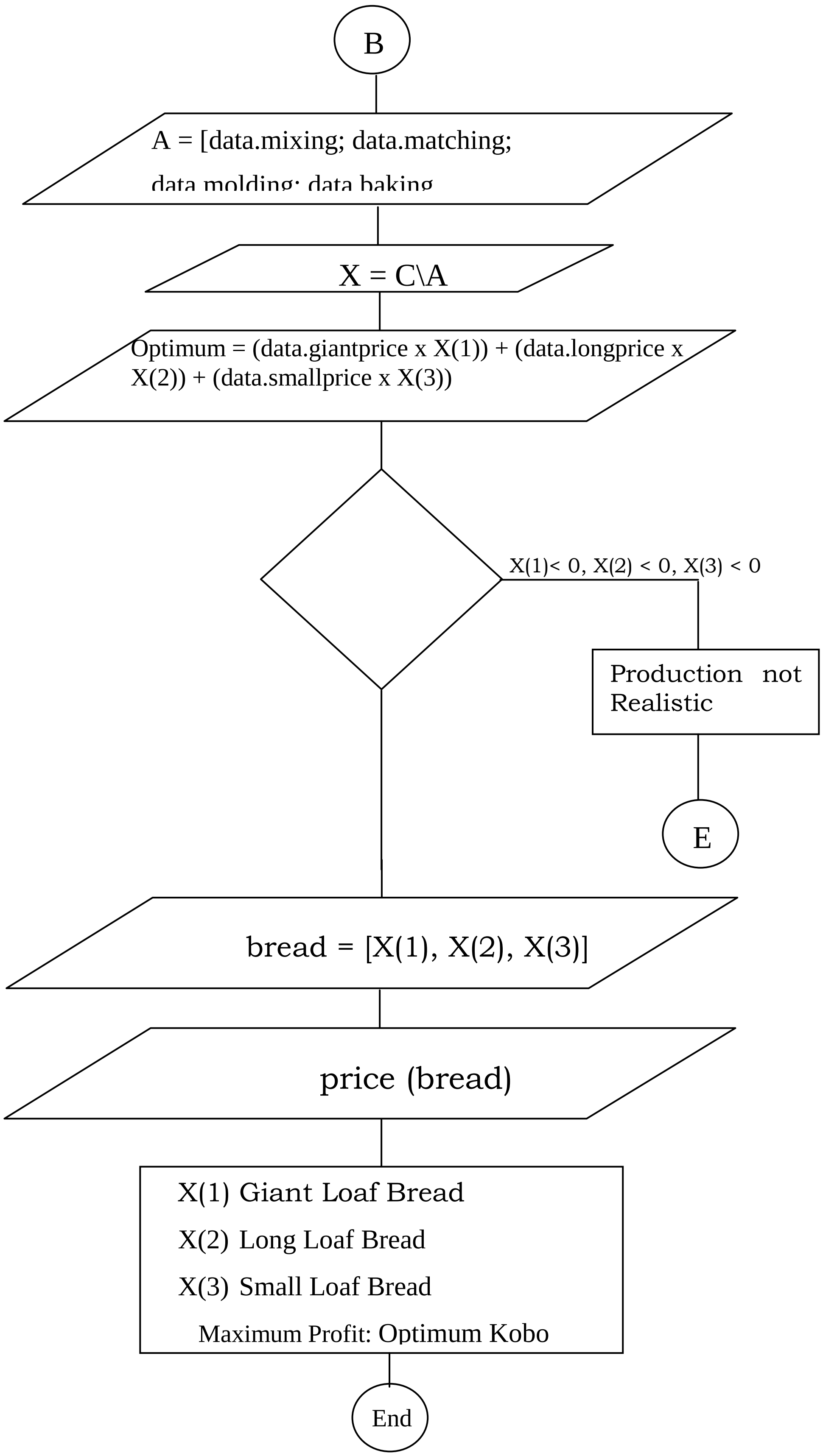
Subject to =
$$\left.\begin{array}{l} dx_1 + ex_2 + fx_3 + S_1 + OS_2 + S_3 + OS_4 = T_1 \\ gx_1 + hx_2 + ix_3 + OS_1 + S_2 + OS_3 + S_4 = T_2 \\ jx_1 + kx_2 + lx_3 + OS_1 + OS_2 + S_3 + OS_4 = T_3 \\ mx_1 + nx_2 + px_3 + OS_1 + OS_2 + OS_3 + S_4 = T_4 \end{array}\right\} \quad (4)$$

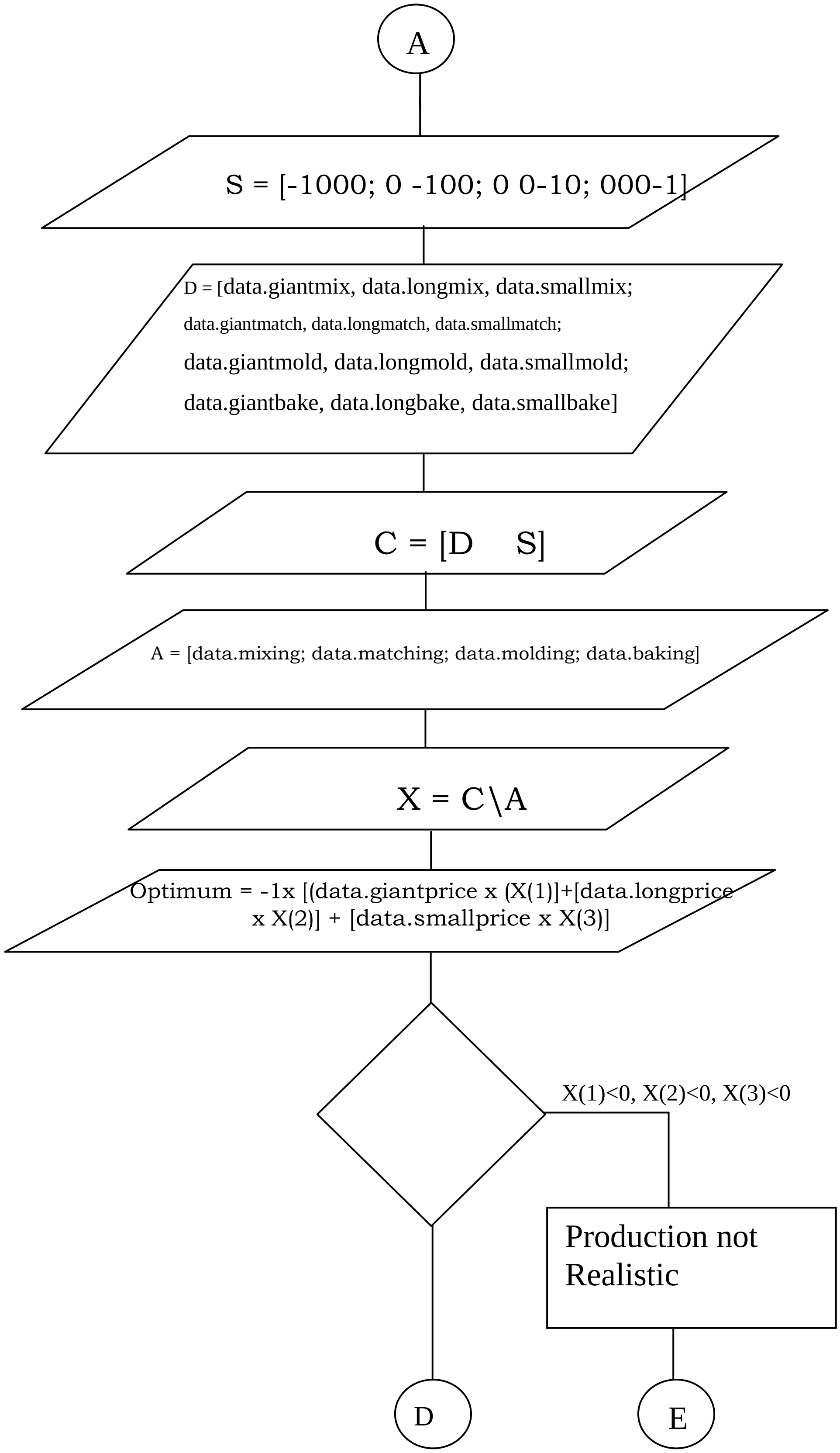
$x_1, x_2, x_3, S_1, S_2, S_3, S_4 \geq 0$ [non-negative] where: x_1, x_2, x_3 = quantities of the giant loaf, long loaf and small loaf respectively called the non-basic variables; S_1, S_2, S_3, S_4 = the slack variables used to eliminate the inequalities generated in the objective function of the LP model set up, P_j = Expected profit to be made after optimization called the total gross amount for outgoing profit, C_j - P_j = Net evaluation row for the objective function of the LP model called decision variable, C_j =objective function coefficients; T_1,T_2, T_3, T_4 = Total available time constants; a, b, c, d, e, f, g, h, i, j, k, I, m n, p = process available time constants.

A) Determination of Non-Basic variables

The adoption of a mathematical equation for selection of non-basic variables is given by n-m (Dibua, 2004).
Where: n = Number of variables, m = Number of constrain equations = 7 – 4 = 3
Thus selection of non-basic variables is 3 (x_1, x_2, x_3)
The flowchart of the MATLAB-Simulator Window is shown in Fig. 2.




B
A = [data.mixing; data.matching;
data.molding; data.baking
X = C\A
Optimum = (data.giantprice x X(1)) + (data.longprice x X(2)) + (data.smallprice x X(3))
X(1)< 0, X(2) < 0, X(3) < 0
Production not Realistic
E
bread = [X(1), X(2), X(3)]
price (bread)
X(1) Giant Loaf Bread
X(2) Long Loaf Bread
X(3) Small Loaf Bread
Maximum Profit: Optimum Kobo
End


A
S = [-1000; 0 -100; 0 0-10; 000-1]
D = [data.giantmix, data.longmix, data.smallmix;
data.giantmatch, data.longmatch, data.smallmatch;
data.giantmold, data.longmold, data.smallmold;
data.giantbake, data.longbake, data.smallbake]
C = [D S]
A = [data.mixing; data.matching; data.molding; data.baking]
X = C\A
Optimum = -1x [(data.giantprice x (X(1)]+[data.longprice x X(2)] + [data.smallprice x X(3)]
X(1)<0, X(2)<0, X(3)<0
Production not Realistic
D
E

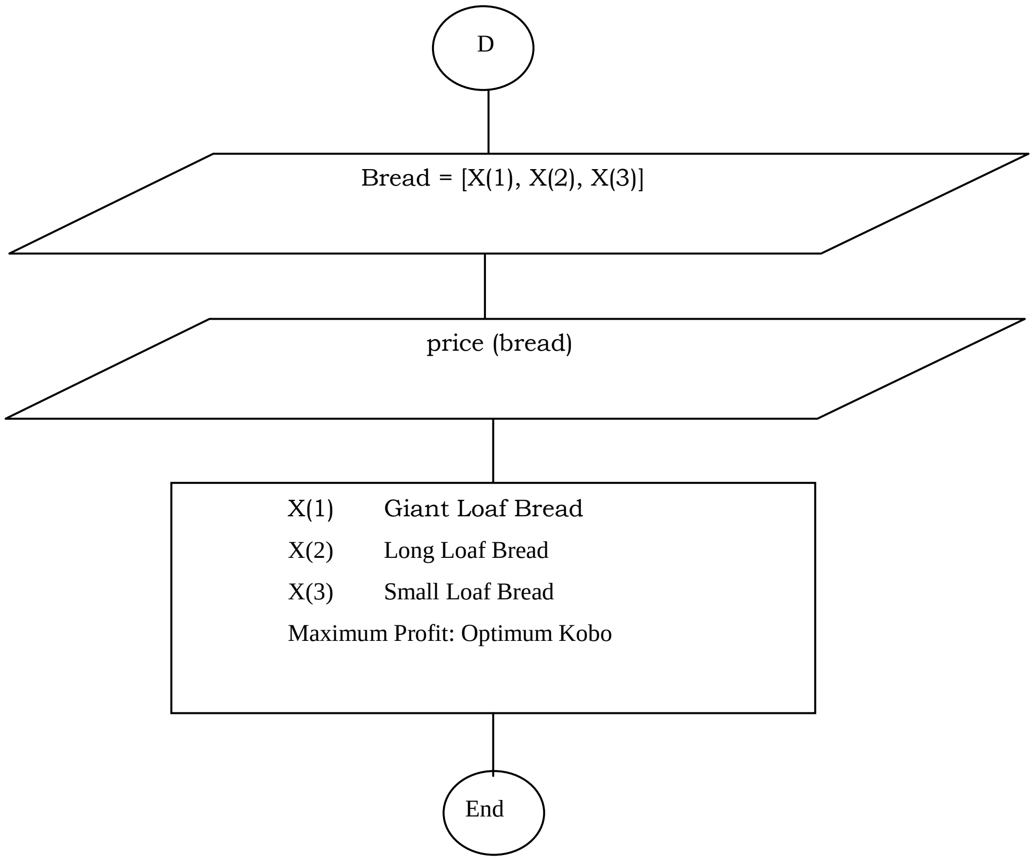


Fig. 2: Flowchart of the BREADPROD simulator *(Source: Field survey)*

B) Mathematical Presentation of the BREADPROD Simulator Model

$$x_1 + 2x_2 + 3x_3 \quad (5)$$

Subject to =

$$\left.\begin{aligned} &4x_1 + 5x_2 + 6x_3 \leq T_1 \\ &7x_1 + 8x_2 + 9x_3 \leq T_2 \\ &10x_1 + 11x_2 + 12x_3 \leq T_3 \\ &13x_1 + 14x_2 + 15x_3 \leq T_4 \end{aligned}\right\} \quad (6)$$

$$(x_1, x_2, x_3 \geq 0)$$

Where: x_1, x_2, x_3 are the non-basic variables; and T_1, T_2, T_3,T_4 are the total available time as applied in chapter four. However, slack variables are introduced to eliminate the equalities so as to solve the model set up thus;

$$x_1 + 2x_2 + 3x_3 + OS_1 + OS_2 + OS_3 + OS_4 \quad (7)$$

Subject to =

$$\left.\begin{aligned} &4x_1 + 5x_2 + 6x_3 + S_1 + OS_2 + OS_3 + OS_4 = T_1 \\ &7x_1 + 8x_2 + 9x_3 + OS_1 + S_2 + OS_3 + OS_4 = T_2 \\ &10x_1 + 11x_2 + 12x_3 + OS_1 + OS_2 + S_3 + OS_4 = T_3 \\ &13x_1 + 14x_2 + 15x_3 + OS_1 + OS_2 + OS_3 + S_4 = T_4 \end{aligned}\right\} \quad (8)$$

$$x_1, x_2, x_3, S_1, S_2, S_3, S_4 \geq 0 \text{ [non-negative]}$$

x_1, x_2, x_3 are quantities of the giant loaf, long loaf and small loaf respectively; S_1, S_2, S_3, S_4 = the slack variables used to eliminate the inequalities generated in the objective function of the LP model set up; T_1,T_2, T_3, T_4 are the Total available time constants while the figures used represent the process available time constants. Production could be unrealistic a time as clearly indicated in the flowchart.

C) Application to Stephens Bread Industry (Relevant Data)

Stephens Bread Industry in Orlu, Imo State Nigeria bakes three sizes of bread loaves: the giant loaf, the long loaf and small loaf. These three sizes of loaves required different amounts of four kinds of labour: mixing, matching, molding and baking.

Information obtained from the factory shows that the factory has 490 minutes of mixing labour, 300 minutes of matching labour, 725 minutes of molding labour and 800 minutes of baking labour each production week. Each giant loaf requires 2 minutes of mixing labour, 1 minute of matching labour, 3 minutes of molding labour and 4minutes of baking labour; each long loaf requires 1 minute of mixing labour1 minute of matching labour, 4 minutes of molding labour and 3minutes of baking labour, each small size loaf requires 2minutes of mixing labour, 1minute of matching labour, 2 minutes of molding labour and 2 minutes of bakinglabour per bag of floor.

Table 2: Process Data for Stephens Bread Industry

Size of loaves	Process Time (Mins) Per Loaf Size				Profit per loaf (kobo)
	Mixing	matching	Molding	Baking	
Giant loaf (x_1)	2	1	3	4	1500
long loaf (x_2)	1	1	4	3	1200
small loaf (x_3)	2	1	2	2	500
Total available Time (mins/day)	490	300	725	800	

Applying a linear programming as a required model for simulation to ascertain an acceptable optimization, the problem can be converted into an algebraic form.

Let; X_1 = No of loaves, giant loaf, X_2 = No of loaves, long loaf, X_3 =No of loaves, small loaf

By applying Eqn.1 and 2 respectively;

L.P model:Max. P = $1500x_1 + 1200x_2 + 500x_3$

Subject to: $2x_1 + x_2 + 2x_3 \leq 490$

$x_1 + x_2 + x_3 \leq 300$

$3x_1 + 4x_2 + 2x_3 \leq 725$

$4x_1 + 3x_2 + 2x_3 \leq 800$

$(x_1, x_2, x_3 \geq 0)$

Introducing necessary slack variables and expressing the subject models to mathematical model equations will yield: By applying eqn. 3 and 4 respectively;

Max. P= $1500x_1 + 1200x_2 + 500x_3 + OS_1 + OS_2 + OS_3 + OS_4$

Subject to = $2x_1 + x_2 + 2x_3 + S_1 + OS_2 + OS_3 + OS_4 = 490$

$x_1 + x_2 + x_3 + OS_1 + S_2 + OS_3 + OS_4 = 300$

$3x_1 + 4x_2 + 2x_3 + OS_1 + OS_2 + S_3 + OS_4 = 725$

$4x_1 + 3x_2 + 2x_3 + OS_1 + OS_2 + OS_3 + S_4 = 800$

$(x_1, x_2, x_3\ S_1, S_2, S_3, S_4 \geq 0$ [Non-negative]

D) Iteration Techniques for Stephens Bread Industry

In the Iteration processes in Table 3 the new values are obtained by subtracting the old values from the product of the corresponding values in the key row and corresponding values in the key column.

New Row Number = old row number – (Corresponding number in key row x corresponding fixed ratio).

Where; Fixed Ratio = $\dfrac{\text{Old Row number in the key column}}{\text{Key number}}$

The successive approximations at the 4th iteration gave the values for x_1, x_2, x_3 which is Giant loaf, Long loaf and Small loaf respectively which is denoted with 1400x_1 for the Giant loaf having 82 loaves, 1100x_2 which is the Long loaf having 96 loaves and 400x_3 which is for Small loaf having 55 loaves. The total profit associated with this production mix per batch is 241500 kobo (₦2,415.00) which is the number of bread produced per size multiplied by the corresponding profit. The value obtained via this model which represents the number of bread produced per size of loaf was validated using the simulator as shown in Fig. 3.

Table 3: Iteration Techniques data for Stephens Bread Industry

2nd ITERATION	**New 0s_1 :**							
	2-1(2) = 0	1-3/4(2)=-1/2	2-1/2(2)=1	1-0(2) =1	0-0(2)=0	0-0(2)=0	0-1/4(2) =-1/2	490-200(2) = 90
	New 0S_2 :							
	1-1(1) =0	1-3/4(1)=1/4	1-1/2(1)=1/2	0-0(1)=0	1-0(1)=1	0-0(1) = 0	0-1/4(1) =-1/4	300-200(1) = 100
	New 0S_3:							
	3-1(3) = 0	4-3/4(3)=7/4	2-1/2(3)= 1/2	0-0 (3)=0	0-0(3)=0	1-0(3) = 1	0-1/4 (3) = -3/4	725-200 (3) = 125
3RD ITERATION	**New 0S_1 :**							
	0-0 (0) = 0	-1/2-1(-1/2) = 0	1-2/7(-1/2) = 8/7	1-0(-1/2) = 1	0-0(-1/2)=0	0-4/7(-1/2) = 2/7	-1/2-(-3/7)(-1/2) = -5/7	90-500/7(-1/2) = 880/7
	New 0S_2:							
	0-0(1/4)=0	1/4-1(1/4) = 0	1/2-2/7(1/4) = 3/7	0-0(1/4) = 0	1-0(1/4) = 1	0-4/7(1/4) = -1/7	-1/4-(-3/7)(1/4) = -1/7	100-500(1/4) = 575/7
	New 1500x_1 :							
	1-0(3/4)=1	3/4-1(3/4) = 0	1/2-2/7(3/4) = 2/7	0-0(3/4)= 0	0-0(3/4) = 0	0-4/7(3/4) = -3/7	1/4-(-3/7)(3/4) = 4/7	200-500/7(3/4) = 1025/7
4TH ITERATION	**New OS_2:**							
	0-0 (3/7) = 0	0-0(3/7)=0	3/7-1(3/7)=0	0-7/8(3/7) = -3/8	1-0(3/7) = 1	-1/7-1/4 (3/7) = -1/4	-1/7-(-5/8)(3/7) = 1/8	575/7-110(3/7) = 35
	New 1200x_2:							
	0-0(2/7) = 0	1-0(2/7) = 1	2/7-1(2/7)=0	0-7/8(2/7) = -1/4	0-0(2/7)=0	4/7-1/4 (2/7) = 1/2	-3/7-(-5/8)(2/7) = -1/4	500/7-110(2/7)=40
	New 1500X_1:							
	1-0(2/7)=1	0-0(2/7) = 0	2/7-1(2/7) = 0	0-7/8(2/7) = -1/4	0-0(2/7) = 0	-3/7-1/4(2/7) = -1/2	4/7-(-5/8)(2/7) = 3/4	1025/7-110(2/7) = 115

Table 4: Primal Result of Iteration Techniques for Stephens Bread Industry

C_j	1500 x_1	1200 x_2	500 x_3	0 S_1	0 S_2	0 S_3	0 S_4		
OS_1	2	1	2	1	0	0	0	490	
OS_2	1	1	1	0	1	0	0	300	IST ITERATION
OS_3	3	4	2	0	0	1	0	725	
OS_4	4	3	2	0	0	0	1	800	
P_j	0	0	0	0	0	0	0		
C_j-P_j	1500	1200	500	0	0	0	0		
	HIGHEST $C_j – P_j$								
OS_1	2	1	2	1	0	0	0	490	
OS_2	1	1	1	0	1	0	0	300	
1500x_1	3	4	2	0	0	1	0	725	
	1	¾	½	0	0	0	¼	200	
OS_1	0	-1/2	1	1	0	0	-½	90	
OS_2	0	¼	½	0	1	0	-¼	100	
OS_3	1	7/4	1/2	0	0	1	-¾	125	2ND ITERATION
1500x_1	0	3/4	1/2	0	0	0	¼	200	
P_j	1500	1125	750	0	0	0	375	300000	
C_j-P_j	0	75	-250	0	0	0	-375		
		HIGHEST Cj - Pj							
OS_1	0	-1/2	1	1	0	0	- ½	90	
OS_2	0	¼	½	0	1	0	- ¼	100	
1200X_2	1	1	2/7	0	0	4/7	- 3/7	500/7	
1500x_1	0	¾	1/2	0	0	0	1/4	200	
OS_1	0	0	8/7	1	0	2/7	-5/7	880/7	
OS_2	0	0	3/7	0	1	-1/7	-1/7	575/5	3RD ITERATION
1200x_2	0	1	2/7	0	0	4/7	-3/7	500/7	
1500x_1	1	0	2/7	0	0	-3/7	4/7	1025/7	
P_j	0	1200	2400/7		0	4800/7	-3600/7	600000/7	
C_j-P_j	1500	0	1100/7	0	0	-4800/7	3600/7		
				0					
500x3	0	0	1	7/8	0	1/4	-5/8	110	
OS_2	0	0	3/7	0	1	-1/7	-1/7	575/7	
1200x_2	0	1	2/7	0	0	4/7	-3/7	500/7	
1100x_1	1	0	2/7	0	0	-3/7	4/7	1025/7	
500x_3	0	0	0	7/8	0	1/4	-5/8	110	
OS_2	0	0	0	-3/8	1	-1/4	1/8	35	4TH ITERATION
1200x_1	0	0	0	-1/4	0	1/2	-1/4	40	
1500x_1	1	0	0	-1/4	0	-1/2	3/4	115	
P_j								275500	

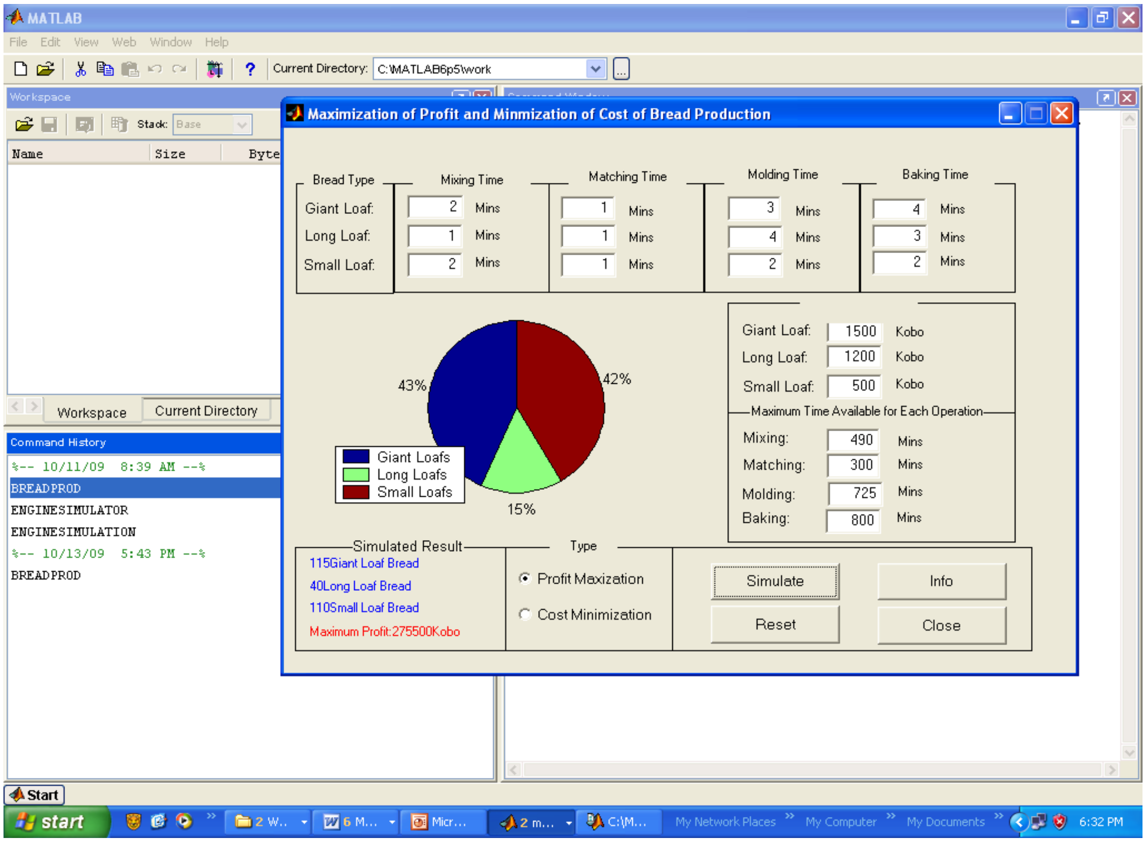


Fig. 3: Result of the simulator for Stephens Bread Industry

IV. RESULTS OF THE SIMULATOR FOR STEPHENS BREAD INDUSTRY

The various process time and profit for the three sizes of the bread were inputted into the simulator, the simulator returned production mix and optimum profit. In the production mix, we have 115 giant loaves, 40 long loaves and 110 small loaves. The giant loaf, long loaf and small loaf are 43%, 42% and 15% of the total production respectively. This production mix yielded a maximum profit of ₦ 2,755.00 per production batch. This simulated result agrees with Simplex Method result obtained for Stephens Bread Industry.

It was observed from their demand data that there is high demand for all their products of which their present production capacity could not meet. Hence, there is need to increase the quantity of bread produced within their production confine which was taken care in the proposed production mix which could also be adjusted when demand fluctuates so as to satisfy customers and maintain steady production.

A) Recommended Optimum Process Time Relevant Data

However, since these bread industries bakes three sizes of bread loaves: the giant loaf, the long loaf and small loaf. These three sizes of loaves require four kinds of labour: mixing, matching, molding and baking. It is recommended that 900 minutes be used for mixing, 800 minutes for matching, 780 minutes for molding and 800 minutes for baking for each production batch. It is also recommended that each giant loaf takes 3 minutes of mixing labour, 4 minutes of matching labour, 2 minutes of molding labour and 2 minutes of baking labour; each long loaf takes 2 minutes of mixing labour, 2 minutes of matching labour, 1 minute of molding labour and 3 minutes of baking labour; each small loaf takes 1 minute of mixing labour, 3 minutes of matching labour, 3 minutes of molding labour and 1 minute of baking labour. The profit made by the two bread industries were compared and a profit of 1500 kobo for giant loaf, 1200 kobo for long loaf and 500 kobo for small loaf were used. This process time and profit recommended will give optimum production mix.

Table 5: Optimum process time

Size of loaves	**Process Time (Mins) Per Loaf Size**				Profit per loaf (kobo)
	Mixing	matching	Molding	Baking	
Giant loaf (x_1)	3	4	2	2	1500
long loaf (x_2)	2	2	1	3	1200
small loaf (x_3)	1	3	3	1	500
Total available Time (mins/day)	900	800	780	800	

Applying a linear programming as a required model for simulation to ascertain an acceptable optimization, the problem can be converted into an algebraic form.

But let x_1 = No. of giant loaf

X_2 = No. of long loaf

X_3 =No. of small loaf

By applying eqn. 1 and 2 respectively, we have

L.P model:Max. P = $ax_1 + bx_2 + cx_3 + \ldots z\,x_n$

Max. P. = $1500x_1 + 1200x_2 + 500x_3$

Subject to: $3x_1 + 2x_2 + x_3 \leq 900$

$4x_1 + 2x_2 + 3x_3 \leq 800$

$2x_1 + x_2 + 3x_3 \leq 780$

$2x_1 + 3x_2 + x_3 \leq 800$

$(x_1, x_2, x_3 \geq 0)$

Introducing necessary slack variables and expressing the subject models to mathematical model equations will yield: By applying eqn. 3 and 4 respectively, we have

Max. P= $1500x_1 + 1200x_2 + 500x_3 + OS_1 + OS_2 + OS_3 + OS_4$

Subject to = $3x_1 + 2x_2 + x_3 + S_1 + OS_2 + OS_3 + OS_4 = 900$

$4x_1 + 2x_2 + 3x_3 + OS_1 + S_2 + OS_3 + OS_4 = 800$

$2x_1 + x_2 + 3x_3 + OS_1 + OS_2 + S_3 + OS_4 = 780$

$2x_1 + 3x_2 + x_3 + OS_1 + OS_2 + OS_3 + S_4 = 800$

$(x_1, x_2, x_3\ S_1, S_2, S_3, S_4 \geq 0$ [Non-negative]$)$

B) Iteration Techniques for Optimum Process Time

In the Iteration processes in Table 4 the new values are obtained by subtracting the old values from the product of the corresponding values in the key row and corresponding values in the key column. New Row Number = old row number – (Corresponding number in key row x corresponding fixed ratio).

$$\text{Where Fixed Ratio} = \frac{\text{Old Row number in the key column}}{\text{Key number}}$$

The linear programming model adopted gave 202 giant loaf size, 102 long loaf and 92 small loaf for the optimum process time production batch which corresponds with the result of the designed BREADPROD simulator as shown in Fig. 3 below.

Table 5 above was used to form the equations above using the various process times.

The result of this recommended optimum process time was run with the simulator (BREADPROD) and the result is shown below:

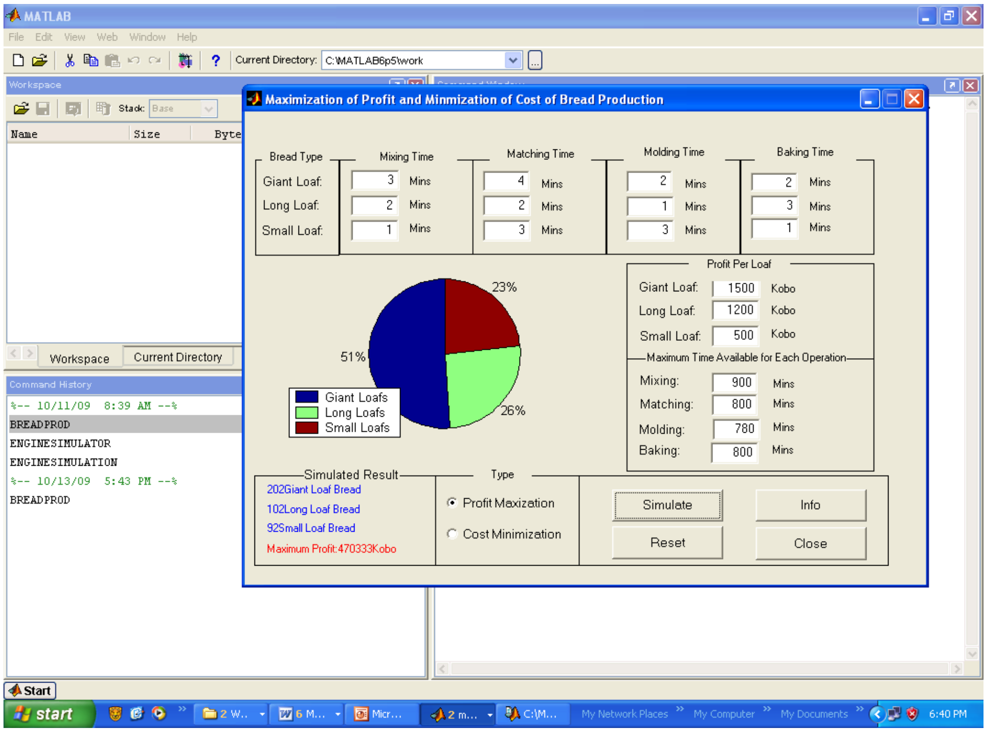


Fig. 4: Result of the simulator for recommended optimum process time

C) Results of the simulator for recommended optimum process time

The result of the proposed production mix shown above gave a production mix of 202 giant loaves, 102 long loaves and 92 small loaves representing 51%, 26% and 23% of the total production respectively.

In this proposed production mix, 900 minutes was proposed for mixing, 800 minutes for matching, 780 minutes for molding and 800 minutes for baking. It therefore, becomes imperative that for the bakeries to achieve this proposed production mix there is a need for them to increase their capacity. It is recommended that two or three vats will be used for mixing, two or three milling machines for matching and enough hands for moulding.

The proposed production mix was solved only by the simulator because, it has been validated that simulator gave the same result as Simplex method in Premier Bread Industry and Stephen Bread Industry analysis. Equally, the simulator is designed in such a way that process time which yield negative product(s) will return a non-realistic production. This can be seen from the flowchart indicating a non-realistic production for x_1, x_2, $x_3 < 0$.

In the proposed production mix, the profit margin of Stephen's bakery was used because it gave a higher maximum profit.

It will be observed from figure 4 that the optimum production mix gave a higher output as regards the number of breads produced per sizes of loaves which clearly shows an increase in productivity. Thus, the proposed production mix is a good attempt to optimize production processes in bread industries for increase in productivity using linear programming as a model.

V. CONCLUSION

In this work it was desired to develop a production mix which will give maximum profit. An attempt was made to analyze various process time and profit margin for Stephens Bread Industry. Linear programming was employed in determining production mix for the bread industry. A simulator designed in MATLAB GUIDE WINDOW was equally used in determining the production mix. The results of the MATLAB GUIDE WINDOW (Simulator) agreed with the results of the linear programming model.

Therefore, the simulator was used in determining an optimum production mix for a proposed model. The model gave a production mix 51% giant loaf, 26% long loaf and 23% small loaf for the bread industry.

However future work will be based on developing a full model that will take care of all the ingredients involved in bread production, so as to guide bread industries on the best mixture to adopt for optimum production both for process time and materials for the production.

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