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Modified Goal Programming Model for Limited Available Budget Allocation for Equipment Procurement under Inflation Condition

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Authors' contributions

This work was carried out in collaboration among all authors. Author OOO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors PKF and BOA managed the analyses of the study. Author BOA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Equipment procurement budget is of a great challenge in manufacturing industries by reasons of its multi-objectives, insufficient funds, and inflation problems. Solutions were proffered to these problems by identifying the strategic decisions required in equipment procurement (machine, accessories, spare parts and miscellaneous costs). Procurement changes from year to year based on equipment industrial needs. Hence eleven (11) scenarios for procurement but this study focused on a scenario where all the decisions are needed for procurement. This problem is multi-objective decision problem where there is need for multi-objective decision tool for its solution, therefore a goal programming tool was adopted and improved by integrating inflation model into it to be able to solve inflation problems. International Brewery Ilesha, Nigeria was used as case study for the model's application to evaluate its performance. The strategic decisions deviated above or positively by 0.4604, 4.1311 and 2.3760 for machines, spare-parts and miscellaneous costs respectively while

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accessories cost was not deviated. Therefore, the procurement cost for Machines, Accessories, Spare-parts and Miscellaneous costs would be (₦ 166,015,000; $ 461,152.77), (₦ 127,968,000; $ 355,466.67), (₦ 548,075,000; $ 1,522,430.56), (₦ 271,091,500; $ 753,031.94). US Dollar exchange rate was at ₦ 360 to a Dollar as at the time of this research. This multi-criteria decision tool will find its application useful in small, medium and large scale industries that equipment procurement budget affects their production.

Keywords: Goal programming; available budget; equipment procurement; strategic decisions; inflation; multi-criteria model.

1. INTRODUCTION

Colapinto et al. [1] introduced the concept of multiple objective optimization (MOO) technique as a type of optimization that handles problems with a set of objectives to be maximized or minimized. This problem has at least two conflicting criteria/objectives. They cannot reach their optimal values simultaneously or satisfaction of one will result in damaging or degrading the full satisfaction of the other(s). They added that there is no single optimal solution in this type of optimization; rather an interaction among different objectives gives rise to a set of compromised solutions, largely known as the trade-off or non-dominated or non-inferior or Pareto-optimal solutions. Multiple objective optimization consists of different problem solutions, such as multiple objective linear programming (MOLP), multiple objective integer linear programming (MOILP), and nonlinear multiple objective optimization (NMOO).

Organizations typically have more good ideas for projects than they have resources available to pursue those ideas. In an industry where there is a problem of using limited resources on multiple objectives, decision analysis can provide direction to the industry on how to achieve maximum benefit from those limited resources. The need for efficiency in the allocation of the resources of an industry forces the need to make a good budget [2].

Budget is a powerful tool for planning and controls the resources available to the manager. In making a budget for equipment procurement, inflation plays an important role on the economic growth and production processes of the company, it creates problems for economic activities and discourages investment and limits export [3].

To achieve a maximum profit, a decision maker would like to develop a model that can consider real-life situations with multiple objectives: a lexicographic (preemptive) goal programming and weighted goal programming (WGP) techniques are used to determine optimal production plans. Preemptive goal programming (PGP) is used to manage a set of multi-objectives criteria by minimizing deviations between the goal/target values and the obtained/realized results, it minimizes the deviations preferentially so that goals of primary importance receive first-priority attention; those of secondary importance receive second-priority attention, and so on in the same manner. In weights method, a single objective function is formed as the weighted sum of the functions representing the goals of the problem [4,5]. In this paper, we adopted a Non-preemptive goal programming model which deals with the goals at the same priority level to determine the cost of procurement of the selected strategic decisions in the International Brewery Plc, Ilesha Nigeria.

Kliestik et al. [6] Enumerated types of analysis in which goal programming is used to perform: determine the required resources to achieve a desired set of objectives, determine the degree of attainment of the goals with the available resources, provide the best satisfying solution under a varying amount of resources and priorities of the goals.

Linear programming (LP) is an application of decision making technique for problems that contain a single objective. In most (LP) problems, the achievement function is to maximize total profit or minimize total cost subject to a set of constraints imposed by the decision environment [6]. A goal programming (GP) model deals with goals simultaneously that are of concern to a decision maker. While a LP model consists of constraints and a single objective function to be maximized or minimized, a goal programming model consists of constraints and a set of goals that are prioritized in some sense [7].

In both LP and GP problems, there are no feasible solutions for the model if the constraints are inconsistent or unpredictable. However, in goal programming, it can be expected that although there is a set of feasible solutions satisfying the constraints, none of them may simultaneously satisfy all the conflicting goals of the organization. The objective of GP is to find a solution that satisfies the true constraints and comes closest to meeting the stated goals [8].

GP approaches analyse how much a projected solution deviates from each stated goal. "Accordingly, for each goal a pair of deviation variables is defined (one equalling the amount by which the solution overachieves the goal; the other equalling the amount by which it fails to meet the goal)" [9]. Several authors [10;11] added that in most real world situations, organizations have multiple and sometimes conflicting objectives. Decision making with multiple objectives has been a new challenge of management science during the past decade. Goal programming is a powerful and most promising technique for decision problems that involve multiple objectives. Decision making is the primary task of management. In the past, management practice has been based primarily on experience and intuition.

Oyebode [12] emphasised that, budget administration can be defined as the whole process of budget management in order to ensure that the set goals of the firm are achieved as planned. "The budgetary process in manufacturing companies usually commences with a strategic session held as external venue involving all management staff" [13].

Tatiana et al. [14] also mentioned that budgeting itself is the process of estimating the needs of the firm for a future period based on past experience and future needs. Budget monitoring or budgetary control is a process of comparing actual results with budgets to serve as a basis for performance evaluation and revision of budgets [15]. This study improved a goal programming model for the allocation of limited available resources (funds) for machinery procurement under inflation condition. The issue of machinery procurement is multi-objective problems. With limited available resources, how justifiable can the resources be optimally allotted for procurement? Hence the development of this model, which will be applicable in small, medium and large scale enterprises where equipment procurement is their major problem.

2. METHODOLOGY

2.1 Strategic Decisions for Model Development

For proper budgeting, four strategic decisions were selected for effective equipment procurement after proper literature reviews, visitation to the International Brewery Plc, Ilesha, Nigeria, for oral interview. These strategic decisions are:

a) **Machines ($\propto_1$):** A machine is a tool that consists of one or more parts, and uses energy to meet a particular goal e.g. labeller, washer, filler, pasteurizer etc.
b) **Accessories (β_1):** An accessory aids the performance of a machine in the industry e.g. beer spoon, beer paddle, beer siphon etc.
c) **Spare-parts (γ_1):** Spare-part is an interchangeable part that is kept in an inventory and used for the repair or replacement of failed parts e.g. hose tail, cask racking spear, female equal tee etc.
d) **Miscellaneous (τ_1):** Supplementary costs not planned for but can still occur during procurement.

2.2 Model Development

2.2.1 Nomenclature

S_T is the total inflated estimated cost

S is the base estimated cost

$j$is the inflation rate

m is the difference between base year and selected year

$(1+j)^m$ is the inflation factor

$$S_T = S(1+j)^m \tag{2.1}$$

$$j = \frac{current\ cost - previous\ cost}{previous\ cost} \times 100 \tag{2.2}$$

The inflation factor and total inflated estimated costs for each year were determined using equations 2.1 and 2.2 respectively.

2.2.2 Determination of inflation factors for cost estimates

Table 1 was the data collected from International Brewery Plc, Ilesha, Nigeria to determine the inflation factors for cost estimates and optimize the estimated cost of machines, accessories, spare-parts and miscellaneous for the current year using an improved goal programming model. The summary of the total inflated estimated cost is as shown in Table 4 which is the data used for preparing the cost of the selected strategic decisions for procurement for the current year.

While considering the inflation factors of the selected strategic decisions, this scenario was to optimize the costs of machine, accessories, spare-parts and miscellaneous for the current year. x_1,x_2,x_3 and x_4 were the decision variables allocated to costs of: Machine ($\propto_1$), Accessory (β_1), Spare parts (γ_1) and Miscellaneous (τ_1) respectively.

2.2.3 Application of goal programming on the strategic decisions

2.2.3.1 Goal programming formulation goals

$$c_{11}x_1 + c_{12}x_2 + c_{13}x_3 + c_{14}x_4 + dv_1{}^- - dv_1{}^+ = (P_v)_{\propto_1} \quad \text{(Machines)}$$

$$c_{21}x_1 + c_{22}x_2 + c_{23}x_3 + c_{24}x_4 + dv_2{}^- - dv_2{}^+ = (P_v)_{\beta_1} \quad \text{(Accessories)}$$

$$c_{31}x_1 + c_{32}x_2 + c_{33}x_3 + c_{34}x_4 + dv_3{}^- - dv_3{}^+ = (P_v)_{\gamma_1} \quad \text{(Spare parts)}$$

$$c_{41}x_1 + c_{42}x_2 + c_{43}x_3 + c_{44}x_4 + dv_4{}^- - dv_4{}^+ = (P_v)_{\tau_1} \quad \text{(Miscellaneous)}$$

Nonnegativity constraints: $x_j \geq 0$, $dv_i{}^+$, $dv_i{}^- \geq 0$.

Where:

c_{ij} is the coefficient associated with variable *j* in the i^{th} goal.

x_j is j^{th} decision variable.

$dv_i{}^-$, $dv_i{}^+$ is negative and positive deviational variables from i target value.

$(P_v)_{\propto_1}$, $(P_v)_{\beta_1}$, $(P_v)_{\gamma_1}$, $(P_v)_{\tau_1}$ are the predicted values and goal target for the cost of machines ($\propto_1$), accessories (β_1), spare-parts (γ_1) and miscellaneous (τ_1) respectively. Table 2 serves as cost information for preparing a budget for the procurement of $\propto_1$, β_1, γ_1 and τ_1 for the current year. c_{ij} is denoted as the cost associated with the decision variables x_j for machines, accessories, spare-parts and miscellaneous.

Assuming the goal target (or predicted value) for the cost of $\propto_1$, β_1, γ_1 and τ_1 are: ₦119,975,000; ₦127,968,000; ₦134,965,000; ₦33,491,500. Therefore, the coefficient associated with the decision variables can be obtained randomly from Table 4 (i.e. Summary of the Total Inflated Estimated Cost) according to decision maker's discretion. The computation is as shown in Table 3.

Since all the goals are equally importance and have the same priority level, non-preemptive goal programming was suggested. Linear goal programming is applicable in this model since we are not sure which of these goals we could meet and how much we could satisfy them. Therefore, it is important to define how much goals are deviated. From Table 4, assuming year 1992, 1998, 2014 and 2017 were selected as inflated cost estimates associated with the decision variables, x_1 , x_2 , x_3 and x_4 respectively. Therefore:

Scenario: Optimize$\propto_1$,β_1,γ_1, τ_1 within acceptable limit using non-preemptive goal programming method.

Goal Programming Formulation Goals:

$$0.1849 \times 10^8 x_1 + 0.0714 \times 10^8 x_2 + 0.1563 \times 10^8 x_3 + 0.0391 \times 10^8 x_4 \geq 1.1998 \times 10^8 \quad \text{(Machines)}$$

$$0.1425 \times 10^8 x_1 + 0.2215 \times 10^8 x_2 + 0.2143 \times 10^8 x_3 + 0.0833 \times 10^8 x_4 \geq 1.2797 \times 10^8 \quad \text{(Accessories)}$$

$$0.6104 \times 10^8 x_1 + 0.6125 \times 10^8 x_2 + 0.6221 \times 10^8 x_3 + 0.2488 \times 10^8 x_4 = 1.3497 \times 10^8 \quad \text{(Spare-parts)}$$

$$0.3019 \times 10^8 x_1 + 0.3114 \times 10^8 x_2 + 0.3403 \times 10^8 x_3 + 0.1607 \times 10^8 x_4 \leq 0.3349 \times 10^8 \quad \text{(Miscellaneous)}$$

Constraints:

$x_1, x_2, x_3, x_4 \geq 0$

Linear Programming Formulation:

Min $G_1 = dv_1{}^-$ (Satisfy Machines Goal)

Min $G_2 = dv_2{}^-$ (Satisfy Accessories Goal)

Min $G_3 = {dv_3}^+ + {dv_3}^-$ (Satisfy Spare-parts Goal)

Min $G_4 = {dv_4}^+$ (Satisfy Miscellaneous Goal)

Min Z $= G_1 + G_2 + G_3 + G_4$

Subject to:

$0.1849 \times 10^8 x_1 + 0.0714 \times 10^8 x_2 + 0.1563 \times 10^8 x_3 + 0.0391 \times 10^8 x_4 - {dv_1}^+ + {dv_1}^- = 1.1998 \times 10^8$ (Machines goal)

$0.1425 \times 10^8 x_1 + 0.2215 \times 10^8 x_2 + 0.2143 \times 10^8 x_3 + 0.0833 \times 10^8 x_4 - {dv_2}^+ + {dv_2}^- = 1.2797 \times 10^8$ (Accessories goal)

$0.6104 \times 10^8 x_1 + 0.6125 \times 10^8 x_2 + 0.6221 \times 10^8 x_3 + 0.2488 \times 10^8 x_4 - {dv_3}^+ + {dv_3}^- = 1.3497 \times 10^8$ (Spare-parts goal)

$0.3019 \times 10^8 x_1 + 0.3114 \times 10^8 x_2 + 0.3403 \times 10^8 x_3 + 0.1607 \times 10^8 x_4 - {dv_4}^+ + {dv_4}^- = 0.3349 \times 10^8$ (Miscellaneous goal)

$x_1, x_2, x_3, x_4, {dv_1}^+, {dv_1}^-, {dv_2}^+, {dv_2}^-, {dv_3}^+, {dv_3}^-, {dv_4}^+, {dv_4}^- \geq 0$

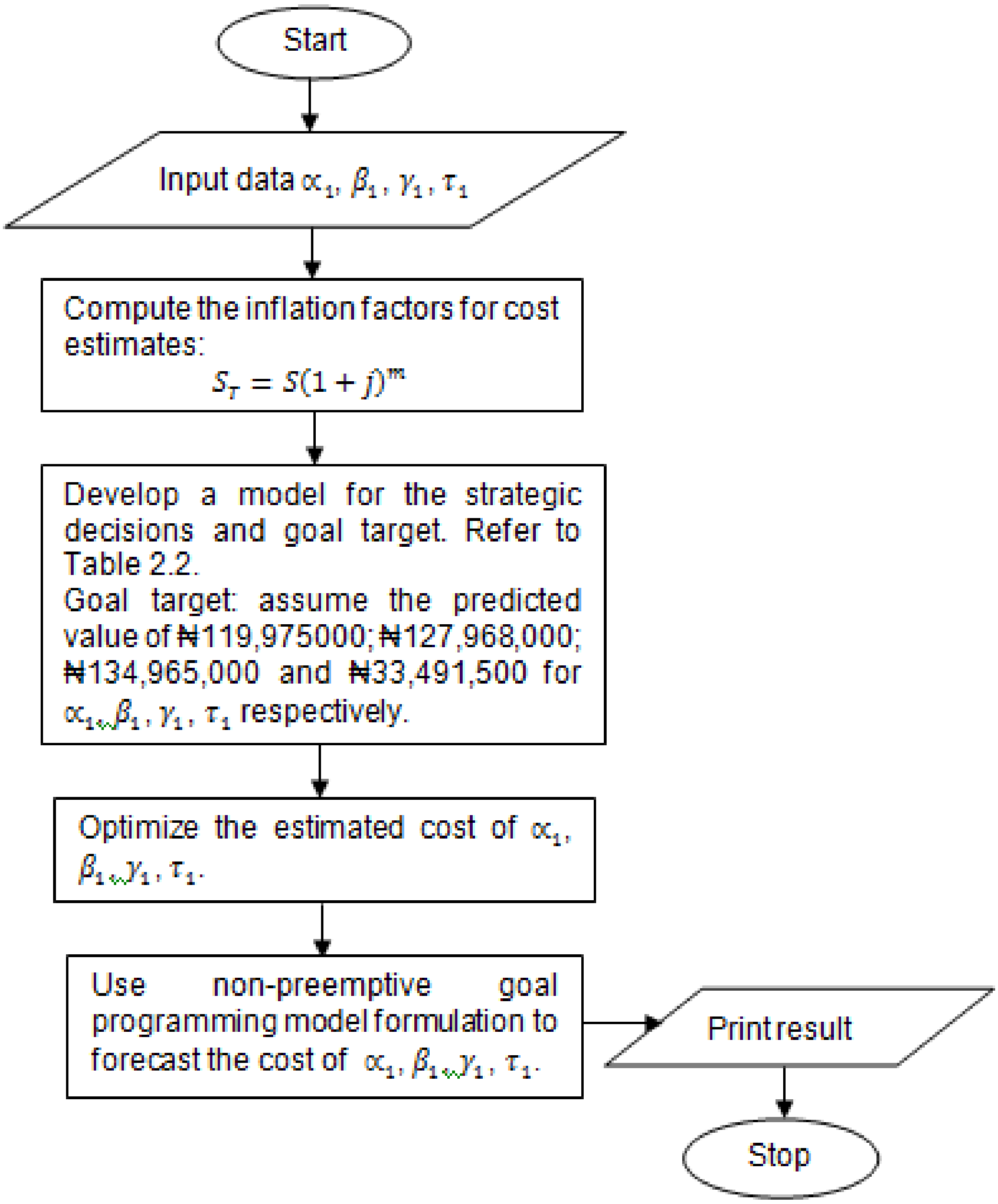

Fig. 1. Flowchart for goal programming model developed

Table 1. Available data from International Brewery Plc, Ilesha, Nigeria

Date	Number of years	Machine ($\propto_1$)	Accessory (β_1)	Spare-parts (γ_1)	Miscellaneous (τ_1)	Total (T_1)
1971	1	2,000,000	1,000,000	1,700,000	500,000	5,200,000
1978	8	2,500,000	1,500,000	2,000,000	600,000	6,600,000
1980	10	2,600,000	1,600,000	2,100,000	650,000	6,950,000
1982	12	2,600,000	1,600,000	2,100,000	650,000	6,950,000
1985	15	2,650,000	1,700,000	2,300,000	1,000,000	7,650,000
1988	18	3,000,000	5,500,000	8,000,000	2,000,000	18,500,000
1989	19	3,000,000	5,500,000	8,000,000	2,000,000	18,500,000
1991	21	5,500,000	6,000,000	10,000,000	2,500,000	24,000,000
1992	22	5,500,000	6,000,000	10,000,000	2,500,000	24,000,000
1993	23	7,300,000	6,500,000	10,500,000	3,000,000	27,300,000
1994	24	10,200,000	12,000,000	15,000,000	5,000,000	42,200,000
1995	25	10,200,000	12,000,000	15,000,000	5,000,000	42,200,000
1996	26	10,200,000	12,000,000	15,000,000	5,000,000	42,200,000
1997	27	10,200,000	12,000,000	15,000,000	5,000,000	42,200,000
1998	28	10,200,000	12,000,000	15,000,000	5,000,000	42,200,000
2001	31	16,000,000	17,500,000	19,200,000	7,500,000	60,200,000
2002	32	16,000,000	17,500,000	19,200,000	7,500,000	60,200,000
2007	37	20,000,000	22,000,000	25,000,000	10,000,000	77,000,000
2008	38	20,000,000	22,000,000	25,000,000	10,000,000	77,000,000
2009	39	20,000,000	22,000,000	25,000,000	10,000,000	77,000,000
2013	43	25,000,000	27,000,000	30,000,000	12,000,000	94,000,000
2014	44	25,000,000	27,000,000	30,000,000	12,000,000	94,000,000
2017	47	27,000,000	29,000,000	32,000,000	14,000,000	102,000,000
2018	48	28,550,000	30,050,000	33,000,000	15,000,000	106,600,000
Total		285,200,000	310,950,000	370,100,000	138,400,000	1,104,650,000

Source: International Brewery Plc, Ilesha, Nigeria, 2018

Table 2. Model for the strategic decisions and goal target

Activities	Machine ($\propto_1$)	Accessory (β_1)	Spare-part (γ_1)	Miscellaneous (τ_1)	Goal target
1	c_{11}	c_{12}	c_{13}	c_{14}	$(P_v)_{\propto_1}$
2	c_{21}	c_{22}	c_{23}	c_{24}	$(P_v)_{\beta_1}$
3	c_{31}	c_{32}	c_{33}	c_{34}	$(P_v)_{\gamma_1}$
4	c_{41}	c_{42}	c_{43}	c_{44}	$(P_v)_{\tau_1}$

Source: Study, 2019

Table 3. Cost data between the strategic decisions and goal target

Activities	Machine ($\propto_1$)	Accessory (β_1)	Spare-part (γ_1)	Miscellaneous (τ_1)	Goal target
1	c_{11}	c_{12}	c_{13}	c_{14}	119,975,000
2	c_{21}	c_{22}	c_{23}	c_{24}	127,968,000
3	c_{31}	c_{32}	c_{33}	c_{34}	134,965,000
4	c_{41}	c_{42}	c_{43}	c_{44}	33,491,500

Source: Study, 2019

3. RESULTS AND DISCUSSION

Ojo et al. [16] Used Statistical Analysis Software (SAS) to determine the correlational strength between the number of years of procurement and each of the strategic decisions, their confidence interval and predicted the costs for subsequent procurement. This study is a continuation of a published work where multi-objectives optimization was considered over the strategic decisions. Though the predicted values for machines, accessories, spare-parts and miscellaneous costs were ₦119,975,000.00; ₦127,968,000.00; ₦134,965,000.00 and ₦33, 491,500.00 respectively.

Joseph and John [17] Made reference to importance of using inflation factor in cost estimates, it can cause continuous fall in the value of money which may affect the production of the company. From Table 4, it was discovered that between the year 1980 and 1983, year 1985 and 1986 etc., the total cost of inflation is the same. Table 1 shows the similar amount of procurement between those years, while year 1978 is greater than 1980, year 1992 is greater than 1993 and year 2002 is greater than 2007 or 2008 or 2009. This is because the inflation rate and the difference between the base year and the selected year contributes to the total cost of inflation.

Tables 5, 6, 7, 8 and 9 showed the iterations for Goal programming computations. While considering budget (i.e. predicted value/goal target) with the influence of inflation over the selected strategic decisions, the optimal solution of ${d_{v3}}^+$ is 4.1311, ${d_{v1}}^+$ is 0.4604, ${d_{v4}}^+$ is 2.3760 and x_1 is 8.9793 with $Z = {d_{v1}}^- + {d_{v2}}^- + {d_{v3}}^+ + {d_{v3}}^- + {d_{v4}}^+ = 0 + 0 + 4.1311 + 0 + 2.3760 = 6.5071 \times 10^8$. This indicates that Spare-parts and Miscellaneous goals were deviated above with the value of 4.1311 and 2.3760 from the objective function. Besides, the fact that the optimum value Z is not zero means that at least one of the goals is not met.

Having compared all the goals at the same priority level, it was discovered that Machines, Spare-parts and Miscellaneous goals were deviated above from the goal constraints. Therefore, the cost of budgeting for the selected strategic decisions would be ₦166,015,000 for Machines (i.e. 119,975,000 deviated above with 0.4604$\times 10^8$); ₦127,968,000 for Accessories (i.e. no deviation); ₦548,075,000 for Spare-parts (i.e. 134,965,000 deviated above with 4.1311 $\times 10^8$); ₦271,091,500 for Miscellaneous (i.e. 33,491,500 deviated above with 2.3760 $\times 10^8$).

Table 4. Summary of the total inflated estimated cost

Date	Number of years	Machine ($\propto_1$)	Accessory (β_1)	Spare-parts (γ_1)	Miscellaneous (τ_1)	Total (T_1)
1971	1	2,000,000	1,000,000	1,700,000	500,000	5,200,000
1978	8	11,920,928.96	25,628,906.25	6,238,749.03	2,149,908.48	45,938,493
1980	10	2,812,160	1,820,444.44	2,315,250	762,847.22	7,710,702
1982	12	2,812,160	1,820,444.44	2,315,250	762,847.22	7,710,702
1985	15	2,805,843.55	2,039,086.91	3,021,714.72	3,641,329.09	11,507,974
1988	18	4,352,586.36	186,253,307.6	336,648,311	16,000,000	543,254,205
1989	19	4,352,586.36	186,253,307.6	336,648,311	16,000,000	543,254,205
1991	21	18,486,111.11	7,140,495.87	15,625,000	3,906,250	45,157,857
1992	22	18,486,111.11	7,140,495.87	15,625,000	3,906,250	45,157,857
1993	23	9,689,090.91	7,041,666.67	11,025,000	3,600,000	31,355,758
1994	24	14,252,054.79	22,153,846.15	21,428,571.43	8,333,333.33	66,167,806
1995	25	14,252,054.79	22,153,846.15	21,428,571.43	8,333,333.33	66,167,806
1996	26	14,252,054.79	22,153,846.15	21,428,571.43	8,333,333.33	66,167,806
1997	27	14,252,054.79	22,153,846.15	21,428,571.43	8,333,333.33	66,167,806
1998	28	14,252,054.79	22,153,846.15	21,428,571.43	8,333,333.33	66,167,806
2001	31	61,756,036.52	54,276,077.84	40,265,318.4	25,312,500	181,609,933
2002	32	61,756,036.52	54,276,077.84	40,265,318.4	25,312,500	181,609,933
2007	37	61,035,156.25	69,078,968.11	93,569,413.76	42,139,917.7	265,823,456
2008	38	61,035,156.25	69,078,968.11	93,569,413.76	42,139,917.7	265,823,456
2009	39	61,035,156.25	69,078,968.11	93,569,413.76	42,139,917.7	265,823,456
2013	43	61,035,156.25	61,253,103.44	62,208,000	24,883,200	209,379,460
2014	44	61,035,156.25	61,253,103.44	62,208,000	24,883,200	209,379,460
2017	47	34,012,224	35,933,597.52	38,836,148.15	22,231,481.48	131,013,451
2018	48	30,188,981.48	31,138,017.24	34,031,250	16,071,428.57	111,429,677
Total (T_y)		641,866,912	1,042,274,268	1,396,827,719	358,010,162	1,104,650,000

Source: Study, 2019

Table 5. First iteration for goal programming computation

Goals	x_1	x_2	x_3	x_4	d_{v1}^+	d_{v1}^-	d_{v2}^+	d_{v2}^-	d_{v3}^+	d_{v3}^-	d_{v4}^+	d_{v4}^-	RHS	Ratio
Mac	0.1849	0.0714	0.1563	0.0391	−1	1	0	0	0	0	0	0	1.1998	6.4889
Acc	0.1425	0.2215	0.2143	0.0833	0	0	−1	1	0	0	0	0	1.2797	8.9804
Spp	0.6104	0.6125	0.6221	0.2488	0	0	0	0	−1	1	0	0	1.3497	2.2112
Mis	0.3019	0.3114	0.3403	0.1607	0	0	0	0	0	0	−1	1	0.3349	1.1093

Source: Study, 2019

Table 6. Second iteration for goal programming computation

Goals	x_1	x_2	x_3	x_4	d_{v1}^+	d_{v1}^-	d_{v2}^+	d_{v2}^-	d_{v3}^+	d_{v3}^-	d_{v4}^+	d_{v4}^-	RHS	Ratio
Mac	0	−0.1193	−0.0521	−0.0593	−1	1	0	0	0	0	0.6125	−0.6125	0.9947	1.6240
Acc	0	0.0745	0.0537	0.0074	0	0	-1	1	0	0	0.4720	−0.4720	1.1216	2.3763
Spp	0	−0.0171	−0.0659	−0.0761	0	0	0	0	-1	1	2.0219	−2.0219	0.6726	0.3327
x_1	1	1.0315	1.1272	0.5323	0	0	0	0	0	0	−3.3124	3.3124	1.1093	−ve

Source: Study, 2019

Table 7. Third iteration for goal programming computation

Goals	x_1	x_2	x_3	x_4	d_{v1}^+	d_{v1}^-	d_{v2}^+	d_{v2}^-	d_{v3}^+	d_{v3}^-	d_{v4}^+	d_{v4}^-	RHS	Ratio
Mac	0	−0.1141	−0.0321	−0.0363	−1	1	0	0	0.3029	−0.3029	0	0	0.7909	2.6111
Acc	0	0.0785	0.0691	0.0251	0	0	−1	1	0.2335	−0.2335	0	0	0.9646	4.1310
d_4^+	0	−0.0085	−0.0326	−0.0326	0	0	0	0	−0.4946	0.4946	1	−1	0.3327	−ve
x_1	1	1.0033	1.0192	0.4078	0	0	0	0	−1.6383	1.6383	0	0	2.2113	−ve

Source: Study, 2019

Table 8. Fourth iteration for goal programming computation

Goals	x_1	x_2	x_3	x_4	d_{v1}^+	d_{v1}^-	d_{v2}^+	d_{v2}^-	d_{v3}^+	d_{v3}^-	d_{v4}^+	d_{v4}^-	RHS	Ratio
d_3^+	0	−0.3767	−0.1060	−0.1198	−3.3014	3.3014	0	0	1	−1	0	0	2.6111	−ve
Acc	0	0.1665	0.0939	0.0531	0.7709	−0.7709	−1	1	0	0	0	0	0.3549	0.4604
d_4^+	0	−0.1948	−0.0850	−0.0969	−1.6329	1.6329	0	0	0	0	1	−1	1.6242	−ve
x_1	1	0.3862	0.8455	0.2115	−5.4087	5.4087	0	0	0	0	0	0	6.4891	−ve

Source: Study, 2019

Table 9. Fifth iteration for goal programming computation

Goals	x_1	x_2	x_3	x_4	d_{v1}^+	d_{v1}^-	d_{v2}^+	d_{v2}^-	d_{v3}^+	d_{v3}^-	d_{v4}^+	d_{v4}^-	RHS
d_{v3}^+	0	0.3364	0.2961	0.1077	0	0	−4.2826	4.2826	1	−1	0	0	4.1311
d_{v1}^+	0	0.2160	0.1218	0.0689	1	−1	−1.2972	1.2972	0	0	0	0	0.4604
d_{v4}^+	0	0.1579	0.1139	0.0156	0	0	−2.1182	2.1182	0	0	1	−1	2.3760
x_1	1	1.5545	1.5043	0.5842	0	0	−7.0162	7.0162	0	0	0	0	8.9793

Source: Study, 2019

4. CONCLUSION

This research work investigated past procurement data/record to predict the cost of procurement of the selected strategic decisions with the assumed goal target in International Brewery Plc, Ilesha, Nigeria. With the influence of rate of inflation, application of non-preemptive goal programming considers goals of the costs of machines, accessories, spare-parts and miscellaneous of equal priority level. Linear goal programming directly dealt with the goals of machines, accessories, spare-parts and miscellaneous costs with the aids of the three types of goals: a lower bound goal (≥), a specific numerical goal (=) and an upper bound goal (≤) to determine the amount of goals being deviated. From the result gotten, goal programming model gave the optimal value for procurement of the selected strategic decisions. The implementation of a developed software package java programming was used. The developed model is also relevant in the area where equipment procurement affects their production plans in small, medium and large scale industries. Hence, it is advisable that the management should review the money available for budgeting in order to avoid continuous fall in the value of money.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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