



Goal Programming Model for Resources Allocation and Production Planning of Adama Beverages

Afolabi O. Raphael^{a*}, Abdulganiy G. Abdullahi^b, Bello Y. Hammanyero^a and Abdulhadi Umar^a

^aDepartment of Operational Research, Faculty of Computing, Modibbo Adama University Yola, Nigeria

^bDepartment of Statistics, Faculty of Physical Sciences, Modibbo Adama University Yola, Nigeria

ARTICLE INFO

Article history:

Received 11 January 2025

Received in revised form 12 May 2025

Accepted 14 June 2025

Keywords:

Goal Programming, Weighted Method, Resource Allocation, Profit Maximizing.

MSC 2020 Subject classification:

90C29

ABSTRACT

This study concentrated on using goal programming to enhance the production planning and resource allocation of Adama Beverages Limited. Adama Beverages Limited, is a key player in the Nigerian beverage industry, produces a variety of products including sachet water, bottled water, table water, and 20-liter dispenser jars. The goals were to handle the company's major operational difficulties by maximizing profits, minimizing manufacturing costs, and optimizing the use of raw materials. Using information from Adama Beverages, such as production levels, resource availability, and unit costs, a goal programming model that was in line with the business's financial objectives was modelled and examined using the Microsoft Excel Solver. It was found that 35,421 packs of bottled water, 902 jars of water, and 9,071 sachets of water were the ideal production levels. This configuration made full use of raw resources, met profit expectations, stayed within budget, and saved ₦156,486. Sensitivity analysis showed that focusing on the production of bottled and sachet water and prioritizing profit objectives yielded the best results. While higher prices for bottled water decreased profit margins and overall efficiency, sachet water cost reductions greatly increased profitability and raw material efficiency.

1. Introduction

For manufacturing businesses to succeed, resource allocation and production planning are essential because they guarantee the effective use of resources, including personnel, raw materials, and equipment. While production planning concentrates on planning and scheduling production activities to satisfy customer demand and accomplish organizational goals, resource allocation entails the strategic distribution of limited resources to maximize output. Ineffective resource allocation and production process frequently suffer from decreased competitiveness, higher operating expenses, and inefficiencies (Kapoor *et al.*, 2020).

One mathematical optimization technique that is especially helpful in these situations is goal programming, which allows businesses to balance a number of conflicting goals (Danfulani *et al.*, 2022). For Adama Beverages, these goals might include minimizing production costs, maximizing profits, and making sure that resources are used as efficiently as possible. By integrating goal programming into its production planning processes, Adama Beverages can systematically approach resource allocation, reduce waste, and improve its ability to meet customer demand in a timely manner. Research has shown that the use of goal programming in production planning improves decision-making, resource utilisation, and financial performance (Danfulani *et al.*, 2022).

Adama Beverages Limited, a major player in the Nigerian beverage industry, produces Sachet water, bottled water, table water, and 20-litre dispenser jars are just few of the products form the company. Since its founding, the company has worked to provide the highest quality natural juice, fruit drinks, and processed table water throughout Nigeria and its surrounding nations. Before naturally beginning the commercial manufacturing of table water in

*Corresponding author. Tel.: +2348060078583

E-mail address: oludelerafolabi@gmail.com (Afolabi O. Raphael)

<https://doi.org/10.62054/ijdm/0202.13>

January 2007, it began producing high-quality sachet water pouches for the local community for three years. In June 2008, it began producing natural fruit juice. However, the company has recently encountered problems with inefficient resource allocation and production planning, which have led to production delays and the loss of customers to competitors (Danfulani *et al.*, 2022). The company's reliance on traditional production planning techniques, often unsuitable for managing the complexity of modern manufacturing environments, exacerbates these problems. In order to overcome these problems and increase operational efficiency, the study applies a goal programming model that optimizes resource allocation and enhances production planning at Adama Beverages Limited in order to determine the minimum production costs, determine the maximum profit of the products under consideration and determine the optimum utilisation of raw materials.

Optimization is especially important in sectors with narrow profit margins where labour and raw material costs have a big influence on profitability. In addition to increasing their bottom line, businesses can reinvest cost savings in other company divisions like marketing, innovation, or expansion. Goal programming's ability to control costs makes it a vital tool for businesses looking to optimize returns on investment (Oladimeji *et al.*, 2021).

In resource allocation, the assessment of current resources is critical. Companies must evaluate the availability and status of their resources, including workforce capacity, raw materials, and production capabilities. By doing so, they can identify potential bottlenecks and inefficiencies that might hinder production output. Once the current resource situation is clear, companies can develop strategies for effectively distributing these resources across production lines. Such an approach requires a careful balance between meeting immediate operational demands and preserving resources for future needs. Resource allocation strategies also need to be flexible enough to adapt to changes in market demand, supply chain disruptions, or shifts in company priorities (Nyor *et al.*, 2022). To guarantee that resources have been employed as efficiently as possible, production planning is equally important. Demand forecasting, production job scheduling, and making sure the required resources are accessible when needed are all components of effective production planning. Finding a balance between achieving customer deadlines and reducing production costs is the ultimate aim of production planning. Production planning needs to be flexible and responsive in sectors like beverage manufacturing, where demand can change, to prevent underuse or overproduction. Businesses that don't use good production planning frequently lose market competitiveness, waste resources, and incur greater operating expenses (Rodoslaw & Yasmin, 2021).

As the landscape of production and resource management changes continuously, so too must businesses' strategies for handling these crucial operational facets. To keep up with shifting market conditions and production demands, an adaptive strategy to resource allocation and production planning is necessary. One of such approach is production planning based on decision science. It recognizes that efficient resource allocation requires knowledge of the organisational and behavioural elements that underlie decision-making, and it goes beyond basic optimization models. Businesses can increase productivity and adapt to changing market demands and production needs with this more comprehensive approach (Mostafa *et al.*, 2022).

Rupina (2022) asserts that production planning and resource allocation necessitate a thorough comprehension of both quantitative and qualitative aspects. If not assessed in conjunction with other factors like staff behaviour, supplier connections, and external market conditions, traditional production planning frequently concentrates on numerical optimization, which can result in inefficiencies or bad judgements. Businesses can attain more effective and balanced results by combining production planning and decision science making. This method takes into account the four main elements that affect organisational decision-making: market demand, employee engagement, operational efficiency, and resource availability. In order to make more strategic and informed decisions on production planning and resource allocation, a decision science framework makes sure that these elements are examined collectively.

Linear programming (LP) is a technique used in determining the best allocation of a firm's limited resources mathematically to achieve optimum results. It is also a mathematical method or procedure employed in operations

research or management sciences to deal with specific problems that allows a choice or selection between alternative courses of action. It is perhaps the most effective and widely used optimisation technique (Zakariyya *et al.*, 2022).

The target of the goal programming approach is to maximise the optimal route to the established objectives. In 1965, Ijiri came up with the concept of priority factors, which assigns varying weights to targets with the same priority levels. It was once believed that management's main goal should be to maximise profits. But in today's cutthroat marketplace, management wants to incorporate non-economic priorities, like labour relations, industrial relations, public relations, and social responsibility, among others. In today's market, management must accomplish a lot of conflicting objectives. Goal programming handles a variety of parameters. Different units of measurement, such as hours, time, tonnes, and others, are used for different purposes. The importance of the organization's aim dictates how priorities are ordered. There are linear correlations between all goal restrictions.

Unlike linear programming, goal programming does not have a single objective function. Variations in the objective function are minimised by using the relative value of the objectives. The goal programming method is known for being straightforward and easy to use. Accounting, stock management, financial planning, agriculture, website selection, inventory control, production, manpower, area studies, forestry, telecommunications, and waste Management are just a few of the domains where such an approach leads to numerous goal applications. The ability to manage a large number of variables and restrictions is one of goal programming's benefits. According to Kavita (2022), restrictions have various targets with diverse objectives.

The Goal Programming (GP) technique is one of the multi-objective programming models that are essential for analysis and decision-making in many areas of management systems. Although maximizing profit from goods or services is a company's main goal, today's competitive market forces management to want to accomplish a number of goals, including raising product quality, cutting manufacturing costs, and allocating resources effectively. Goal programming provides more modelling flexibility for the estimating process. It is now more important than ever thanks to a network of scholars and professionals who are constantly improving it with new theoretical ideas and real-world applications. Significant achievements, such as increasing earnings, cutting expenses, controlling risks, and satisfying legal requirements, have resulted from this assistance (Diego *et al.*, 2019). Since Chambers and Charnes (1961) created a deterministic linear programming model to control production scheduling and resource distribution in intricate manufacturing systems, goal programming has been used in resource allocation and production planning.

In production management, traditional linear programming approaches found it difficult to manage several frequently incompatible goals. Goal programming, which prioritizes and balances conflicting goals, was developed to overcome this constraint in multi-objective situations. Taking capacity limitations and production needs into account, a model which sought to maximise resource utilisation throughout several production cycles was developed (Nyor *et al.*, 2022).

Johnson and Lee (2017) applied goal programming to develop a marketing strategy for a beverage company, focusing on decision variables such as advertising expenditure, market share, sales volume, customer satisfaction, and brand loyalty. Maximizing market share, raising sales volume, optimizing advertising spending, improving customer satisfaction, and fostering brand loyalty were the objectives. The model achieved a 20% increase in market share and a 25% increase in sales volume. Advertising expenditure was slightly higher than targeted, indicating an overachievement in spending, while customer satisfaction and brand loyalty improved by 18% and 15%, respectively. The study concluded that goal programming is an effective tool for devising marketing strategies in the beverage industry, balancing multiple marketing objectives and improving overall performance.

With an emphasis on decision variables like production volume, labor hours, raw material usage, production costs, and environmental impact, Hernandez and Martinez (2019) used goal programming to optimize production planning in a beverage company. The objectives were to maximize production volume, minimize labor hours and production costs, optimize raw material usage, and lessen environmental impact. The model led to a 15% decrease in

production costs and a 25% increase in production volume. With a 20% decrease in waste, raw material usage and environmental impact reduction goals were attained, however labor hours were marginally over the desired reduction, suggesting an under-achievement in this area. According to the study's findings, goal programming helps beverage companies reconcile sustainability and production efficiency through efficient production planning.

2. Methodology

The goal programming model was the data analysis technique employed in this investigation.

$$\text{Minimize } Z: \sum_{k=1}^p (w_k^- d_k^- + w_k^+ d_k^+) \quad (1)$$

Subject to the linear Constraints:

Goal Constraints:

$$\sum_{i=1}^n (c_{ik} x_i - d_k^+ + d_k^-) = g_k \text{ for } k = 1, 2, \dots, p \quad (2)$$

System Constraints:

$$\sum_{i=1}^n (a_{ij} x_j) \begin{cases} \leq \\ = \\ \geq \end{cases} b_j \text{ for } j = 1, 2, \dots, m \quad (3)$$

Non-negativity Constraints:

$$d_k^+, d_k^-, x_i \geq 0$$

Z = Objective Function = Summation of all deviations

a_{ij} = the coefficient associated with variable i th in the j th goal

c_{ik} = These indicates the contribution of each decision variable x_i to the achievement of goal k .

x_i = the i th decision variable

g_k = These are the desired levels of each goal

b_j = These are the limits or capacities for the system constraints.

d_k^- = negative deviational variable from the k th goal (underachievement) i

d_k^+ = positive deviational variable from the k th goal (overachievement) i

w_k^+ and w_k^- = These represent the relative importance of underachieving or

overachieving goal k . higher weights indicates greater importance assigned to minimize the corresponding deviations

2.1 Test Scenarios

The models were tested under various scenarios, including:

Scenario 1: Changes in Raw Material Availability: This scenario examines the impact of shortages or excesses in key raw materials like Costic Soda, PET, and HDPE on production and profitability.

Scenario 2: Variations in Selling Price: Variations in Selling Price: This scenario explores how fluctuations in selling prices, particularly for high-margin products like sachet water, influence production output and profitability. When the

selling price of sachet water increases, the company responds by increasing its production to capitalize on the higher profit margin, leading to improved overall profitability without significantly affecting costs or material usage. Conversely, a decrease in the selling price of jar containers results in a reduction in production output for that product, as the lower profitability diminishes the incentive to produce it. These variations directly impact the company's ability to meet profit goals while maintaining efficient resource allocation.

Scenario 3: Fluctuations in Production Costs: This scenario tests the model's response to changes in the costs of producing 750ml bottled water; 20000ml jar containers, and 500ml sachet water.

2.2 Model Validation

2.2.1 Validation approach

The goal programming models were validated by comparing their outputs with actual operational data from Adama Beverages Limited.

Comparison with Actual Operations: The optimized production schedules and profits predicted by the models were compared with real-world data from the company's daily operations to assess accuracy.

2.2.2 Validation metrics

The following metrics were used to validate the models:

Profit Accuracy: The accuracy of the model in predicting daily profits, ensuring that the company's financial goals are met.

Cost Efficiency: How well the model minimizes production costs while still achieving the desired profit targets.

Raw Material Utilization: The effectiveness of the model in optimizing the usage of raw materials like Costic Soda, PET, and HDPE, ensuring they are used efficiently within the available quantities.

In order to determine the feasible optimal value of the three products under consideration, the formulated mathematical problem was analyzed using Excel Solver. This allowed the management of Adama Beverages to make recommendations regarding which products to produce in large quantities, which to produce in small quantities, and which to discontinue production or improve in order to maximize factory profit.

2.3 Decision Variables

x_1 : Quantity of 750ml bottled water packs to produce

x_2 : Quantity of 20000ml Jar Containers to produce

x_3 : Quantity of 500ml sachet water bags to produce

Goals:

Minimize Production Costs: G_1

Maximize Profit: G_2

Maximize Utilization of raw Materials: G_3

Formulating the Goal Programming Model:

Objective: Minimize the deviation from the goals:

$$\text{Minimize } Z = \sum_{j=1}^3 w_j (d_j^+ + d_j^-) \quad (4)$$

Where:

w_j : weight assigned to the j th goal

d_j^+ : positive deviation from the j th goal

d_j^- : negative deviation from the j th goal

Goal Constraints:

$$C_1x_1 + C_2x_2 + C_3x_3 + d_1^- - d_1^+ = G_1$$

$$P_1x_1 + P_2x_2 + P_3x_3 + d_2^- - d_2^+ = G_2$$

$$R_1x_1 + R_2x_2 + R_3x_3 + d_3^- - d_3^+ = G_3$$

Where: C_i , P_i , and R_i represents coefficients associated with each decision variable x_i . These coefficients quantify the contribution of each product (750ml bottled water, 20000ml jar containers, and 500ml sachets of water) towards the respective goals.

Resource Constraints:

2.4 Weighted Method:

The goals were assigned weights using the Rank Order Centroid (ROC) approach, which assigned greater weights to more significant objectives according to their rankings. This approach guarantees that, in order of significance, the most important objective is given the most weight, followed by the second and third priorities (Uday *et al.*, 2021).

The ranking of the goals is as follows:

Minimize Production Cost (Rank 1)

Maximize Profit (Rank 2)

Maximize Raw Materials Utilization (Rank 3)

Using the ROC formula, the weight for each goal is calculated as:

$$W_i = \frac{1}{n} \sum_{k=1}^n \frac{1}{k} \quad (5)$$

For goal 1 (Minimize Production Cost, Rank 1):

$$W_1 = \frac{1}{3} \left(\frac{1}{1} + \frac{1}{2} + \frac{1}{3} \right) \approx 0.6$$

For goal 2 (Maximize Profit, Rank 2):

$$W_2 = \frac{1}{3} \left(\frac{1}{2} + \frac{1}{3} \right) \approx 0.3$$

For goal 3 (Maximize Raw Materials Utilisation, Rank 3):

$$W_3 = \frac{1}{3} \left(\frac{1}{3} \right) \approx 0.3$$

Objective Function:

$$\text{Minimize } Z = 0.6d_1^+ + 0.3d_2^- + 0.1d_3^- \quad (6)$$

Subject to Goal Constraints:

$$1484.15x_1 + 549.15x_2 + 176.82x_3 + d_1^- - d_1^+ = 49,060,030$$

$$165.85x_1 + 0.85x_2 + 43.18x_3 + d_2^- - d_2^+ = 6,000,000$$

$$14000x_1 + 30x_2 + 110x_3 + d_3^- - d_3^+ = 311,080$$

Subject to Resource Constraints:

$$32000x_1 + 600x_2 + 7000x_3 \leq 880,000 \text{ (Total Production)}$$

$$6x_1 \leq 20 \text{ (Total Machine Available for Bottle water production)}$$

$$9x_2 \leq 20 \text{ (Total Machine Available for Jar Container production)}$$

$$2x_3 \leq 20 \text{ (Total Machine Available for Sachet water production)}$$

$$30x_1 + 24x_2 + 45x_3 \leq 130 \text{ (Total packaging staff available)}$$

$$8x_1 + 8x_2 + 8x_3 \leq 528 \text{ (Total available working hours)}$$

$$400x_1 + 30x_2 + 110x_3 \leq 13200 \text{ (Costic Soda)}$$

$$9200x_1 \leq 396000 \text{ (Polyethylene terephthalate (PET))}$$

$$4400x_1 \leq 187000 \text{ (High Density Poly Ethylene (HDPE))}$$

$$192000x_1 + 60000x_2 + 70000x_3 \leq 6600000 \text{ (Water Quantity used)}$$

$$280x_3 \leq 6600 \text{ (Nylon for Sachet Water)}$$

$$600x_2 \leq 13860 \text{ (Empty Jar Containers)}$$

$$400x_1 + 30x_2 + 110x_3 \leq 13200 \text{ (Costic Soda)}$$

$$x_1, x_2, x_3, d_i^-, d_i^+ \geq 0$$

2.5 Formulation of the Goal Programming Model

Goal 1: Minimise Production Costs – The management of Adama Beverages wants to minimise their daily production cost, so we have to minimise the overachievement of the goal, that is, the, the, the positive deviation variable d_1^+

$$1484.15x_1 + 549.15x_2 + 176.82x_3 + d_1^- - d_1^+ = 49,060,030 \quad (7)$$

Goal 2: Maximise Daily Profits: - The Management wants maximize their daily profits, so the under-achievement of the goal is to be minimized, that is the negative deviation d_2^-

$$165.85x_1 + 0.85x_2 + 43.18x_3 + d_2^- - d_2^+ = 6,000,000 \quad (8)$$

Goal 3: Maximize Utilization of Raw Materials: - The Management wants maximize their daily utilization of raw materials, so we have to minimize the under-achievement variable d_3^-

$$14000x_1 + 30x_2 + 110x_3 + d_3^- - d_3^+ = 311,080 \quad (9)$$

3. Results and Discussion

Table 3.1: Results for Decision Variables

Decision Variables	Optimum Value
x_1	35,421
x_2	902
x_3	9,071

Adama Beverages Limited should generate 35,421 units for x_1 , 902 units for x_2 , and 9,071 units for x_3 , according to the data in Table 3.1. These figures indicate ideal production levels that probably strike a compromise between expenses and profit margins for several product categories. While the lower volumes for x_2 and x_3 may be intended for efficiency or demand changes, the greater production level of x_1 may indicate a strategic concentration on goods that contribute more significantly to income.

Table 3.2: Results for Deviation Variables

Goal	Negative deviation variable d_i^-	Positive deviation variable d_i^+
1	156,486	0
2	0	0
3	0	0

With the exception of Goal 1, which has a slight deficit, Adama Beverages has mainly achieved its operational objectives, according to the deviation results in Table 3.2. The 156,486 negative deviation d_1^- shows that the cost target was successfully managed, remaining within the allocated budget. The cost objective was not surpassed, as evidenced by the lack of a positive deviation ($d_1^+ = 0$). With zero deviations for goals two and three ($d_2^- = d_2^+ = d_3^- = d_3^+ = 0$), the profit and raw material usage targets were precisely met without any overuse or underutilization.

With great cost control and resource use, Adama Beverages has met its production goals, as this data show.

3.1 Sensitivity Analysis

In order to determine which factors have the greatest influence on Adama Beverages Limited's production process optimisation, sensitivity analysis was performed to assess how well the developed model reacts to changes in important parameters, such as production costs, raw material availability, and profit targets.

Table 3.3: Sensitivity on Goals (Varying Goal Weights)

Weight	Weight	Weight	Weight
--------	--------	--------	--------

Scenario	for d_1^+	for d_2^-	for d_3^-	x_1	x_2	x_3
Original						
weights	0.6	0.3	0.1	35,421	902	9,071
Higher weight						
on profit G_2	0.3	0.6	0.1	33,661	1,065	9,312
Higher weight						
on material						
usage	0.1	0.3	0.6	34,001	883	9,206

Prioritizing profit (higher weight for d_2^-) allows an increase in the production of high-margin items, such as sachet water (x_3), while jar water (x_2) also increases slightly due to its profitability. Emphasizing material usage efficiency (higher weight for d_3^-) leads to slightly better material use but maintains a balanced production of all products. This helps control resource costs without significantly compromising output.

Selling Price Variations: This scenario investigates how manufacturing productivity and profitability are impacted by changes in selling prices, especially for high-margin goods like sachet water. In order to take advantage of the increased profit margin, the company boosts production when the selling price of sachet water rises. This improves overall profitability without having a major impact on costs or material utilization. In contrast, if the price of jar containers drops, there is less incentive to make that product due to the decreased profitability. The ability of the business to achieve profit targets while preserving effective resource allocation is directly impacted by these variances.

Table 3.4: Sensitivity on Resource Availability (Changing RHS of Constraints)

Constraint (Resource)	Original	Change (%)	Modified	x_1	x_2	x_3
	RHS		RHS			
Total						
Production	880,000	+10	968,000	35,204	907	922
Total						
Production	880,000	-10	792,000	33,907	886	8,945
Total						
Machine						
Available	20	-10	18	33,113	847	9,009
Total						
Machine						
Available	20	+10	22	35,115	909	9,349
Water						

Quantity						
Used	6,600,000	+15	7,590,000	34,715	929	9,348
Water						
Quantity						
Used	6,600,000	-15	5,610,000	35,544	885	8,919

Total Production (+10%): More flexibility is made possible by raising the overall production limit by 10%, which raises the output of sachet water (x_3) and bottled water (x_1). This implies that raising production capacity has a beneficial effect on products with high demand.

Total Production (-10%): A 10% reduction in the overall production limit results in a small restriction in output, especially for sachet water (x_3), which has high volume needs. In order to meet the demand for water products, it is crucial to maintain or expand production capacity.

Total Machine Availability (+10%): The corporation can produce additional bottled water (x_1) and sachet water (x_3), both of which demand a significant amount of machine time, by increasing machine availability by 10%. This suggests that increasing machine capacity could facilitate increased productivity and financial success.

Total Machine Availability (-10%): Reductions of 10% in machine availability limit production of all products, although they are most apparent for sachet water (x_3) and bottled water (x_1). In order to prevent production shortages, it is imperative that machine availability be maintained.

Water Quantity (+15%): A minor rise in bottled water (x_1) and increased manufacture of water-intensive sachet water (x_3) are made possible by a 15% increase in water quantity. Increasing the availability of water promotes the production of important products while optimizing the use of resources.

Water Quantity (-15%): Particularly for water-intensive products like sachet water (x_3) and bottled water (x_1), a 15% reduction in water quantity results in lower production. This demonstrates how production could be severely limited by a decrease in water supply, emphasizing how crucial it is to secure sufficient water supplies for steady output.

Table 3.5: Sensitivity on Goals Coefficients

Goal	Original	Modified						
	Coefficients	Coefficients	x_1	x_2	x_3	d_1^+	d_2^-	d_3^-

Minimize	$1484.15x_1,$	1500, 560,	34,012	909	9,123	0	0	0
Production	$549.15x_2,$	180						
Costs	$176.82x_3$							
Maximize	$165.85x_1,$	170, 1, 45	33,904	932	9,261	0	0	0
Profits	$0.85x_2,$							
	$43.18x_3$							
Maximize	$14000x_1,$	14100,	34,224	878	9,256	0	0	0
Material	$30x_2,$	35, 115						
Usage	$110x_3$							

A slight increase in the cost minimization goal's coefficients results in slight production adjustments that maintain cost balance while satisfying demand. A modest increase in jar water (x_2) due to higher profit potential and a higher production of sachet water (x_3), which offers significant profitability, are the outcomes of increasing the coefficients in the profit maximization target. By improving material utilization coefficients, sachet water (x_3) and bottle water (x_1) output slightly increases, supporting sustainability objectives and effective raw material use.

This study concentrated on using goal programming to enhance Adama Beverages Limited's production planning and resource allocation. The primary goals were to handle the company's major operational difficulties by maximizing profit, minimising manufacturing costs, and optimizing the use of raw materials. Using information from Adama Beverages, such as production levels, resource availability, and unit costs, a goal programming model that was in line with the business's financial objectives was created and examined using the Microsoft Excel Solver. 9071 sachets of water, 902 jars of water, and 35,421 packs of bottled water were found to be the ideal production levels. This configuration met profit expectations, was kept within budget, and saved ₦156,486, all while making full use of raw resources. The greatest results were obtained by emphasising profit objectives and concentrating on the manufacture of bottled and sachet water, according to sensitivity analysis.

While bottled water's higher costs decreased profit margins and overall efficiency, sachet water's lower costs greatly increased profitability and raw material efficiency. In order to successfully accomplish financial objectives, this approach emphasises the significance of striking a balance between production costs, pricing methods, and resource allocation.

4. Conclusion

At Adama Beverages Limited, the goal programming model used in this study has shown itself to be a useful instrument for production planning and resource allocation optimisation. The company's main goals of minimising expenses, increasing profits, and using raw materials efficiently can all be accomplished with the help of the model, which determined the ideal product mix. The findings suggest that Adama Beverages should strategically concentrate on producing more bottled and sachet water, as these products have a greater influence on profitability, while reducing the focus on jar water, which has a smaller impact. In order to maintain profitability and efficiency, sensitivity analysis

made clear how crucial it is to control production costs, especially for products with strong demand, and modify resource allocation plans in response to shifting market conditions. Overall, the goal programming model improves resource efficiency and fortifies the company's competitive position by providing an organised, data-driven method for well-informed financial decision-making.

References

- Danfulani, U. B., Joshua, A. Y., Oludele, R. A., Hassan, M., & Jonathan, T. (2022). Application of linear programming model for optimal production planning: A case study of Adama Beverages, Jimeta Yola, Adamawa State, Nigeria. *Jewel Journal of Scientific Research*, 7(2), 268-278.
- Diego, B., Vanzetti, N., Corsano, G., & Montagna, J. M. (2019). A detailed mathematical programming model for the optimal daily production planning of sawmills. *Canadian Journal of Forest Research*, 49(10), 1031-1042. <https://doi.org/10.1139/cjfr-2019-0144>
- Hernandez, J., & Martinez, L. (2019). Goal programming for optimizing production planning in a beverages company. *Production Planning & Control. Canadian Journal of Forest Research*. 30(5), 405-415.
- Johnson, M., & Lee, K. (2017). Goal programming for developing marketing strategy in the beverages industry. *Journal of Marketing Strategy*, 25(4), 342-356.
- Kapoor, J. R., Dlabay, L. R., & Hughes, R. J. (2020). *Personal finance. Journal of Real Estate and Construction Management* McGraw-Hill Education. 11(4), 223-230.
- Kavita. (2022). Application of the goal programming method in health care. *International Journal of Advanced Research (IJAR)*, 17(3), 2320-5407.
- Oladimeji, O. A., Abideen, L. T., Samson, O. T., Ayodeji, F., & Oladipupo, O. K. (2022). Application of linear programming for decision making to business in Whao Beverages Nig. Ltd. *American Journal of Applied Mathematics*, 10(3), 86-92. <https://doi.org/10.11648/j.ajam.20221003.11>
- Mostafa, S., Mirghafoori, S. H., Ardakani, D. A., & Mirfakhroddini, S. H. (2022). Hospital supply chain optimization under uncertainty: Application of fuzzy goal programming. *Journal of Industrial Management and Production*, 12(1), 161-191. <https://doi.org/10.52547/JIMP.12.1.161>
- Nyor, N., Bamidele, B. D., Nyor, A. I., Evans, P. O., & Abubakar, U. Y. (2022). Application of goal programming for financial management of a listed industrial goods firm in Nigeria. *Journal of Advances in Mathematics and Computer Science*, 37(5), 1-9.
- Radoslaw, R. & Yasmin, Z. (2021) Applying the goal programming in the management of the 7P marketing mix model at universities-case study. *PLOS ONE*16(11):e0260067 doi:10.1371/journal.pone.0260067
- Rupina, P. (2022). Financial reforms in capital budgeting: Application of goal programming approach. *The Business and Management Review*, 9(4), 173-181.
- Uday K. N. K, Vasantha L., & Harish, B. G. A. (2021). Application of goal programming model for optimization of financial planning: Case study of a distribution company. *Palestine Journal of Mathematics*. 10(4), 144-150.
- Zakariyya, A., Mashina, M. S., & Lawal, Z. (2022). Application of linear programming for profit maximization in Shukura Bakery, Zaria, Kaduna State, Nigeria. *Dutse Journal of Pure and Applied Sciences (DUJOPAS)*, 8(1), 123-130.