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PROFIT MAXIMISATION FOR BAKERY PRODUCTS USING LINEAR PROGRAMMING PROBLEM(LPP)

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Abstract: Linear Programming is a numerical streamlining procedure that empowers bakery shops proprietors and supervisors to go with informed choices in regards to the accomplish the essential target of benefit boost. LPP is mainly used for Profit Maximisation or Cost Minimisation. This research paper talks about the resource allocation in the manufacturing of two well-known cake items: Black Forest and White Forest cakes. The essential spotlight is on overseeing restricted unrefined components, including milk, sugar, and eggs, as well as sticking to time limitations. By using both Graphical Method and Simplex LP method the results showed that the bakery should produce 88 Black Forest cake pieces per day and 8 White Forest cake pieces per day to reach the profits of Rs.1131 per day.

Keywords: **Black Forest, White Forest, Profit maximisation, Cake Production, Raw Materials, Milk, Sugar, Egg, Time Constraints, Optimization, Linear Programming, Efficiency, Graphical Method, Simplex LP**

INTRODUCTION

Linear Programming Problem (LPP) is a numerical improvement method used to track down the best result in a numerical model with straight connections. It has a rich history tracing all the way back to the 1930s.

The bakery industry is a dynamic area with a diverse scope of items that take care of different purchaser inclinations. Bakery shops whether huge or small, face consistent difficulties in overseeing assets, production cycles, and item portfolios to boost benefits. One powerful device for tending to these difficulties is Linear Programming Problem (LPP). Linear Programming is a numerical streamlining procedure that empowers bakery shops proprietors and supervisors to go with informed choices in regards to the creation blend, asset portion, and valuing methodologies to accomplish the essential target of benefit boost.

The idea of Linear programming includes figuring out a numerical model of the pastry kitchen's tasks, including expenses, incomes, and limitations. The goal is to track down the ideal blend of pastry kitchen items to deliver, taking into account these variables, while augmenting the general benefit.

This is accomplished through Linear programming, a technique that investigates the possible arrangement space to decide the most beneficial strategy.

The bakery industry is eminent for its different scope of heavenly treats, and two enduring top choices are the Black Forest and White Forest cakes. These cakes, with their interesting flavours and engaging style, have earned a committed following among customers.

By utilizing Linear programming, the pastry kitchen proprietor can decide the number of every item to create to amplify the benefit while sticking to requirements like fixing accessibility and creation hours. In the advanced pastry kitchen scene, it is vital to streamline resource allocation. It guarantees effective creation, limits squander, and eventually impacts the main concern. This research paper centres around the use of Linear programming, a numerical improvement strategy, to address this test.

This methodology engages bakery shop to arrive at informed conclusions about estimating, creation, and asset designation. Pastry kitchen proprietors can try different things with various situations, like modifying recipes, changing costs, or putting resources into extra gear, to track down the most beneficial mix of items.

All in all, the utilization of Linear Programming in the bakery industry offers a precise and quantitative way to deal with improving creation, estimating, and asset distribution to accomplish benefit boost. By considering every single important variable and limitations, bread kitchen proprietors can upgrade their dynamic cycles and accomplish more noteworthy benefit in this cutthroat and developing business sector.

Objectives:

To study about the efficient dispensing of components to produce both the cakes.

To optimise the production of both the cakes for maximisation of profits.

LITERATURE REVIEW

This research paper explores the application of LP in optimizing cake production of 2 cakes that is vanilla and black forest cakes. It explores the bakery business, LP foundations and real-world application demonstrating the right mathematical recipe to success [12].

The demand for cake as a complementary food increase, impacting production levels and profits. This study analyses the maximum profit of the Maesa Cake and Bakery Shop in Permata Legenda Branch, selling Banana Bolu and Banana Bolen. Linear programming and the simplex method were used, with observational data obtained from interviews with shop owners. The researchers used Ms. Excel and POM for Windows to calculate the simplex method and POM for Windows to find the maximum profit. The maximum profit achieved is IDR 270,000.00 per day [14].

Linear programming is a technique used to optimize management decisions and increase output in businesses. This study focuses on optimizing profit in a manufacturing sector using data from Baker's Cottage reports. The study found that producing chicken floss and Frank Cheese was necessary for maximum monthly profit, while other bread types were not required. This approach helps businesses maximize profit and reduces trial-and-error methods [9].

The bakery industry, ranging from small to large, faces challenges in allocating scarce resources, impacting gross profit and margin. This study aimed to determine the number of products to produce, compare results using Linear Programming, Integer Linear Programming, and trial-and-error methods, and determine product limits using sensitivity analysis. Results showed that Templicious Enterprise should produce standard pavlova, superbaby pavlova, and personal pavlova for a profit of RM 446.99 [5].

This paper uses linear programming to optimize the profit of a local bakery, Shukura Bakery, in Nigeria. It considers four types of bread: small, medium, family, and slice family loaf. The research uses the simplex method to determine the optimal profit, finding that family loaf contributes more to the bakery's profit [1].

This study aims to maximize profit for a Malaysian SMEs, ABC Sdn Bhd, by using a linear programming model to optimize product mix. The study identifies current production processes and formulates a viable product mix to ensure profitability. The findings provide insights into linear programming methods for determining maximum profit for different product mixes, thereby benefiting other SMEs in Malaysia [15].

Linear programming is a mathematical modelling technique used in decision-making for resource allocation. This study applied it to Khadija Special Bread Dutsinma to determine the optimal bread quantity for maximum profit. The simplex algorithm was

used. Results showed that reducing bread production by 340grams yielded more profit, suggesting a need for more bread production and sales [16].

This paper uses linear programming to determine the optimal product mix for Gusau Sweet Factory Limited, based on financial records. The study identifies daily production of Toffee and Lollipop for maximum profit, using the revised simplex algorithm [3].

This study applied linear programming to a decision-making problem at the University of Benin Bakery in Nigeria. The goal was to determine the daily bread production quantity to maximize profit, considering production constraints. Data from the bakery's financial records was collected and solved using Linear Programming Solver software. The solution suggested 667 extra-large bread units daily for a daily profit of $100,000 [6].

The research paper utilized the Simplex algorithm in Linear Programming to maximize profit in a bakery by distributing raw materials among competing products. Results showed that cakes, breads, and macarons contributed more to profit, indicating higher production of cakes is necessary [8].

A Mumbai-based XYZ bakery aims to maximize profits and maintain product quality, quantity, and shelf life. To achieve this, a linear programming (LP) mathematical model is developed using the Integer Programming Method algorithm. The bakery allocates raw materials like cupcakes, pastries, and cakes as variables to maximize income [7].

This paper explores the use of linear programming in optimizing profits in a production industry. It uses secondary data from Landmark University Bakery to solve a linear programming problem. The solution suggests concentrating on producing 14,000 Family loaf loaves and 10,571 Chocolate loaves to achieve a monthly profit of N1,860,000. The analysis reveals that Family loaf and Chocolate bread contribute objectively to profit, suggesting more production and sales are needed to maximize profit [11].

This study demonstrates the use of linear programming methods to maximize profit at Johnsons Nig. Ltd, Bakery division. Using the Simplex method, the optimal solution was found to be three units of large Kings bread size with an objective value contribution of 125 naira. Sensitivity analysis revealed that the optimal solution must remain between 50-30 for the coefficient of x to remain unchanged, otherwise, it will lead to discontinuity [10].

This research aims to optimize the home industry of Bintang Bakery by maximizing profits. Using Lindo tools and simplex method, the industry achieved an optimal profit level of Rp 19.750.000 by producing 3740 flavoured bread pieces, 1300 packaged bread rolls, and 520 loaves of bread packaging [4].

This paper uses linear programming and the Simplex algorithm to optimize bakery profits. It reveals that 1000 units of small loaf, 500 units of big loaf, and 0 units of giant loaf should be produced to maximize profit. The analysis reveals that small and big loaf contribute objectively to profit, indicating the need for more production and sales [13].

The study used the Simplex algorithm to allocate raw materials in a bakery for profit maximization. Results showed that 962 small loaf units, 38 big loaf units, and 0 giant loaf units should be produced to achieve a profit of N20385, with smaller and bigger loaf types contributing to profit [2].

RESEARCH METHODOLOGY

The data collected was based on two cakes mainly Black Forest and White Forest cakes. The main reason behind choosing these two particular cakes was their popularity.

Table 1: This table shows the constraints and its values

Constraints	Cake 1 (Black Forest)	Cake 2 (White Forest)	Total Availability
Milk	2 cups	5 cups	280 cups
Sugar	4 cups	0 cups	350 cups
Eggs	1 egg	4 eggs	120 eggs
Time	1 Hour	2 Hours	400 hours
Profit	Rs.12/unit	Rs.10/unit	

Data Analysis

Let, **x be the no of units of Black Forest cake pieces produced per day**

y be the no of units of White Forest cake pieces produced per day

Objective Function: Profit Maximisation: 12x+10y

Constraints are as follows:

a. Time Constraint
Total time available for the production is 400 hours
Time taken to produce Black Forest cake is 1 hour
Time taken to produce White Forest cake is 2 hours
Constraint is: $1x+2y \leq 400$

One cup of milk = 30ml

One cup of Sugar = 20grams

b. Milk Constraint
Total availability of milk for the production is 280 cups
Total milk cups used to produce Black Forest cake is 2 cups
Total milk cups used to produce White Forest cake is 5 cups
Constraint is: $2x+5y \leq 280$

c. Sugar Constraint:
Total availability of Sugar for the production is 350 cups
Total Sugar cups used to produce Black Forest cake is 4 cups
Total Sugar cups used to produce White Forest cake is 0 cups
Constraint is: $4x+0y \leq 350$

d. Eggs Constraint:
Total availability of Eggs for the production is 120 eggs
Total Eggs used to produce Black Forest cake is 1 egg
Total Eggs used to produce White Forest cake is 4 eggs
Constraint is: $1x+4y \leq 120$

e. Non-Negative Constraint:
$x \geq 0$ and $y \geq 0$

Linear programming problem is to maximise the profits

Maximise $Z = 12x+10y$

Subjected to:

$2x+5y \leq 280$ (Milk)

$4x+0y \leq 350$ (Sugar)

$1x+4y \leq 120$ (Eggs)

$1x+2y \leq 400$ (Time)

$x \geq 0$ & $y \geq 0$ (non-negative constraints)

Graphical Method

Step 01: Converting the inequalities into equalities and substituting x and y as zero.

Table 2: This table shows conversion of inequalities into equalities of Milk constraint

C1 (Milk)		
X	0	140
Y	56	0

Table 3: This table shows conversion of inequalities into equalities of Sugar constraint

C2 (Sugar)		
X	0	87.5
Y	350	0

Table 4: This table shows conversion of inequalities into equalities of Eggs constraint

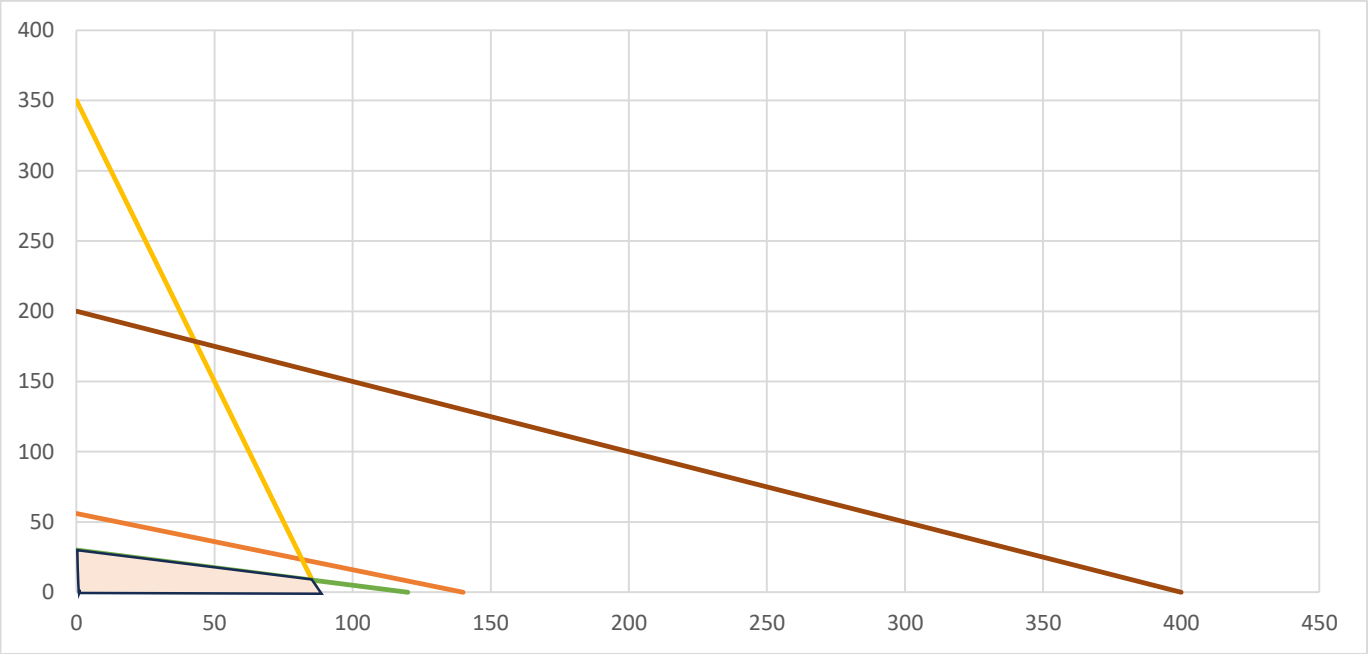
C3 (Eggs)		
X	0	120
Y	30	0

Table 5: This table shows conversion of inequalities into equalities of Time constraint

C4 (Time)		
X	0	400
Y	200	0

Step 02: Graphical Representation of the solution

Graph shows the feasible points that are obtained by solving the problem graphically



Step 03: Feasible Points

Table 6: This table shows conversion of inequalities into equalities of Time constraint

FEASIBLE POINTS	Z = 12x+10y
(0,0)	0
(88.5,0)	1062
(87.5,8.125)	1131.25
(30,0)	360

The graphical solution gives the following solution:

Max Z = 1131.25

When x = 87.5 and y = 8.125

From the graph it can be inferred that the bakery should produce 88 cake pieces of Black Forest and 8 cake pieces of White Forest cakes and the profit will be 1131.25 per day.

Simplex LP

Table 7: This table shows the constraints formed by the data

Decision Variables	**X**	**Y**		**Objective Function**	
Values	0	0		0	
Co-efficient	12	10			
Constraints			LHS		RHS
C1 (Milk)	2	5	0	≤	280
C2 (Sugar)	4	0	0	≤	350
C3 (Eggs)	1	4	0	≤	120
C4 (Time)	1	2	0	≤	400

Table 8: This table shows the solution obtained through Simplex LP

Decision Variables	**X**	**Y**		**Objective Function**	
Values	87.5	8.125		1131	
Co-efficient	12	10			
Constraints			LHS		RHS
C1 (Milk)	2	5	215.6	≤	280
C2 (Sugar)	4	0	350	≤	350
C3 (Eggs)	1	4	120	≤	120
C4 (Time)	1	2	103.8	≤	400

Solution according to Simplex LP method:

Max Z = 1131 when x = 87.5 and y = 8.125

Interpretation:

As the values of the graphical method and simplex method are same, that is, x = 87.5 and y = 8.125 and maximum value is 1131 (as the number of units cannot be in decimals, rounding off to the nearest value)

From the simplex method we get exact values of the problem where the bakery should produce 88 cake pieces of Black Forest per day and 8 cake pieces of White Forest cakes per day and the profit will be Rs.1131.25 per day.

CONCLUSION

The objective of this study was to apply the simplex method for finding the optimum solution for a profit maximization problem with the help of MS Excel. The bakery should produce 88 Black Forest cake pieces per day and 8 White Forest cake pieces per day to reach profits of Rs.1131 per day. According to studies and research, organizations may find the best answer for issues like cost reduction and profit maximization by using the simplex technique. The assessments and research findings demonstrate that the usage of the simplex LP in corporate and business settings demonstrates worthwhile for accomplishing ideal results in situations like profit maximisation and cost minimisation.

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