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FUZZY OPTIMIZATION TECHNIQUE IN PRODUCTION INDUSTRY

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Abstract

The purpose of this article is to demonstrate how to use the Optimization Technique to maximize profits in a manufacturing organization. This research looked at how raw resources are utilized in Nestle milk products. Fuzzy optimization was used to examine several uncertain parameters, and the answer was obtained using an optimization software.

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1. Introduction

A human's logical judgment in picking possibilities is called decision making. It has a huge popularity in the product manufacturing industry. Because their respective markets are very competitive. As a result, decision-making plays an important role at the managerial level of industrial firms. In a productive setting, Decision Making (DM) comprises of procedures and criteria for determining the optimal alternative in certain and uncertain situations. When dealing with decision-making problems in which the situation is known or uncertain, fuzzy set theory appears to be an optimistic method. When the given data is not crisp, fuzzy modelling helps us deal with variables that represent the idea of uncertainty. Different strategies can be used in Fuzzy Linear Programming. The preliminary defuzzification of fuzzy variables is a common aspect of the approaches described above. To obtain the single final solution, the resulting model is solved. By using alternative criteria such as probability maximization to meet a minimum stated profit, many Linear Programming problems can be derived from an initial fuzzy Linear programming issue. Bellman and Zadeh were the first mathematicians to create fuzzy decision-making models based on maximizing. In classical composition, this approach was used to multi-objective linear programming problems. Zimmermann developed a fuzzy technique to solving linear programming issues.

2. Fuzzy Sets

Prof. L. A. Zadeh [8] was the first to introduce the idea of fuzzy set theory. Fuzzy set theory has lately been used to a variety of topics, including switching theory, automata theory, and decision theory. The idea of fuzziness may be simply understood by considering how a person researching the meaning of a word can take it differently depending on the weather.

3. Fuzzy Linear Programming

Fuzzy Linear Programming arises from the fact that classical Linear Programming is frequently effective in real-world applications. In fact, several coefficients in classical Linear Programming problems may not be well-defined, either because their values are dependent on other variables. Now we consider the Fuzzy Linear Programming Problem $Max\ Z = \tilde{C}^T x$

Subject to $\widetilde{A}x \leq \widetilde{b}\ x \geq 0$.

The probability distribution of the optional objective function Z must be determined in order to solve this problem. Many researchers have solved this challenge by making the fuzzy objective function and fuzzy constraints with crisp values.

4. Modified Zimmermann Method

As proven by Zimmermann, a linear programming problem with a fuzzy target function and fuzzy inequalities is as follows:

$$C^T x \tilde{\geq} b_0$$

$$(AX)_i \leq \widetilde{b}_i,\ i = 1, 2, \ldots, m,\ x \geq 0$$

Inequality is a symmetrical model with one constraint: the objective function. Inequality is converted to a matrix form as follows to create general formulation:

Changing the intervals in membership functions yields the optimum solution for the modified Zimmermann's technique. The membership function has been modified as follows:

$$\mu_0(x) = \begin{cases} 0; & \text{if } Cx \leq b_0 - d_0 \\ \dfrac{Cx - (b_0 - d_0)}{d_0}; & \text{if } b_0 - d_0 \leq Cx \leq b_0 \\ 1; & \text{if } Cx \geq b_0 \end{cases}$$

$$\mu_i(x) = \begin{cases} 0; & \text{if } (Ax)_i \geq b_i \\ 1 - \dfrac{(Ax)_i - (b_i - d_i)}{d_i}; & \text{if } b_i - d_i \leq (Ax)_i \leq b_i \\ 1; & \text{if } (Ax)_i \leq b_i - d_i \end{cases}$$

In which d is a matrix of admissible violation. Introducing the auxiliary variable λ, the model is changed into $\mu_0(x) \geq \lambda,\ \mu_i(x) \geq \lambda;\ \lambda \in [0, 1]$. The fuzzy LPP is obtained by reducing the model:

$Max\ \lambda$

Subject to $Cx - \lambda d_0 \geq b_0 - d_0$

$(Ax)_i + \lambda d_i \leq b_i, \forall i$

$\lambda \in [0, 1], x \geq 0$

5. Application

Table 1. Decision Variables and Cost details.

Variable	Product package	Cost	Price	Profit
x_1	Nestle a + Grekyo Yoghurt	110	151	41
x_2	Nestle Actiplus Probiotic Dahi	150	178	28
x_3	Nestle Bhuna Jeera Raita	85	110	25
x_4	Nestle Milk maid	90	128	38
x_5	Nestle Everyday Ghee	150	200	50
Expected Demand		1,45,384		
Tolerance level for Demand		2,359		
Expected Profit		₹ 69,198.17(in Million)		
Tolerance level for profit		₹ 4,552		

Table 2. Raw materials used for production per month.

Raw materials	Production in Kg	x_1	x_2	x_3	x_4	x_5
Milk Solids	8650	760	810	685	840	720
Double Toned Milk	5050	925	750	875	750	825
Sugar	6800	810	880	750	725	850
Milk Fat	2300	380	410	365	520	380
Stabiliser	3750	10	45	25	45	10
Iodized Salt	600	80	75	55	45	60
Iodized Salt	29	11	4	5	5	4

6. Fuzzy Linear Programming Model

Problem was modeled as monthly basis and the same is given below:

Max λ

Subject to

$$151x_1 + 178x_2 + 110x_3 + 128x_4 + 200x_5 - 4552\lambda \geq 64646$$

$$x_1 + x_2 + x_3 + x_4 + x_5 + 2359\lambda \leq 145384$$

$$760x_1 + 810x_2 + 685x_3 + 840x_4 + 720x_5 \leq 8650$$

$$425x_1 + 750x_2 + 875x_3 + 750x_4 + 825x_5 \leq 5050$$

$$810x_1 + 880x_2 + 750x_3 + 725x_4 + 850x_5 \leq 8300$$

$$380x_1 + 4140x_2 + 365x_3 + 520x_4 + 380x_5 \leq 3750$$

$$10x_1 + 45x_2 + 25x_3 + 45x_4 + 10x_5 \leq 600$$

$$80x_1 + 75x_2 + 55x_3 + 45x_4 + 60x_5 \leq 6300$$

$$11x_1 + 4x_2 + 5x_3 + 4x_5 \leq 29$$

$$x_1, x_2, x_3, x_4, x_5 \geq 0$$

$$\lambda \in [0, 1]$$

LINGO optimization software was used to solve the problem's Fuzzy Linear Programming model. The solution's outcomes are listed below.

Software Result

Objective Function Value: 69103

Variable	Value
x_1	27
x_2	63
x_3	106

x_4	84
x_5	157

Hence, total profit for the Milk Products of Nestle company is 69,103 (in Million).

7. Conclusion

In this study, Fuzzy Linear Programming was used to simulate an issue at the Nestle food manufacturing company. Both the objective function and the constraints in the model are fuzzy. It was discovered using a modified Zimmermann's method. Zimmermann's approach is one of the methods used to solve the Fuzzy Linear Programming Problem. As a consequence, the solution determines the amount of production needed for each product in order to maximize profit by fulfilling demand.

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