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Sensitivity Analysis for Fuzzy Linear Programming Problem by Mehar Method

Sozan Saber Haider Ali
Dep. of Statistics and Informatics, Collage of Administration and Economics, University of Sulaimani, Sulaymaniyah, Iraq
Email: sozan.haider@univsul.edu.iq, ORCID ID:/ https://orcid.org/0009-0008-0335-5313

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Correspondence:
Sozan Saber Haider Ali
Email:sozan.haider@univsul.edu.iq

Abstract

Numerous manufacturing companies face significant financial setbacks due to excessive raw material costs, low profits, and no taxes on imported goods. The production companies also suffer from uncertainty concerning expenses, production levels, sales figures, and the accessibility of raw materials. Therefore, in our study, we developed an innovative method to design a fuzzy linear programming model customised for the Doura Refinery of the Middle Refineries Company. We emphasised five essential products: white oil, naphtha, light puffs, heavy Jet, and liquid gas. The main goal of our approach was to achieve optimal decision-making by identifying the most favourable production quantities and evaluating the corresponding net income derived from product sales. Following the Mehar method, we employed a methodology that converts the fuzzy linear programming problem into a standard linear programming problem. Subsequently, we conducted a sensitivity analysis, focusing only on the impact of fuzzy cost changes, and successfully derived optimal solutions for this case. Therefore, we aim to resolve the challenges of fuzzy linear programming and explore how cost changes impact this problem using Mehar's method.

1. Introduction

The significance of delving into Operations Research lies in its role in bridging the gap between abstract problems and real-world scenarios. The discipline facilitates a systematic representation by devising precise mathematical models that encapsulate the various components of a given problem. Presenting these models through a series of mathematical relationships clarifies the problem's intricacies and provides diverse alternatives for decision-making. This process contributes to a comprehensive understanding of the problem's elements and the influencing factors.

Linear programming stands out as a widely utilised operational research technique, having undergone extensive exploration and enhancement by researchers from diverse perspectives over the past six decades. Despite its longstanding history, there is a continual need to devise novel approaches that align more effectively with real-world problems within the linear programming framework. Unlike the conventional approach that mandates well-defined and precise parameters in linear programming models, the reality of the actual world doesn't always conform to such assumptions. Typically, experts require estimating many parameters in a linear programming model due to the inherent uncertainties in the real-world environment.

Linear programming encounters challenges when dealing with inaccurate data, primarily because its models demand clear and precise parameters. When data suffers from inaccuracies, an alternative approach involves representing the parameters of the linear programming problem using fuzzy numbers. This shift towards fuzzy linear programming is a robust tool for constructing practical optimisation models that accommodate the uncertainties inherent in real-world problems [2,3,4,8].

In the natural environment, controlling costs, including the cost of raw materials, especially the ambiguity of the expenses, production quantities, and raw materials, is difficult. In such a case, one can resort to post-optimization analysis (sensitivity analysis) to address these changes because a change in standards may lead to a change in the number of profits.

2. Preliminaries

This segment outlines fundamental definitions and arithmetic operations pertaining to fuzzy numbers.

2.1 Fuzzy set theory

A fuzzy set serves as an extension of the traditional set concept. Unlike classical sets, which sharply divide elements into either members or non-members, fuzzy sets allow for a more nuanced representation. Many commonly utilised categories for describing our perception of reality lack a clear-cut distinction. Instead, these categories exhibit fuzzy boundaries, where the shift from membership to non-membership is gradual rather than sudden. Introducing fuzzy sets addresses this vagueness by removing sharp boundaries that separate members from non-members. Mathematically, a fuzzy set is characterised by attributing a value within the interval of [0,1], representing its membership grade. This grade signifies the extent to which an individual aligns with or is compatible with the concept represented by the fuzzy set.

Consequently, individuals can belong to a fuzzy set to varying degrees, as indicated by their membership grade, which can be larger or smaller. A full member is associated with a membership grade of 1, while a complete non-membership is denoted by a membership grade of 0, respectively [3,7,10,12].

2.2 Membership Functions

A membership function (MF) is a graphical representation illustrating how each point in the input space is assigned a membership value ranging from 0 to 1. The input space, also called the universe of discourse, acts as the domain for this mapping. Alternatively, the membership function visually portrays the degree of involvement of each input. In the context of any set X, a membership function on XIs essentially any function that maps from XTo the actual unit interval [0,1]. Commonly symbolised as μ_A, The membership function associated with a fuzzy set allocates a membership degree, $\mu_A(x)$, to each element x within X. This degree serves to quantify the extent of membership for the given element. xIn the fuzzy set. A value of 0 indicates that. $x$does not belong to the fuzzy set, while a value of 1 signifies complete membership. The intricate process of designing these membership functions is pivotal in developing a fuzzy logic controller (FC), with the sole constraint being that the values must fall within the [0,1] range. In contrast to crisp sets, a fuzzy set can be depicted by an infinite array of membership functions. [1,3,8].

2.3 Membership Function: Basic Concepts

- The support of a fuzzy set A encompasses all points x in the set X where the membership degree $\mu_A(x)$Is greater than 0. This concept can be mathematically represented as:

$$equalCapSupport\ (A) \ = \ \{(x, \mu_A(x)) / \ \mu_A(x)) > 0)\} \tag{1}$$

- Core: The core of a fuzzy set A comprises all elements x in the set X where the membership degree $\mu_A(x)$ equals 1. This concept can be expressed mathematically as:

$$core\ (A)\ =\ \{(x, \mu_A(x))/\mu_A(x)) = 1)\} \tag{2}$$

- **$\boldsymbol{\alpha}$**-Cut: An $\alpha\ -cut$ for a fuzzy set A is the set of elements in X with a degree of membership greater than or equal to α. This can be mathematically denoted as $A\alpha = \{x\epsilon X|\ \mu_A(x) \geq \alpha\}$
- Strong **$\boldsymbol{\alpha}$**-Cut: $A_\alpha = \{x\epsilon X|\ \mu_A(x) > \alpha\}$, In this case 'A' is defined as Crisp set.
- Height: The height of a fuzzy set refers to the maximum degree of membership within the set, see Figure (1) [3,4,7].

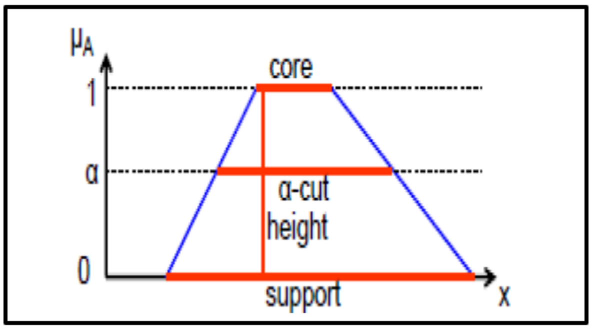

Figure (1): Membership Function in the Fuzzy Logic

2.4 Linear Membership Function

It signifies the membership values of an element in a fuzzy group through a linear representation, with one crucial type being the trapezoidal membership function. This function is a significant form of linear membership function and is defined as a fuzzy number. $\tilde{A} = (a_1, a_2, a_3, a_4)$ and its membership function is defined as:

$$\mu_A(x) = \begin{cases} \dfrac{(x-a_1)}{(a_2-a_1)} & a_1 \leq x \leq a_2 \\ 1 & a_2 \leq x \leq a_3 \\ \dfrac{(x-a_4)}{(a_3-a_4)} & a_3 \leq x \leq a_4 \\ 0 & O.W \end{cases} \tag{3}$$

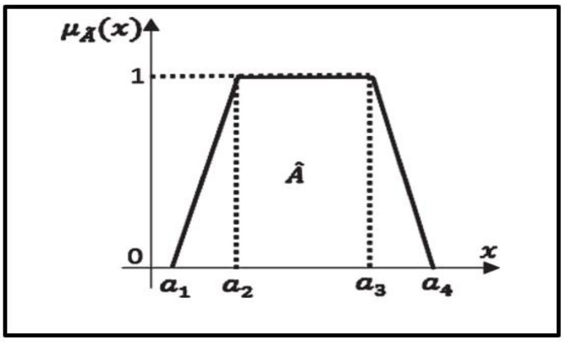

Figure (2): Trapezoidal fuzzy number $\tilde{A} = (a_1, a_2, a_3, a_4)$

3. Ranking Approach

A various methodologies have been suggested to rank fuzzy numbers, and among them, an uncomplicated and easily comprehensible ranking technique proposed by Yager is commonly adopted for the ranking of fuzzy numbers in this paper in which a ranking index $R(\tilde{A})$ is calculated for the fuzzy number $\tilde{A} = (a_1, a_2, a_3, a_4)$ from its $\lambda - cut$ $A_\lambda = [a_2 - (a_2 - a_1)\lambda\,, a_3 + (a_4 - a_3)\lambda]$ according to the following formula [2,4,10]:

$$\mathcal{R}(\widetilde{A}) = \frac{1}{2}\left(\int_{0}^{1}(a_2 - (a_2 - a_1)\lambda)d\lambda + \int_{0}^{1}(a_3 + (a_4 - a_3)\lambda)d\lambda\right) = \frac{a_1 + a_2 + a_3 + a_4}{4} \quad (4)$$

Considering that $\mathcal{R}(\lambda)$ is computed based on the extreme values of $\lambda - cut$ of $\tilde{A}$ i.e., $a_2 - (a_2 - a_1)\lambda$ and $a_3 + (a_4 - a_3)\lambda$, rather than its membership function, Knowing the specific shape of the membership functions of the fuzzy numbers slated for ranking is not necessary. Unlike many ranking techniques that necessitate understanding the membership functions of all fuzzy numbers [2,3] in question, Yager's ranking index can be utilized even when the specific structure of the membership function of a fuzzy number is not revealed or explicitly known [2,4,11].

4. Sensitivity Analysis

After solving a given linear problem, sensitivity analysis is conducted to explore how alterations to the problem impact the optimal solution. Specifically, discrete changes such as modifying the cost coefficients vector (c), adjusting the right-hand-side vector (b), and altering the constraint matrix (A) are considered. The analysis also delves into the implications of introducing a new variable or constraint to the model. Leveraging the calculations from solving the original problem, sensitivity analysis commences from the existing optimal tableau. Additionally, this examination of discrete changes can extend to understanding how continuous changes affect the optimal solution, termed parametric analysis. However, this discussion focuses solely on the first case, involving changes in the objective function.

5. Fuzzy Linear Programming Problem

The theory of fuzzy sets plays a crucial role in shaping the decision-making process, leading to the formulation of problems known as fuzzy linear programming (FLP) problems. Zimmermann (1978) introduced the FLP problem, where the primary goal is to identify the optimal solution in the presence of imprecise, vague, uncertain, or incomplete information. The central challenge in FLP lies in developing an optimisation model capable of deriving the best solution based on subjective professional judgments. And the FLP model is defined by [5,6,9]:

$$\begin{aligned} &\tilde{Z} \approx Maximize(orMinimize)\sum_{j=1}^{n}\tilde{c}_j\widetilde{x}_j \\ &s.t. \\ &\sum_{j=1}^{n}\tilde{a}_{ij}\widetilde{x}_j \leq \tilde{b}_i \qquad ,i = 1,2,3,\ldots,m \\ &\widetilde{x}_j \geq 0 \qquad ,j = 1,2,3,\ldots,n \end{aligned} \quad (5)$$

Where: $\tilde{c}_j$: parameters of the fuzzy objective function. $\widetilde{x}_j$: fuzzy decision variables. $\tilde{a}_{ij}$: fuzzy constraint coefficients. $\tilde{b}_i$: fuzzy right-hand side of the constraints.

6. The Optimum Solution for Fuzzy Linear Programming Problems Employing Fuzzy Logic

A collection of fuzzy numbers represented by $\tilde{x}_j$ is considered a fuzzy optimal solution for equation (5) if it adheres to the specified properties [5,11]:

(i). $\sum_{j=1}^{n}\tilde{a}_{ij}\tilde{x}_j \leq, \approx, \geq \tilde{b}_i \qquad ,i = 1,2,\ldots,m$

(ii). $\tilde{x}_j \geq 0 \qquad ,j = 1,2,\ldots,n$

(iii). If there exists any set of fuzzy numbers $\tilde{y}_j$ such that:

$\sum_{j=1}^{n} \tilde{a}_{ij}\tilde{x}_j \leq, \approx, \geq \tilde{b}_i \quad , i = 1,2, \dots, m$ and $\tilde{y}_j \geq 0,\ for\ all\ \ j = 1,2, \dots., n$

Then:

$\sum_{j=1}^{n} \tilde{c}_j \otimes \tilde{x}_j \geq \sum_{j=1}^{n} \tilde{c}_j \otimes \tilde{y}_j$ (in case of maximisation problem) and

$\sum_{j=1}^{n} \tilde{c}_j \otimes \tilde{x}_j \leq \sum_{j=1}^{n} \tilde{c}_j \otimes \tilde{y}_j$ (in case of minimisation problem).

7. Proposed Mehar's Method

This section introduces Mehar's method as a novel approach aimed at addressing the constraints of current methods. Mehar's method determines the fuzzy optimal solution for FLP problems. The procedural steps of Mehar's method for solving FLP problems are outlined as follows:

Step 1: Transform the Fuzzy Linear Programming (FLP) problem into a Crisp Linear Programming (CLP) problem.

$$\begin{aligned}
&Maximize(orMinimize) = R(\tilde{c}^t \otimes \tilde{x}) \\
&s.t. \\
&R(A\tilde{x}) \leq or \geq or = R(\tilde{b}) \\
&d_j \ominus c_j \geq 0 , \\
&b_j \ominus a_j \geq 0 , \\
&c_j \ominus b_j \geq 0 , \\
&a_j \geq 0 , \qquad for\ j = 1,2,3,\dots,n
\end{aligned} \tag{6}$$

Step 2: Solve the Crisp Linear Programming (CLP) problem derived in the initial step by solving it to determine the optimal solution $a_j, b_j , c_j, and\ d_j$.

Step 3: Calculate the fuzzy optimal solution by substituting the values of $a_j, b_j , c_j, and\ d_j$ obtained from Step 2, in $\tilde{x}_j = (a_j, b_j , c_j, d_j)$ and determine the fuzzy optimal value by substituting the values of $\tilde{x}_j = (a_j, b_j , c_j, d_j)$ in $\sum_{j=1}^{n} \tilde{c}_j \otimes \tilde{x}_j$.

Step 4: Check the case of change in the cost vector.

If the cost vector $\tilde{c}_j$ changes to $\tilde{C}_j$ in the given FLP problem, then replace:

$R(\tilde{c}^t \otimes \tilde{x})$ by $R(\tilde{C}^t \otimes \tilde{x})$in CLP problem to obtain:

$$\begin{aligned}
&Maximize\ \ (or\ Minimum) = R(\tilde{C}^t \otimes \tilde{x}) \\
&s.t. \\
&R(A\tilde{x}) \leq or \geq or = R(\tilde{b}) \\
&d_j \ominus c_j \geq 0 , \\
&b_j \ominus a_j \geq 0 , \\
&c_j \ominus b_j \geq 0 , \\
&a_j \geq 0 , \qquad for\ j = 1,2,3,\dots,n
\end{aligned} \tag{7}$$

Apply the current sensitivity analysis technique to determine the optimal solution for equation (7), leveraging the optimal solution derived from equation (5). Utilise Step 3 of Mehar's method to ascertain the fuzzy optimal solution and fuzzy optimal value for the resulting Fuzzy Linear Programming (FLP) problem. If these values satisfy the optimal conditions, the old solution is still optimal for the new problem. Otherwise, the fuzzy primal simplex algorithm will continue as usual.

The main advantage of Mehar's method over existing methods is its ability to handle a broader range of fuzzy sensitivity analysis problems. While traditional methods are limited in addressing these cases, Mehar's method provides a more versatile and comprehensive approach, making it suitable for a broader range of fuzzy linear programming problems [11,13].

8. Application Part

Following the paper's theoretical exposition of fuzzy linear programming, the practical aspect is explored, illustrating the process of constructing a fuzzy linear programming model for products. This application is demonstrated through the context of the Middel Refineries Company, specifically the Doura Refinery, focusing on five distinct products: white oil, naphtha, light puffs, heavy Jet, and liquid gas. The objective is to attain an optimal decision by determining the ideal production quantities and assessing the resulting net income from product sales. The methodology involves employing the fuzzy linear programming approach in the model to guide these decision-making processes:

8.1 The Data was Organized and Gathered following the Subsequent:

Table (1) illustrates the unchanging selling prices of products alongside quarterly fluctuating production costs, influenced by expenses such as purchasing crude oil, maintenance costs, production requirements, and chemicals. These factors contribute to the continuous adjustments in production costs. Daily production quantities are outlined in Table (2), daily order quantities are presented in Table (3), and the requisites for production inputs are detailed in Table (4).

Table (1): displays the prices at which products are sold and the associated production costs, both denominated in USD

Product \ m^3	Selling price	Production cost			
White Oil	96	30	50	70	90
Naphtha	60	20	30	65	85
Light Puffs	75	30	50	65	90
Heavy Jet	50	20	30	55	75
Liquid Gas	150	50	75	90	105

Table (2): Daily production quantities

Product\ m^3	2	3	4	1
White Oil	749	772	796	819
Naphtha	725	740	765	820
Light Puffs	427	441	454	467
Heavy Jet	562	579	597	615
Liquid Gas	381	393	405	417

Table (3): Daily order quantities

Product \ m^3	2	3	4	1
White Oil	749	772	796	819
Naphtha	725	740	765	820
Light Puffs	427	441	454	467
Heavy Jet	562	579	597	615
Liquid Gas	381	393	405	417

Table (4): The needs of production inputs

Product	Cooling Water/m^3	Water vapors/m^3	Electric power/watt	Fuel used/m^3
White Oil	3.25	4.39	5.39	3.67
	3.20	4.53	5.56	3.78
	3.30	4.66	5.73	3.90

	3.72	4.80	5.90	4.01
Naphtha	3.25	4.39	5.39	3.67
	3.20	4.53	5.56	3.78
	3.30	4.66	5.73	3.90
	3.72	4.80	5.90	4.01
Light Puffs	3.25	4.80	5.39	3.67
	3.20	4.39	5.56	3.78
	3.30	4.53	5.73	3.90
	3.72	4.66	5.90	4.01
Heavy Jet	22.52	3.12	1.73	5.34
	23.23	3.22	1.78	5.50
	23.93	3.31	1.84	5.67
	24.64	3.41	1.89	5.84
Liquid Gas	3.25	5.06	5.39	3.67
	3.51	5.22	5.56	3.78
	3.62	5.38	5.73	3.90
	3.72	5.53	5.90	4.01
The Available quantity of production Supplies	265792.64	274098.66	282404.68	290710.7
	77958.4	80394.6	82830.8	85267
	5376924.16	5544953.04	5712981.92	5881010.8
	227584	234696	241808	248920

8.2 Description of the Data

In this paper, we have four tables about price and costs, daily production quantities, daily order quantities, and the needs for production inputs measured by cubic meters as shown in the appendices. The data have been collected for one year from (1/1/2022 to 31/12/2022) in Doura Oil Refinery. The data contained (5) variables which are described below:

X_1: White Oil, $X_2: Naphtha,$ $X_3: Light\ Puffs,$ $X_4: Heavy\ Jet,$ $X_5: Liquid\ Gas$

$$\tilde{X}_i = (x_i, y_i, t_i) \qquad i = 1,2,\dots,5 \tag{8}$$

$$P_j = Price \qquad j = 1,2,\dots,5 \tag{9}$$

The model comprises the following elements:

Objective Function: A maximization function representing the difference between selling prices and fuzzy production costs.

Constraints:

- Production constraints
- Product demand constraints
- Production requirement constraints

1. Specifically, the objective function seeks to maximize the result of subtracting fuzzy production costs from selling prices. The constraints encompass limitations related to production, product demand, and production requirements

$$\begin{aligned} Max\,(\tilde{Z}) = {} & (P_1)\tilde{X}_1 + (P_2)\tilde{X}_2 + (P_3)\tilde{X}_3 + (P_4)\tilde{X}_4 + (P_5)\tilde{X}_5 - (a_1, b_1, c_1)\tilde{X}_1 \\ & - (a_2, b_2, c_2)\tilde{X}_2 - (a_3, b_3, c_3)\tilde{X}_3 - (a_4, b_4, c_4)\tilde{X}_4 - (a_5, b_5, c_5)\tilde{X}_5 \end{aligned} \tag{10}$$

2. Constraints in the model include the following categories

   Production constraints

   Product demand constraints

   Production requirement constraints, which encompass cooling water constraints:

   - Cooling water constraints

$$(a_1, b_1, c_1)\tilde{X}_1 + (a_2, b_2, c_2)\tilde{X}_2 + (a_3, b_3, c_3)\tilde{X}_3 + (a_4, b_4, c_4)\tilde{X}_4 + (a_5, b_5, c_5)\tilde{X}_5 \le (A, B, C) \quad (11)$$

- Water vapor constraints

$$(a_1, b_1, c_1)\tilde{X}_1 + (a_2, b_2, c_2)\tilde{X}_2 + (a_3, b_3, c_3)\tilde{X}_3 + (a_4, b_4, c_4)\tilde{X}_4 + (a_5, b_5, c_5)\tilde{X}_5 \le (A, B, C) \quad (12)$$

- Electric power constraints

$$(a_1, b_1, c_1)\tilde{X}_1 + (a_2, b_2, c_2)\tilde{X}_2 + (a_3, b_3, c_3)\tilde{X}_3 + (a_4, b_4, c_4)\tilde{X}_4 + (a_5, b_5, c_5)\tilde{X}_5 \le (A, B, C) \quad (13)$$

- Fuel used constraints
- Non-negative constraint:

$$(a_1, b_1, c_1)\tilde{X}_1 + (a_2, b_2, c_2)\tilde{X}_2 + (a_3, b_3, c_3)\tilde{X}_3 + (a_4, b_4, c_4)\tilde{X}_4 + (a_5, b_5, c_5)\tilde{X}_5 \le (A, B, C) \quad (14)$$

$$\tilde{X}_i \ge 0 \qquad , if \;\; i = 1,2, \ldots\ldots, 5 \quad (15)$$

Following the completion of model construction, every fuzzy variable $\tilde{X}_i$ will undergo conversion to (x_i, y_i, t_i) in the initial model.

Non-negative constraint: $(x_i, y_i, t_i) \ge 0$

To determine the optimal production quantities and determine the net revenues, four semesters will be used. For find the optimal solution through ready by the software package PyCharm (2023) as follows:

$\tilde{x}_1 = (749,\ 772,\ 796,\ 819)$

$\tilde{x}_2 = (802,\ 740,\ 682,\ 520)$

$\tilde{x}_3 = (453,\ 456,\ 482,\ 467)$

$\tilde{x}_4 = (713,\ 735,\ 597,\ 615)$

$\tilde{x}_5 = (381,\ 393,\ 405,\ 417)$

$\tilde{Z} = (161389,\ 113287,\ 43411,\ -11701)$

Earnings for the second quarter are 161389

Earnings for the third quarter are 113287

Earnings for the fourth quarter are 43411

Earnings for the first quarter are -11701

Table (5): The Optimal Solution

Product	2	3	4	1	Robust Method
White Oil	749	772	796	819	784
Naphtha	802	740	682	520	763
Light Puffs	453	456	482	467	474
Heavy Jet	713	735	597	615	746
Liquid Gas	381	393	405	417	399
Net profit/$	161389$	113287$	43411$	-11701	72803$

8.3 Change in Fuzzy Costs:

The Company adjusted the fuzzy production costs of each variable for all four seasons to achieve better profits. This is by taking advantage of the costs of previous years, changes that have led to a decline in profits, whether caused by war or changes in operating systems and equipment. The company reduced the cost by 0.4 for all quarters in 2022.

Table (6): The new costs in USD

Product \ m^3	Production cost			
	2	3	4	1
White Oil	18	30	42	54
Naphtha	12	18	39	51
Light Puffs	12	30	39	54
Heavy Jet	20	18	33	45
Liquid Gas	30	45	54	63

The same constraints as the original model are used because the cost change affects only the objective function. Also, to find the optimal solution after the change in fuzzy costs, we use the software package PyCharm (2023) as follows:

$\tilde{x}_1 = (749,\ 772,\ 796,\ 819,\ 784)$

$\tilde{x}_2 = (802,\ 740,\ 765,\ 820,\ 763)$

$\tilde{x}_3 = (453,\ 456,\ 481,\ 495,\ 474)$

$\tilde{x}_4 = (713,\ 735,\ 757,\ 779,\ 746)$

$\tilde{x}_5 = (381,\ 393,\ 405,\ 417,\ 339)$

$\tilde{Z} = (192567,\ 167337,\ 128114,\ 92357,\ 143999)$

Table (7): The optimal solution after change in fuzzy costs

Product	2	3	4	1	Robust Method
White Oil	749	772	796	819	784
Naphtha	802	740	765	820	763
Light Puffs	453	456	481	495	474
Heavy Jet	92347	735	757	779	746
Liquid Gas	381	393	405	417	339
Net profit/$	192567$	167337$	128114$	92347$	143999$

We note that when costs decrease, this only affects the value of the objective function, which increases from 72803 to 143999, with production quantities remaining the same.

9. Results and Discussion

Fuzzy linear programming is a highly effective method, especially in addressing problems characterised by instability and fluctuations. Its efficiency in resource utilisation makes it a preferred approach for obtaining optimal solutions closely aligned with the inherent nature of the problem. The paper delves into sensitivity analysis within fuzzy linear programming problems, highlighting its capacity to handle scenarios where the variables are fuzzy numbers. The Mehar method underscores that if a solution exists for a given problem, it implies the existence of an infinite set of alternative solutions. Furthermore, arithmetic operations involving fuzzy numbers become necessary when striving to find the fuzzy optimal solution and conducting sensitivity analysis using conventional methods. In contrast, the proposed Mehar methods simplify the process by relying on arithmetic operations involving real numbers, making them more straightforward to apply than existing methods. This underscores the advantage of utilising Mehar methods for their ease of application compared to the more complex arithmetic operations associated with fuzzy numbers.

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تحليل الحساسية لمشكلة البرمجة الخطية الضبابية بطريقة Mehar

سوزان صابر حيدر
قسم الاحصاء والمعلوماتية – كلية الادارة والاقتصاد - جامعة السليمانية - الاسليمانيه – العراق
Email: sozan.haider@univsul.edu.iq, ORCiD/ https://orcid.org/0009-0008-0335-5313

المستخلص

تواجه العديد من شركات التصنيع انتكاسات مالية كبيرة بسبب مجموعة من العوامل مثل تكاليف المواد الخام الباهظة، والأرباح المنخفضة، وعدم فرض ضرائب على السلع المستوردة، وتواجه شركة الإنتاج أيضًا حالة من عدم اليقين فيما يتعلق بشأن التكلفة ومستويات الإنتاج والمبيعات وتوافر مواد الخام. لذلك؛ قمنا في دراستنا بتطبيق نهج جديد لإنشاء نموذج برمجة خطية ضبابية مصمم خصيصاً لشركة مصافي الوسط وتحديداً مصفاة دورة من خلال التركيز على خمسة من منتجات الشركة، وهذه المنتجات هي نفط الابيض، النفتا، نفتا الخفيفة، الطائرة ثقيلة، الغاز السائل. كان هدفنا الأساسي هو الوصول إلى القرار الأمثل من خلال تحديد كميات الإنتاج الأكثر فائدة وتقييم صافي الدخل الناتج من مبيعات المنتجات. ولتحقيق ذلك، لقد استخدمنا منهجية تتضمن تحويل مشكلة البرمجة الخطية الضبابية (FLP) إلى مشكلة برمجة خطية عادية، وذلك باتباع طريقة Mehar. وبعد ذلك، أجرينا تحليل الحساسية، مع التركيز على تأثير التغيرات الغامضة في التكلفة، ونجحنا في استخلاص الحلول المثلى لهذه الحالة. لذلك هدفنا هو حل مشكلة البرمجة الخطية الضبابية واستكشاف كيفية تأثير التغيرات في التكاليف على هذه المشكلة باستخدام طريقة Mehar.

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المراسلة:
أسم الباحث: سوزان صابر حيدر
Email: sozan.haider@univsul.edu.iq