Neutrosophic Statistical Analysis on Gold Rate

Kala Raja Mohan [1]*, R. Narmada Devi[2], Nagadevi Bala Nagaram [3], T. Bharathi[4] and Suresh Rasappan[5]

[1,2,3] Department of Mathematics, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Chennai, India. [1] kalamohan24@yahoo.co.in [2]narmadadevi23@gmail.com [3]nagaramnagadevibala@gmail.com
[4]Department of Mathematics, Loyala College, Nungambakkam, Chennai-600 034, Tamil Nadu, India.
prith.bharu23@gmail.com

[5]Mathematics Section, College of Technology and Information Sciences, University of Technology and Applied Sciences-Ibri, Post Box-466, Postal Code-516, Ibri, Sultanate of Oman. mrpsuresh83@gmail.com
* Correspondence: kalamohan24@yahoo.co.in;

Abstract: Gold ornaments are always been seen as a metal of pride and happiness. It is also considered to be one of the auspicious costliest metals. Gold rate is found at an increasing rate from an early period. This paper analyzes the gold rate at six different cities in India. For each of the cities, neutrosophic mean and coefficient of variation have been calculated. The analysis results have been presented. In addition to that the neutrosophic analysis based on each month also has been calculated. The results help to know the beneficial month and city for the purchase of gold.

Keywords: Gold Price; Neutrosophic mean; Coefficient of variation; Neutrosophic statistics;

1. Introduction

Gold is a naturally occurring chemical element. It is one of the elements which is less reactive than other metals. The luster of the metal is not lost since it does not react with oxygen, acids etc. Being malleable it can be easily molded into any favorable design as we require. From ancient times to modern times, gold possesses its own tradition and it is one of the favorite metals liked by women. Gold ornaments are worn by people to look pretty well, as a prestigious thing to show off their status and so on. In many of the middle class families, golden ornaments are bought as savings to make use for pledging when there is a need for money. Apart from these, wearing of gold also helps us in regulate our body temperature. Gold is also a useful metal.

In the ancient period, ornaments were worn by both men and women to beautify themselves and look elegant. Women even used jewelry from their head to toe. In the early period beads and shells were used to make ornaments. But these ornaments did not have a good life. Then people of the Indus valley region introduced jewels made of metal. Gold has been regarded as a precious metal that occupies the first position as mangal sutra at the beginning of marriage life. Diamonds are the next adorable stones which were also first introduced by Indians. Diamonds tie up with gold in making pretty ornaments.

There are many kinds of ornaments which are worn in different parts of the body. Maangtika, paasa, veni are the names of the ornaments that are used in hair plaiting. These are the ornaments that are worn by women occasionally to give a special look during functions like marriage, baby shower ceremony and so on. Jhumkas, chandbalis, kanvelis are worn as earrings. Nath is an ornament worn as nose pins.   Gulbandh, rani haar and satlada are a few ornaments worn on neck similar to necklace. Kamarbandh is worn around the waist. Hands are decorated with bracelets, bangles. Hathpool ornament is worn as a connector of rings worn in fingers, which looks like a spider web. Paizeb,

ghungroo payals, toe ring payals are worn to beautify feet. Most popular models of jewellery are termed as bead jewels, bridal jewels, antique jewels, kundan jewels, ivory jewels, temple jewellery, jadau jewels.

Most of the people invest in gold savings. People also look for auspicious days to turn their money into gold. It would be helpful if the people were aware of the month and place where the price of gold could be an optimized state for the buyers. With a motive to make people beneficial from the purchase, this study is conducted to predict the rate of gold considering 6 popular cities in Tamilnadu.

Many researchers have done their work on neutrosophic statistical analysis. A few of them are listed as literature survey as given below. Muhammad Aslam in 2019 proposed a plan to identify a plan based on attributes using the method of interval in neutrosophic statistics [4]. The same researcher in 2019 performed a neutrosophic analysis on identifying the applications used by university students [6]. R. Dhavaseelan et al in 2019 discussed about neutrosophic continuity [5]. Alexandra Dolores Molina Manzano et al in 2020 conducted an analysis for people aged between 16 to 18 regarding the voting systems by applying neutrosophic statistical analysis [7]. Broumi said et al in 2020 introduced trapezoidal fuzzy numbers in obtaining a new distance measure with the usage of centroids [8]. Muhammad Naveed Jafar et al in 2020 discussed about the neutrosophic environment concerning the similarity measures in trigonometric functions [9]. Carlos Acosta Mayorga et al in 2021 analyzed on surgical site infection after the procedures of vascular surgery. Concerning the field of medical sciences, statistical approaches for management with indeterminacy were involved in their work [10]. Ishmal Shahzadi et al in 2021 underwent neutrosophic statistical analysis to report on the income of YouTube channels [11]. Fernando Castro Sánchez et al in 2021 processed their work on developing education by applying neutrosophic and plithogenic statistical analysis [12]. Lysbeth Kruscthalia Álvarez Gómez   et al in 2021 involved themselves in making an analysis on E-commerce [13].

Lester Wong Vázquez et al in 2021 Rehabilitation of Arterial Hypertension using neutrosophic statistical analysis [14]. Sara Guerrón Enríquez et al in 2021 considered Arthrofibrosis of the Knee Rehabilitation for their study. They applied neutrosophic statistical analysis for their study [16]. Abdullah Gamal et al in 2022 have framed an intelligent model related to the manufacturing sector in overcoming the barriers during COVID pandemic [18]. Elizabeth Cristina Mayorga Aldaiz et al in 2022 conducted an assessment of university students for rehabilitation using neutrosophic statistical analysis [19]. Kenia Mariela Peñafiel Jaramillo et al in 2022 performed an analysis to know the behavioral medical knowledge among university students with the help of neutrosophic statistical analysis [20]. Florentin Smarandache in 2022 performed a comparative study on neutrosophic statistics and plithogenic statistics [22].

Muhammad Rafiq et al in 2022 proposed a statistical analysis for formulating a trend in the temperature of Baluchistan at Pakistan [24]. Rushikesh Ghule, Abhijeet Gadhave in 2022 used a machine learning approach in the method of forecasting the rate of gold [26]. Said Broumi et al in 2022 constructed a survey process on identifying the problems in medical diagnosis. They used neutrosophic sets along with their hybrid structures for their research work. [27]. Ishmal Shahzadi in 2023 performed a statistical analysis on the temperature of various cities of Pakistan [30]. Muhammad Aslam, and Muhammad Saleem in 2023 privileged to used F test neturosophic statistics to make analysis on linear applications [32]. Regan Murugesan et al in 2023 have conducted a study on variants of covid applying Neutrosophic cognitive maps and Fuzzy cognitive maps [33]. Aral et al in 2023 have discussed normed linear spaces. They have considered difference sequence of fractional order and their strongly lacunary convergence with order β in their work [28]. Kandemir et al in 2023 have done a work similar to previously mentioned work of Aral et al with order α [31]. Mohamed Abdel-Basset et al in 2023 did a network security communication with the help of their optimization model [23]. Nada A. Nabeeh et al in 2022 discussed their twin type block chain technology and its production [25]. Ayman H. Abdel-aziem et al in 2023 presented on decision making algorithm with respect to bank sector in bringing about optimization in investment [29]. Uma G and Nandhitha S in 2023 performed their study Neutrosophic Poisson distribution with a quick switching system [34].

Waleed Tawfiq Al-Nami in 2023 discussed the strategies for the safety of people in the crowd applying their ranks and analysis [35].

The work done by a few other researchers in predicting the price of gold applying various methods is listed below. M. Khalid et al in 2014 performed forecasting on the price of gold collected evidences from the Pakistan gold market [1] Iftikhar ul Sami and Khurum Nazir Junejo in 2017 presented their work on prediction of gold rate using machine language approach [2]. Naliniprava Tripathy in 2017 applied moving average model which integrates with auto regression for their analysis in foretelling the price of gold [3]. Mustafa Yurtsever in 2021 made an analysis on forecasting the price of gold using the methods of LSTM, Bi-LSTM and GRU [15]. Sultan Salem et al in 2021 performed a life time data analysis in finding the properties and their applications applying neutrosophic lognormal method [17]. Laor Boongasame in 2022 made use of the association rule and memory of long and short term in the forecasting of the price of gold [21].

This paper aims at bringing out an analysis on the rate of gold comparison at various regions of India using neutrosophic statistics.

2. Methodology

The prediction of gold rate involved various steps. Initially the period on which the data is to be collected is finalized. Then the required data is collected with the help of the application related to it. The collected data are tabulated in required format. Then the neutrosophic statistical measures such as mean and standard deviation are evaluated with the help of MATLAB software. With the calculated data. Neutrosophic statistical analysis is performed and the conclusion is given. which are given as diagrammatic representation beneath given as Figure 1.
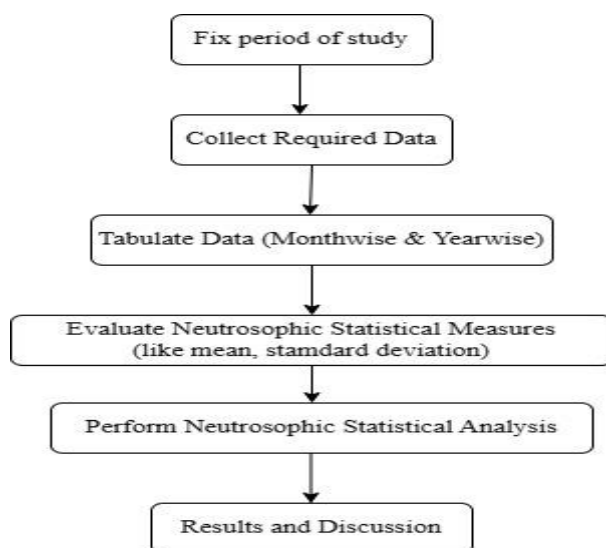

Figure 1: Schema of the proposed procedure

Various definitions applied related to the work performed are listed below.

Consider $X_N = X_L + X_U I_N, I_N \in [I_L, I_U]$ to be a neutrosophic random variable representing the rate of gold at various month and at various cities. Her X_L denotes the lower rate of gold and X_U denotes the upper rate of gold. I_N is the interval of indeterminacy.

The neutrosophic average of gold data $X_N \in [X_L, X_U]$ is $\bar{X}_N = \bar{X}_L + \bar{X}_U I_N; I_N \in [I_L, I_U]$

for which $\bar{X}_L = \sum_{i=1}^{n_N} \bar{X}_{iL}, \bar{X}_U = \sum_{i=1}^{n_N} \bar{X}_{iU}$ and $n_N = [n_L, n_U]$

The neutrosophic standard deviation is calculated as given below.

$$\sum_{i=1}^{n_N}(X_i - \bar{X}_{iU})^2 = \sum_{i-1}^{n_N}\begin{bmatrix}\min\begin{pmatrix}(a_i + b_iI_L)(\bar{a} + \bar{b}I_L), (a_i + b_iI_L)(\bar{a} + \bar{b}I_U)\\(a_i + b_iI_U)(\bar{a} + \bar{b}I_L), (a_i + b_iI_L)(\bar{a} + \bar{b}I_L)\end{pmatrix}\\\max\begin{pmatrix}(a_i + b_iI_L)(\bar{a} + \bar{b}I_L), (a_i + b_iI_L)(\bar{a} + \bar{b}I_U)\\(a_i + b_iI_U)(\bar{a} + \bar{b}I_L), (a_i + b_iI_L)(\bar{a} + \bar{b}I_L)\end{pmatrix}\end{bmatrix}$$

where $I \in [I_L, I_U]$ and $a_i = X_L$; $b_i = X_U$

The neutrosophic sample variance is $S_N^2 = \dfrac{\sum_{i=1}^{n_N}(X_i - \bar{X}_{iN})^2}{n_N}$; $S_N^2 \in [S_L^2, S_U^2]$

The neutrosophic form of $S_N^2 \in [S_L^2, S_U^2]$ is given as $a_S + b_S I_{NS} \in [I_{LS}, I_{US}]$

The consistency on the rate of gold can be known from the coefficient of variation given as

$$CV_N = \frac{\sqrt{s_N^2}}{\bar{X}_N} \times 100; \quad C_{VN} \in [C_{VL}, C_{VU}]$$

The neutrosophic form of CV_N is $a_v + b_v I_{Nv}$; $I_{Nv} \in [I_{Lv}, I_{Uv}]$

3. Data Collection

The rate of gold remains different even in a same day. It also remains different in different places of the state. In such case of uncertainty, the data to be collected from reliable source. It is proposed to consider six major cities in India for the analysis on gold rates. The cities considered for analysis are Chennai, Kolkatta, Bangalore, Madurai, Hyderabad and Delhi. The everyday price of 22 carat gold in each of these cities are collected from the application named 'Indian Daily Gold Prices Android App' which can be downloaded using the link https://goo.gl/KoCNzt/. The collected rate are for one gram of gold which is mentioned in rupees. The data ranging from February 1 2022 to January 31, 2023 are collected. From the collected data, maximum and minimum rate corresponding to each month is listed out and presented in Tables as given below. Table 1 represents the low and high gold price rate corresponding the cities Chennai, Kolkatta, Bangalore. Table 2 corresponds to the low and high gold price rate corresponding to the cities Madurai, Hyderabad and Delhi.

Table 1. Gold price in rupees for the first three cities

	Chennai		Kolkatta		Bangalore	
	Low	**High**	**Low**	**High**	**Low**	**High**
Feb	5099.86	5330.14	5033.4	5283.5	5117.4	5283.5
Mar	5245.9	5549.19	5278.5	5659.4	5278.5	5659.4
Apr	5369.46	5599.74	5287.5	5496.1	5287.5	5496.1
May	5178.5	5436.86	5179.4	5361.2	5179.4	5361.2
Jun	5240.28	5434.28	4897.65	5434.28	5240.28	5434.28
Jul	5167.26	5397.54	5157.49	5393.45	5167.26	5397.54
Aug	5279.59	5408.78	5281.09	5337.26	5290.83	5341.38
Sep	5144.8	5268.36	5146.25	5269.85	5144.8	5268.36
Oct	5195.35	5375.08	5196.81	5376.6	5195.35	5375.08
Nov	5234.66	5526.72	5179.96	5498.64	5178.5	5526.72
Dec	5532.34	5740.15	5477.73	5685.6	5526.72	5740.15
Jan	5717.69	5998.52	5668.74	5959.2	5717.69	5998.52

Table 2. Gold price in rupees for the second three cities

	Madurai		Hyderabad		Delhi	
	Low	**High**	**Low**	**High**	**Low**	**High**
Feb	5116.71	5330.14	5033.4	5283.5	5117.4	5283.5
Mar	5245.9	5594.12	5278.5	5659.6	5278.5	5659.4
Apr	5369.46	5599.74	5287.4	5496	5287.5	5496.1
May	5178.5	5436.86	5179.4	5361.2	5179.4	5361.2
Jun	5240.28	5434.28	4897.65	5434.28	4897.65	5434.28
Jul	5167.26	5397.54	5157.49	5393.45	5157.49	5393.45
Aug	5290.83	5341.38	5281.09	5337.26	5281.09	5337.26
Sep	5144.8	5268.36	5146.25	5269.85	5146.25	5269.85
Oct	5195.35	5375.08	5196.81	5376.6	5196.81	5376.6
Nov	5234.66	5526.72	5179.96	5498.64	5179.96	5498.64
Dec	5532.34	5740.15	5477.73	5685.6	5477.73	5685.6
Jan	5717.69	5998.52	5668.74	5959.2	5668.74	5959.2

Using the data presented in Table 1 and 2, neutrosophic statistical analysis is conducted whose outcome is presented in section 4.

4. Results and Interpretation

The neutrosophic statistical analysis is performed to the data on gold price. The city wise data analysis are presented from Table 3 to Table 5. The month wise data analysis are presented form Table 6 to Table 9. Table 3 represents the city wise neutrosophic mean of gold data. Table 4 represents the city wise neutrosophic standard deviation of gold data. Table 5 represents the city wise neutrosophic coefficient of variation of gold data. Table 6 represents the month wise neutrosophic mean of gold data. Table 7 represents the month wise neutrosophic standard deviation of gold data. Table 8 represents the month wise neutrosophic coefficient of variation of gold data.

Table 3. The Neutrosophic mean of gold price at different cities

Cities	$\bar{X}_N$	$a_{\bar{X}} + b_{\bar{X}}I_{N\bar{X};}\ I_{N\bar{X};} \in [I_{L\bar{X}^-}, I_{U\bar{X}}]$
Chennai	[5283.81, 5505.45]	5283.81+5505.45IN, IN $\in$ [0, 0.04]
Kolkatta	[5232.04, 5479.59]	5232.04+5479.59IN, IN $\in$ [0, 0.04]
Bangalore	[5277.02, 5490.19]	5277.02+5490.19IN, IN $\in$ [0, 0.038]
Madurai	[5286.15, 5503.57]	5286.15+5503.57IN, IN $\in$ [0, 0.039]
Hyderabad	[5232.04, 5479.60]	5232.04+5479.60IN, IN $\in$ [0, 0.044]
Delhi	[5239.04, 5479.59]	5239.04+5479.59IN, IN $\in$ [0, 0.043]

The neutrosophic average rate of gold at Chennai city lies between 5283.81 and 5505.45 and at Kolkatta city lies between 5232.04, 5479.59. Both these cities are with a measure of indeterminacy being 0.04. Bangalore city has a neutrosophic average rate of gold lying between 5277.02 and 5490.19 with a measure of indeterminacy 0.038. The neutrosophic average rate of gold at Madurai lies between 5286.15, 5503.57 with a indeterminacy rate of 0.039. The neutrosophic average rate of gold at

Hyderabad lies between 5232.04, 5479.60 with a indeterminacy rate of 0.044. The neutrosophic average rate of gold at Delhi lies between 5239.04, 5479.59 with a indeterminacy rate of 0.043. It is seen that the neutrosophic average at low rate of gold is minimum at Kolkatta city which can be considered for purchase.

Table 4. Gold price as its Neutrosophic standard deviation at preferred cities

City	S_N	$a_S + b_S I_{NS;}$ $I_{NS;}$ $\in [I_{LS}$, $I_{US}]$
Chennai	[178.07, 200.94]	178.07+200.94IN, IN $\in$ [0, 0.1]
Kolkatta	[197.63, 200.51]	197.63+200.51IN, IN $\in$ [0, 0.015]
Bangalore	[175.58, 214.59]	175.58+214.59IN, IN $\in$ [0, 0.18]
Madurai	[176.54, 206.19]	176.54+206.19IN, IN $\in$ [0, 0.14]
Hyderabad	[197.63, 200.52]	197.63+200.52IN, IN $\in$ [0, 0.01]
Delhi	[191.34, 200.51]	191.34+200.51IN, IN $\in$ [0, 0.04]

The neutrosophic standard deviation at Chennai city lies between 178.07 and 200.94 with a measure of indeterminacy 0.01. The neutrosophic standard deviation at Kolkatta city lies between 197.63 and 200.51 with a measure of indeterminacy 0.015. The neutrosophic standard deviation at Bangalore city lies between 175.58 and 214.59 with a measure of indeterminacy 0.018. The neutrosophic standard deviation at Madurai city lies between 176.54 and 206.19 with a measure of indeterminacy 0.014. The neutrosophic standard deviation at Hyderabad city lies between 197.63 and 200.52 with a measure of indeterminacy 0.01. The neutrosophic standard deviation at Delhi city lies between 191.3 and 200.51 with a measure of indeterminacy 0.014. The least standard deviation among the low gold rate is found at Bangalore city. Among the high gold rate minimum is found equal at both Kolkotta and Delhi city.

Table 5. Gold price as its neutrosophic coefficient of variation at different cities

City	CV_N	$a_V + b_V I_{NV;}$ $I_{NV;}$ $\in [I_{LV}$, $I_{UV}]$
Chennai	[3.37, 3.65]	3.37+3.65IN, IN $\in$ [0, 0.08]
Kolkatta	[3.78, 3.66]	3.78-3.66IN, IN $\in$ [0, 0.032]
Bangalore	[3.33, 3.91]	3.33+3.91IN, IN $\in$ [0,0.14]
Madurai	[3.34, 3.75]	3.34+3.75IN, IN $\in$ [0, 0.109]
Hyderabad	[3.78, 3.66]	3.78-3.66IN, IN $\in$ [0, 0.032]
Delhi	[3.65, 3.66]	3.65+3.66IN, IN $\in$ [0, 0.001]

The neutrosophic coefficient of variation at Chennai city lies between 3.37 and 3.65 with a measure of indeterminacy 0.06. The neutrosophic coefficient of variation at Kolkatta city lies between 3.78 and 3.66 with a measure of indeterminacy 0.0305. The neutrosophic coefficient of variation at Bangalore city lies between 3.33 and 3.91 with a measure of indeterminacy 0.14. The neutrosophic coefficient of variation at Madurai city lies between 3.34 and 3.75 with a measure of indeterminacy 0.09. The neutrosophic coefficient of variation at Hyderabad city lies between 3.78 and 3.66 with a measure of indeterminacy 0.033. The neutrosophic coefficient of variation at Delhi city lies between 3.65 and 3.66 with a measure of indeterminacy 0.001. The minimum coefficient of variation is found among low gold rate at Madurai city and the minimum among the high gold rate if found at Chennai.

Table 6. The Neutrosophic mean of gold price taken monthwise

Month	$\bar{X}_N$	$a_{\bar{X}} + b_{\bar{X}} I_{N\bar{X};}$ $I_{N\bar{X};}$ $\in [I_{L\bar{X}^-}$, $I_{U\bar{X}}]$
$\mathcal{F}eb$	[5086.36, 5299.05]	5086.36+5299.05IN, IN $\in$ [0, 0.04]
Mar	[5267.63, 5630.19]	5267.63+5630.19IN, IN $\in$ [0, 0.06]

Apr	[5314.80, 5530.63]	5314.80+5530.63IN, IN ∈ [0, 0.04]
May	[5179.1, 5386.42]	5179.1+5386.42IN, IN ∈ [0, 0.03]
Jun	[5068.97, 5434.28]	5068.97+5434.28IN, IN ∈ [0, 0.06]
Jul	[5162.38, 5395.495]	5162.38+5395.495IN, IN ∈ [0, 0.04]
Aug	[5284.09, 5350.56]	5284.09+5350.56IN, IN ∈ [0, 0.01]
Sep	[5145.53, 5269.11]	5145.53+5269.11IN, IN ∈ [0, 0.023]
Oct	[5196.08, 5375.84]	5196.08+5375.84IN, IN ∈ [0, 0.033]
Nov	[5197.95, 5512.68]	5197.95+5512.68IN, IN ∈ [0, 0.057]
Dec	[5504.10, 5712.88]	5504.10+5712.88IN, IN ∈ [0, 0.036]
Jan	[5693.22, 5978.86]	5693.22+5978.86IN, IN ∈ [0, 0.047]

The neutrosophic average rate of gold at Febraury month lies between 5086.36 and 5299.05 and with a measure of indeterminacy being 0.1. The neutrosophic average rate of gold at March month lies between 5267.63 and 5630.19 and with a measure of indeterminacy being 0.07. The neutrosophic average rate of gold at April month lies between 5314.80 and 5530.63 and with a measure of indeterminacy being 0.03. The neutrosophic average rate of gold at May month lies between 5179.1 and 5386.42 and with a measure of indeterminacy being 0.03. The neutrosophic average rate of gold at June month lies between 5068.97 and 5434.28 and with a measure of indeterminacy being 0.06. The neutrosophic average rate of gold at July month lies between 5162.38 and 5395.495 and with a measure of indeterminacy being 0.04. The neutrosophic average rate of gold at August month lies between 5284.09 and 5350.56 and with a measure of indeterminacy being 0.01. The neutrosophic average rate of gold at September month lies between 5145.53 and 5269.11 and with a measure of indeterminacy being 0.023. The neutrosophic average rate of gold at October month lies between 5196.08 and 5375.84 and with a measure of indeterminacy being 0.033. The neutrosophic average rate of gold at November month lies between 5197.95 and 5512.68 and with a measure of indeterminacy being 0.057. The neutrosophic average rate of gold at December month lies between 5504.10 and 5712.88 and with a measure of indeterminacy being 0.036. The neutrosophic average rate of gold at January month lies between 5693.22 and 5978.86 and with a measure of indeterminacy being 0.047. The neutrosophic average is found to be minimum at the month of September which can be considered to be the favorite moth for the purchase of gold. The minimum mean among the low rate of gold is found at June month and the minimum mean among the high gold rate is found at September month.

Table 7. The Neutrosophic standard deviation of gold price taken monthwise

Month	S_N	$a_S + b_S I_{NS;}\ I_{NS;}\ \in [I_{LS}\ , I_{US}]$
Feb	[41.57, 24.08]	41.57-24.08IN, IN ∈ [0, 0.7564]
Mar	[16.84, 47.51]	16.84+47.51IN, IN ∈ [0, 0.64]
Apr	[42.34, 53.53]	42.34+53.53IN, IN ∈ [0, 0.209]
May	[0.46, 39.07]	0.46+39.07IN, IN ∈ [0, 0.98]
Jun	[187.67, 0]	187.67+0IN, IN ∈ [0, 0.1]
Jul	[5.35, 2.24]	5.35-2.24IN, IN ∈ [0, 1.388]
Aug	[5.26, 28.60]	5.26+28.60IN, IN ∈ [0, 0.81]
Sep	[0.79, 0.82]	0.79+0.82IN, IN ∈ [0, 0.037]
Oct	[0.80, 0.83]	0.80+0.83IN, IN ∈ [0, 0.03]
Nov	[28.44, 15.38]	28.44-15.38IN, IN ∈ [0, 0.849]
Dec	[28.96, 29.88]	28.96-29.88IN, IN ∈ [0, 0.03079]
Jan	[26.81, 21.5]	26.81-21.5IN, IN ∈ [0, 0.2469]

The neutrosophic standard deviation at February month lies between 41.57 and 24.08 with a measure of indeterminacy 0.7564. The neutrosophic standard deviation at March month lies between 16.84 and 47.51 with a measure of indeterminacy 0.64. The neutrosophic standard deviation at April month lies between 42.34 and 53.53 with a measure of indeterminacy 0.209. The neutrosophic standard deviation at May month lies between 0.46 and 39.07 with a measure of indeterminacy 0.98. The neutrosophic standard deviation at June month lies between 187.67 and 0 with a measure of indeterminacy 0, 0.1. The neutrosophic standard deviation at July month lies between 5.35 and 2.24 with a measure of indeterminacy 1.388. The neutrosophic standard deviation at August month lies between 5.26 and 28.60 with a measure of indeterminacy 0.81. The neutrosophic standard deviation at September month lies between 0.79 and 0.82 with a measure of indeterminacy 0.037. The neutrosophic standard deviation at October month lies between 0.80 and 0.83 with a measure of indeterminacy 0.03. The neutrosophic standard deviation at November month lies between 28.44 and 15.38 with a measure of indeterminacy 0.849. The neutrosophic standard deviation at December month lies between 28.96 and 29.88 with a measure of indeterminacy 0.03079. The neutrosophic standard deviation at January month lies between 26.81 and 21.5 with a measure of indeterminacy 0.2469. The minimum standard deviation among low rate of gold is found at May month and minimum standard deviation among high gold rate is found at June month.

Table 8. The Neutrosophic coefficient of variation of gold price taken monthwise

Month	CV_N	$a_V + b_V I_{NV};\ I_{NV};\ \in [I_{LV}\ ,I_{UV}]$
$\mathcal{F}eb$	[0.82, 0.45]	0.82-0.45IN, IN $\in$ [0, 0.822]
Mar	[0.32, 0.84]	0.32+0.84IN, IN $\in$ [0, 0.61]
Apr	[0.80, 0.97]	0.80+0.97IN, IN $\in$ [0, 0.17]
May	[0.01, 0.73]	0.01+0.73IN, IN $\in$ [0, 0.98]
Jun	[3.70, 0]	3.70+0IN, IN $\in$ [0, 0.1]
Jul	[0.10, 0.04]	0.10-0.04IN, IN $\in$ [0, 1.5]
Aug	[0.10, 0.53]	0.10+0.53IN, IN $\in$ [0, 0.81]
Sep	[0.02, 0.02]	0.02+0.02IN, IN $\in$ [0, 0]
Oct	[0.02, 0.02]	0.02+0.02IN, IN $\in$ [0, 0]
Nov	[0.55, 0.28]	0.55-0.28IN, IN $\in$ [0, 0.96]
Dec	[0.53, 0.52]	0.53-0.52IN, IN $\in$ [0, 0.019]
Jan	[0.47, 0.36]	0.47-0.36IN, IN $\in$ [0, 0.3056]

The neutrosophic coefficient of variation of rate of gold at Febraury month lies between 0.82, 0.45 and with a measure of indeterminacy being 0.822. The neutrosophic coefficient of variation of rate of gold at March month lies between 0.32, 0.84 and with a measure of indeterminacy being 0.61. The neutrosophic coefficient of variation of rate of gold at April month lies between 0.80, 0.97 and with a measure of indeterminacy being 0.17. The neutrosophic coefficient of variation of rate of gold at May month lies between 0.01, 0.73 and with a measure of indeterminacy being 0.98. The neutrosophic coefficient of variation of rate of gold at June month lies between 3.70, 0 and with a measure of indeterminacy being 0.1. The neutrosophic coefficient of variation of rate of gold at July month lies between 0.10, 0.04 and with a measure of indeterminacy being 1.5. The neutrosophic coefficient of variation of rate of gold at August month lies between 0.10, 0.53 and with a measure of indeterminacy being 0.81. The neutrosophic coefficient of variation of rate of gold at September month lies between 0.02, 0.02 and with a measure of indeterminacy being 0. The neutrosophic coefficient of variation of rate of gold at October month lies between 0.02, 0.02 and with a measure of indeterminacy being 0. The neutrosophic coefficient of variation of rate of gold at November month lies between 0.55, 0.28 and with a measure of indeterminacy being 0.96. The neutrosophic coefficient of variation of rate

of gold at December month lies between 0.53, 0.52 and with a measure of indeterminacy being 0.019. The neutrosophic coefficient of variation of rate of gold at January month lies between 0.47, 0.36 and with a measure of indeterminacy being 0.3056. The minimum coefficient of variation among low gold rate is found at September and October month. The minimum coefficient of variation among high gold rate is found at June month.

4. Comparative study

The gold rate of six different cities are analysed using neutrosophic statistics. The analysis is performed in two ways. In the first method, the gold rates of the cities are considered. In the second method, the changes in gold rate in every month are considered. For both the methods, the neutrosophic mean, neutrosophic standard deviation, neutrosophic coefficient of variation are calculated. This comparison helps to check the beneficial month and city for the purchase of gold.

5. Future Work

Though this study has been made targeting gold as is basic element, the same type of prediction is also required in many other situations also. Hence as a future work it is proposed to develop an user friendly application which is suitable for any kind of prediction which applies neutrosophic statistical analysis. The application is to be developed with a motive to get an updated rate prediction which helps any of the user to know the current scenario on which they need. Various machine learning techniques to evaluated neutrosophic statistical measures can also be performed as a future work.

6. Conclusion

In this article, the neutrosophic analysis on cost of gold for various six cities are collected. Their rate has been analyzed both city wise and month wise. The results obtained among the city wise data indicates the favourable city to purchase gold is kolkatta at first. Then it can be Delhi, Madurai and Chennai. Month wise analysis of gold rate indicates that it is beneficial to purchase gold during June month. Thus according to this study, gold lovers can make use of June month at Kolkatta for their purchase to make this shopping beneficial. Most of the peoples who demand for gold wait for a better period and cost to make their wish possible. This study has brought about an analysis which has provided with a suggestion on which month and place it is beneficiary for the buyers of gold. This gives a prediction of gold rate, which provides an optimized situation to buy gold, even in uncertainty condition.

References

1. M. Khalid, Mariam Sultana, Faheem Zaidi, Forecasting Gold Price: Evidence from Pakistan Market, *Research Journal of Finance and Accounting*, 2014, Vol.5, No.3, PP. 70–74.
2. Iftikhar ul Sami, Khurum Nazir Junejo, Predicting Future Gold Rates using Machine Learning Approach, *International Journal of Advanced Computer Science and Applications*, 2017, Vol. 8, No. 12, PP. 92-99.
3. Naliniprava Tripathy, Forecasting Gold Price with Auto Regressive Integrated Moving Average Model, *International Journal of Economics and Financial Issues*, 2017, Vol.7, No.4, PP. 324-329.
4. Muhammad Aslam, A new attribute sampling plan using neutrosophic statistical interval method, *Complex & Intelligent Systems*, 2019, https://doi.org/10.1007/s40747-018-0088-6, PP. 1–6.
5. R. Dhavaseelan, R. Narmada Devi, S. Jafari and Qays Hatem Imran, Neutrosophic α^m – continuity, *Neutrosophic Sets and Systems*, 2019, Vol. 27, PP. 171-179.
6. Muhammad Aslam, Neutrosophic analysis of variance: application to university students, *Complex & Intelligent Systems*, 2019, https://doi.org/10.1007/s40747-019-0107-2, PP. 1-5.

7.   Alexandra Dolores Molina Manzano, Jesahel Yanette Vildoso Villegas , Laura Marlene Ochoa Escobar and Leonardo Toapanta Jiménez, Neutrosophic Statistical Analysis of the Incidence of the Facultative Vote of Young People between 16 and 18 Years Old in the Electoral Process of Ecuador, *Neutrosophic Sets and Systems*, 2 020, Vol. 37, PP. 355-360.

8.   Broumi said, Malayalan Lathamaheswari, Ruipu Tan, Deivanayagampillai Nagarajan, Talea Mohamed, Florentin Smarandache, Assia Bakali, A new distance measure for trapezoidal fuzzy neutrosophic numbers based on the centroids, *Neutrosophic Sets and Systems*, 2020, Vol. 35, PP. 478-502.

9.   Muhammad Naveed Jafar, Asma Farooq Lahore Garrison, Komal Javed Lahore Garrison *Neutrosophic Sets and Systems*, 2020, Vol. 35, PP. 478-502., Komal Javed Lahore Garrison, Similarity Measures of Tangent, Cotangent and Cosines in Neutrosophic Environment and their Application in Selection of Academic Programs, *International Journal of Computer Applications*, 2020, Vol. 17, No. 46, PP. 17-24.

10.   Carlos Acosta Mayorga, Piedad Elizabeth Acurio Padilla, Guillermo Bastidas Tello and Abdel Bermúdez del Sol, Statistical Methods and Management of Indeterminacy in Medical Sciences. Surgical Site Infection Study after Vascular Surgery Procedures, *Neutrosophic Sets and Systems*, 2021, Vol.44,PP. 133-139.

11.   Ishmal Shahzadi, Muhammad Aslam and Hussain Aslam, Ishmal Shahzadi1 , Muhammad Aslam2* and Hussain Aslam, *Neutrosophic Sets and Systems*, 2021, Vol. 93, PP. 101-106.

12.   Fernando Castro Sánchez, Jorge Hernán Almeida Blacio, María Gabriel Flores Bracho, Danilo Rafael Andrade Santamaria and Ricardo Sánchez Casanova.Neutrosophic and Plithogenic Statistical Analysis in Educational Development, *Neutrosophic Sets and Systems*. 2021, Vol.44, PP. 223-234.

13.   Lysbeth Kruscthalia Álvarez Gómez, Mireya Silvana Cuarán Guerrero, Jimena Elizabeth Montes de Oca Sánchez, Mónica Elizabeth Benalcázar Paladines and Asnioby Hernandez Lopez, Neutrosophic Statistical Analysis of E-commerce, *Neutrosophic Sets and Systems*, 2021, Vol.44, PP. 170-178.

14.   Lester Wong Vázquez, María Fernanda Orozco Noboa, Francisco Xavier Poveda Paredes and Jorge Marcelo Quintana Yánez, Neutrosophic Statistical Analysis of the Rehabilitation of Arterial Hypertension, *Neutrosophic Sets and Systems*, 2021, Vol.44, PP. 442-447.

15.   Mustafa Yurtsever, Gold Price Forecasting Using LSTM, Bi-LSTM and GRU, *European Journal of Science and Technology*, 2021, Vol. 31, No. 1, PP. 341-347.

16.   Sara Guerrón Enríquez, Zuly Ribel Nazate Chugá, Ruth Isabel Tavera María Clemencia Villarea Gel and Darvin Manuel Ramírez Guerra, Neutrosophic Statistical Analysis of Arthrofibrosis of the Knee Rehabilitation,*Neutrosophic Sets and Systems*,   2021, Vol.44,PP. 45-52.

17.   Sultan Salem, Zahid Khan, Hamdi Ayed, Ameni Brahmia, and Adnan Amin, The Neutrosophic Lognormal Model in Lifetime Data Analysis: Properties and Applications, *Journal of Function Spaces*, 2021, Article ID 6337759, PP. 1–9.

18.   Abdullah Gamal, Mohamed Abdel-Basset, Ripon K. Chakrabortty, Intelligent model for contemporary supply chain barriers in manufacturing sectors under the impact of COVID-19 pandemic, Expert Systems with Applications, 2022, Vol. 205, 117711, PP. 1-18.

19.   Elizabeth Cristina Mayorga Aldaz, Rosita Elizabeth Olivo Torres, Silvia Tatiana Tite Andi and Flor Betzabet Morocho Quinchuela, Neutrosophic Statistical Analysis of Self-Assessment of Rehabilitation Knowledge in University Students,   *Neutrosophic Sets and System*s, 2022, Vol.52, PP. 287-292.

20.   Kenia Mariela Peñafiel Jaramillo. Denisse Isabel Suaste Pazmiño and Alex Ramón Valencia Herrera, Neutrosophic Statistical Analysis of Behavioral Medicine Knowledge in University Students, *Neutrosophic Sets and Systems*, 2022, Vol. 52, PP. 225-230.

21.   Laor Boongasame, Piboonlit Viriyaphol, Kriangkrai Tassanavipas and Punnarumol Temdee, Gold-Price Forecasting Method Using Long Short-Term Memory and the Association Rule, *Journal of Mobile Multimedia*, 2022, Vol. 19_1, PP. 165–186.

22.   Florentin Smarandache, Neutrosophic Statistics is an extension of Interval Statistics, while Plithogenic Statistics is the most general form of statistics, *International Journal of Neutrosophic Science*, 2022, Vol. 19, No. 01, PP. 148-165.

23.   Mohamed Abdel-Basset, Abdullah Gamal, Karam M Sallam, Ibrahim Elgendi, Kumudu Munasinghe and Abras Jamalipour, An optimization Model for Appraising Intrusion-Detection Systems for Network Security Communications: Applications, Challenges and Solutions, Sensers, 2022, Vol. 22, 4123, PP. 1-26.

24. Muhammad Rafiq, Yue Cong, Yanpei Cheng, Ghani Rahman, Ahmad Ali, Muhammad Iqbal, Ammara Latif, Imtiaz Ali, Aqsa Rehan, Aun Zahoor, Rahat Ullah, Spatio-Statistical Analysis of Temperature and Trend Detection in Baluchistan, Pakistan, *Ecological Questions*, 2022, Vol. 33, No. 3, PP. 1-22.

25. Mohamed Abdel-Basset, Abdullah Gamal, Karam M Sallam, Ibrahim Elgendi, Kumudu Munasinghe and Abras Jamalipour, An optimization Model for Appraising Intrusion-Detection Systems for Network Security Communications: Applications, Challenges and Solutions, Sensers, 2022, Vol. 22, 4123, PP. 1-26.

26. Nada A. Nabeeh, Mohamed Abel-Basset, Abdullah Gamal and Victor Chang, Evaluation of Production of Twin Based on Blockchain Technology, Electronics, 2022, Vol. 11, 1268, PP. 1-18.

27. Rushikesh Ghule, Abhijeet Gadhave, Gold Price Prediction using Machine Learning, *International Journal of Scientific Research in Engineering and Management*, 2022, Vol. 6, No. 6, PP. 1-9.

28. Said Broumi,Mamoni Dhar, Abdellah Bakhouyi, Assia Bakali,Mohamed Talea, Medical Diagnosis Problems Based on Neutrosophic Sets and Their Hybrid Structures: A Survey, *Neutrosophic Sets and Systems*, 2022, Vol. 49, PP. 1-18.

29. Aral, Nazlım Deniz; Kandemir, Hacer Şengül; Et, Mikail, Strongly lacunary convergence of order β of difference sequences of fractional order in neutrosophic normed spaces. Filomat, 2023, Vol. 37, 6443--6451.

30. Ayman H. Abdel-aziem, Hoda K Mohamed, Ahmed Abdelhafeez, Neutrosophic Decision Making Model for Investment Portfolios Selection and Optimizing based on Wide Variety of Investment Opportunities and Many Criteria in Market, Neutrosophic Systems With Applications, (2023), Vol.6, PP. 32–38.

31. Ishmal Shahzadi, Neutrosophic Statistical Analysis of Temperature of Different Cities of Pakistan, *Neutrosophic Sets and Systems*, 2023, Vol. 53, PP. 137-164.

32. Kandemir, Hacer Şengül; Et, Mikail; Çakalli, Hüseyin, Strongly lacunary convergence of order α in neutrosophic normed spaces. Trans. A. Razmadze Math. Inst. 177, 2023, Vol. 1, PP. 71--76.

33. Muhammad Aslam, and Muhammad Saleem, Neutrosophic test of linearity with application, *AIMS Mathematics*, 2023, Vol. 8, No. 4, PP. 7981–7989.

34. Regan Murugesan, Yamini Parthiban, R. Narmada Devi, Kala Raja Mohan and Sathish Kumar Kumaravel, A Comparative Study of Fuzzy Cognitive Maps and Neutrosophic Cognitive Maps on Covid Variants, *Neutrosophic Sets and Systems*, 2023, Vol. 55, PP. 329-343.

35. Uma G, and Nandhitha S, An Investigative Study on Quick Switching System using Fuzzy and Neutrosophic Poisson Distribution, Neutrosophic Systems With Applications, 2023, Vol.7, PP. 61–70.

36. Waleed Tawfiq Al-Nami, "Ranking and Analysis the Strategies of Crowd Management to Reduce the Risks of Crushes and Stampedes in Crowded Environments and Ensure the Safety of Passengers", Neutrosophic Systems with Applications, 2023, Vol. 8, PP. 61–78.