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Tropezoidal Neutrosophic Deal with Logarithmic Demand with Shortage of Deteriorating Items

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Abstract: In this paper is to introduce trapezoidal neutrosophic deal with logarithmic demand model with shortage of deteriorating items. Order of enact customers can be place by the vendor depending on the stock accessibility. Logarithmic demand is related to several products, in this paper developed with the shortage of items at the beginning. Finally, valuable example is given to extract the optimum value and obtain effective valuable results.

Keywords: Inventory, Tropezoidal Neutrosophic number, deterioration, shortage, logarithmic demand.

1. INTRODUCTION

Initial stage of LPG Gas business starts with the Shortage against the booking and offers. With the incorporation of dual objects that is logarithmic demand and business starts with shortage. Many products of daily used in demand but LPG is the crucial. This will boost up retailers order in positive mode. Some products are huge need for people, like Milk, Oil, flour, beverages whose scarcity loss the customer's trust and received design. This scenario stimulates retailer to order intemperate quantity of items, despite of deterioration. So any uncertainty situation of decaying or due to deterioration is not negligible. The purpose is denied due to damage or spoiled items. Deterioration helps in managing several items due to virtue of modern advanced storage technics Deterioration factor is incorporated in this proposed model. For on-going successful business Inventory model demonstrate the real time problem.

Chakraborty et al. [3] focus on pentagonal neutrosophic numbers and their distinct properties. Smarandache [20] By considering the non-standard analysis, they implemented a neutrosophic set and a neutrosophic logic. Also, neutrosophic model of inventory without shortages is provides by Mullai et al. [14]. Chakraborty et al. [4] various types of triangular neutrosophic numbers, de-neutrosophication models and their applications have been clarified. Adaraniwon et al. [2], ignited the concept of An inventory model for delayed degradation of power demand goods, taking into account shortages and missed sales.

Burwell et al unraveled the issue emerging in trade by giving discounts and displayed financial qunatity size demonstrates with demand price dependent. Shin et al [18] discussed an optimal strategy or salable price and volume under vendor credit. Shula et al developed a three-factor order rate for new released product deteriorate couples of methods supported stable required rates and once launching the item in consumer use, it creates stable need.

Wen et al recommended a energetic estimating arrangement for offering a given commodities of indistinguishable biodegradable items over a restricted time skyline on the online. The deal closes either once the full stock oversubscribed out, or once released the launching date. Target of the vendor is to find a ultimate valuation reach that optimize to complete anticipated incomes.

Lin (2006) [13] the EOQ model designed reflects how the pattern of demand which is value, cash discount depends on market demand and product availability. They mention EOQ system that takes under consideration selling price relay directly on inflation and continuance. Occurrence and singularity of the optimum answer is unsolved during this article.

Karaaslan [7] formulated and analytically solved in multi-guidelines, Gaussian sole-rate neutrosophic numbers and their implementation. Smarandache [20] argued that Neutrosophic, probability of neutrosophic number, logic and set, unifying space of logic. Murugappan [15] mentioned the inventory model of neutrosophic variable, unit priced neutrosophic.

2. ASSUMPTIONS AND NOTATION

Assume that the shortages accumulated till time t_1 up to level $I_1(t_1)$ and order placed to the corporate seller at time t_1 , therefore uncovered demand consummated and inventory meets up to level $I_2(t_1)$. The inventory level $I_2(t_1)$ is comfortable to meet the demand until time T. The optimal time t_1 are going to be resolve. $I_1(t_1)$ and $I_2(t_1)$, that optimize the overall inventory price. Inventory depletion is shown in Fig 1.

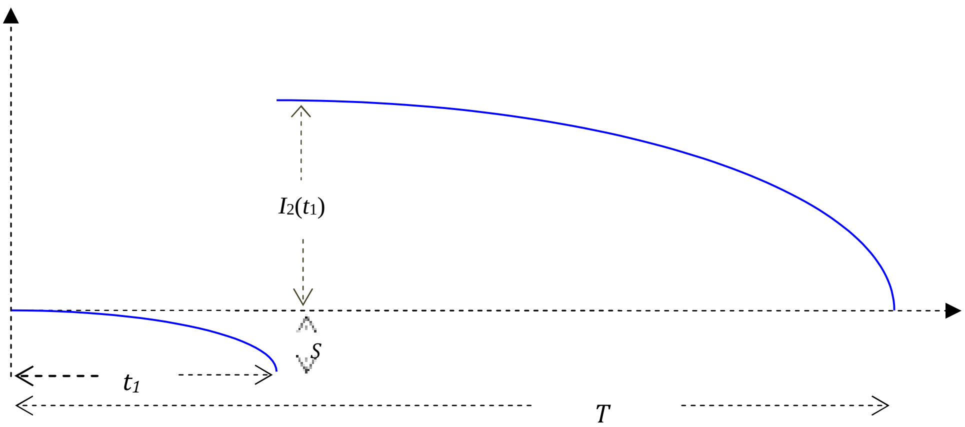

Figure: 1

The following symbols are used throughout this paper:

$D(t)$: Demand rate is $D(t)=\alpha\log(\beta t)$, where $\alpha > 1$ *and* $\beta > 1$ are positive real values

.

$I_1(t)$: Stock level at time t, $0 < t < t_1$

$I_2(t)$: Stock level at time t, $t_1 < t < T$

Q : Total order Quantity per cycle

$\emptyset$: Rate of deterioration $0 < \emptyset < 1$

C_1 : Holding cost per unit time

C_2 : Deterioration cost

C_3 : Shortage cost per unit time

$\widetilde{C_1}$: Holding cost per unit time

$\widetilde{C_2}$: Deterioration cost

$\widetilde{C_3}$: Shortage cost per unit time

T : Span time

$t_1{}^*$: Optimal time for accumulating shortage

$TF(t_1)$: Optimal mean inventory price,

H_C : Total holding price,

D_C : Total deterioration cost.

S_c : Total shortage units in the system,

3. MATHEMATICAL MODEL

3.1 Definition: Neutrosophic Set: Smarandache[20]

A collection of $\widetilde{Ns}$ in the universal discourse X, A symbolic notation by x, it is said to be neutrosophic set if $\widetilde{Ns} = \{\langle x;[\rho_{\widetilde{Ns}}(x), \sigma_{\widetilde{Ns}}(x), \tau_{\widetilde{Ns}}(x)]\rangle : x \in X\}$, where $\rho_{\widetilde{Ns}}(x): X \to [0,1]$ is called the real membership function, which addresses the level of confirmtion, $\sigma_{\widetilde{Ns}}(x): X \to [0,1]$ is called the dubiety membership, which denotes the degree of vagueness, and $\tau_{\widetilde{Ns}}(x): X \to [0,1]$ is called the falsehood membership, which demonstrates the level of scepticism on the decision taken by the decision maker $\rho_{SV\widetilde{TrNs}}(x)$, $\sigma_{SV\widetilde{TrNs}}(x)$, $\tau_{SV\widetilde{TrNs}}(x)$ The accompanying relationship reveals: $0 \le \rho_{SV\widetilde{TrNs}}(x) + \sigma_{SV\widetilde{TrNs}}(x) + \tau_{SV\widetilde{TrNs}}(x) \le 3$

3.2 Definition: Single Valued Neutrosophic Set: Chakraborty [3]

A set of Neutrosphic is $\widetilde{Ns}$ in the definition 3.1. is claimed to be a single-Valued neutrosophic set ($SV\widetilde{TrNs}$) if x may be single valued independent variable. $SV\widetilde{TrNs} = \{\langle x;$ $[\rho_{SV\widetilde{TrNs}}(x), \sigma_{SV\widetilde{TrNs}}(x), \tau_{SV\widetilde{TrNs}}(x)]\rangle : x \in X\}$, where $\rho_{SV\widetilde{TrNs}}(x)$, $\sigma_{SV\widetilde{TrNs}}(x)$, $\tau_{SV\widetilde{TrNs}}(x)$ provided the method of accuracy, dubiety and falsehood memberships function respectively.

Definition 3.2.1: (Neutro-normal.)

If there exist three variable φ_0, χ_0& ψ_0 , for which $\rho_{SV\widetilde{TrNs}}(\varphi_0) = 1$, $\rho_{SV\widetilde{TrNs}}(\chi_0) = 1$ &$\tau_{SV\widetilde{TrNs}}(\psi_0) = 1$, then the $SV\widetilde{TrNs}$ is called neutro-normal.

Definition 3.2.2: (Neutro-convex.)
$\widetilde{SVTrNs}$ is called Neutro-convex, which provides that $\widetilde{SVTrNs}$ is a member of a real value by satisfying the accompanying conditions:

i. $\rho_{\widetilde{SVTrNs}}\langle \vartheta\, \varphi_1 + (1-\vartheta)\varphi_2\rangle \geq min\langle\, \rho_{\widetilde{SVTrNs}}\,(\varphi_1),\;\; \rho_{\widetilde{SVTrNs}}\,(\varphi_2)\rangle$

ii. $\sigma_{\widetilde{SVTrNs}}\langle \vartheta\varphi + (\ 1-\vartheta)\varphi_2\rangle \leq\ max\langle \sigma_{\widetilde{SVTrNs}}\,(\varphi_1), \sigma_{\widetilde{SVTrNs}}\,(\varphi_2)\rangle$

iii. $\tau_{\widetilde{SVTrNs}}(\langle \vartheta\varphi_1 + (1-\vartheta)\varphi_2\rangle \leq max\langle \tau_{\widetilde{SVTrNs}}(\,(\varphi_1), \tau_{\widetilde{SVTrNs}}(\,(\varphi_2)\rangle$

where φ_1& $\in\mathbb{R}$ *and* $\vartheta\in$ [0, 1]

Definition 3.3 (Tropezoidal Single Valued Neutrosophic Number)

Neutrosophic number with tropezoidal Single Valued ($\tilde{\Omega}$) is defined a $\tilde{\Omega}$=< $(r_1, r_2, r_3, r_4{:}\, \Upsilon), (u_1, u_2, u_3, u_4{:}\, \lambda), (q_1, q_2, q_3, q_4{:}\, \eta)$ > , *whereμ, ϑ, ζ*∈ [0,1]. The real membership function $\rho_{\tilde{\Omega}}$: R → [0, ϒ], the dubiety membership function $\sigma_{\tilde{\Omega}}$: R → [λ, 1] and the falsehood membership function $\tau_{\tilde{\Omega}}$: : R → [η, 1] are characterized as follows:

$$\pi_{\tilde{\Omega}} = \begin{cases} \vartheta_{\tilde{\Omega}l}(x), & r_1 \leq x < r_2 \\ \Upsilon, & r_2 \leq x < r_3 \\ \vartheta_{\tilde{\Omega}r}(x)\,, & r_3 < x \leq r_4 \\ 0, & otherwise \end{cases}$$

$$\theta_{\tilde{\Omega}} = \begin{cases} \varepsilon_{\tilde{\Omega}l}(x), & u_1 \leq x < u_2 \\ \lambda, & u_2 \leq x < u_3 \\ \varepsilon_{\tilde{\Omega}r}(x)\,, & u_3 < x \leq u_4 \\ 1, & otherwise \end{cases}$$

$$\eta_{\tilde{\Omega}} = \begin{cases} \ell_{\tilde{\Omega}l}(x), & q_1 \leq x < q_2 \\ \eta, & q_2 \leq x < q_3 \\ \ell_{\tilde{\Omega}r}(x)\,, & q_3 < x \leq q_4 \\ 1, & otherwise \end{cases}$$

3.4 De-neutrosophication of Tropezoidal single Valued Neutrosophic number:

This system, the expulsion region procedure executed to assess the de-neutrosophication worth of tropezoidal single esteemed neutrosophic number is $\tilde{\Omega}$ =< $(r_1, r_2, r_3, r_4{:}\, \Upsilon), (u_1, u_2, u_3, u_4{:}\, \lambda), (q_1, q_2, q_3, q_4{:}\, \eta)$ > , de-neutrosophic form $\tilde{S}$ is provided as $TrneuD_{\tilde{\Omega}} = \left(\frac{r_1+r_2+r_3+r_4+u_1+u_2+u_3+u_4+q_1+q_2+q_3+q_4}{12}\right)$

$$\frac{dI_1(t)}{dt} = -\,\alpha\log(\beta t) \qquad 0 \leq t \leq t_1 \qquad I_1(0) = 0 \tag{1}$$

$$\frac{dI_2(t)}{dt} + \emptyset\, I_2(t) = -\,\alpha\log(\beta t) \qquad t_1 \leq t \leq T \tag{2}$$

Boundary values for above two differential equations are $I_1(0) = 0\,, I_2(\mathrm{T}) = 0$

On solving equation (1), we get

$$I_1(t) = \mathrm{A} - \int_0^t \alpha\log(\beta t)\,dt \quad with \quad I_1(0) = 0 \tag{3}$$

$$I_1(t) = \alpha t \circledcirc \alpha t\log(\beta t)$$

On solving equation (2), we get

$$I_2(t)e^{\emptyset t} = \mathrm{B} - \int_0^t \alpha\, e^{\emptyset t} \log(\beta t)\, dt \quad with \quad I_2(T) = 0 \qquad \textbf{(4)}$$

Applying boundary condition $I_2(T) = 0$, in the above equation, we get

$$I_2(t) = \alpha\left(T + \frac{\emptyset T^2}{2}\right)\log(\beta T) - \alpha\emptyset T t\log(\beta T) - \alpha t\log(\beta t) - \alpha(T - t) + \alpha\emptyset(Tt - \frac{T^2}{4} - \frac{3t^2}{4}) \qquad \textbf{(5)}$$

Ordering cost O_c= A

Deteriorated cost (D_c) in time $[t_1, T]$ is

$$D_c = C_1\left\{I_1(t) - \int_{t_1}^{T} \alpha \log(\beta t)\, dt \right\}$$

$$= C_1\left\{\alpha\left(T + \frac{\emptyset T^2}{2}\right)\log(\beta T) - \alpha\emptyset T\, t_1\log(\beta T) - \alpha \mathrm{T}\log(\beta T) + \alpha\emptyset\left(T\, t_1 - \frac{T^2}{4} - \frac{3\, t_1{}^2}{4}\right)\right\} \qquad \textbf{(6)}$$

Holding cost H_C , over time $[t_1, T]$

$$H_c = C_2 \int_{t_1}^{T} I_2(t)\, dt$$

$$H_c = C_2\{(\mathrm{T} - t_1)\left(\alpha\left(T + \frac{\emptyset T^2}{2}\right)\log(\beta T) - aT\right) - \alpha\emptyset\frac{(T^3 - T\, t_1{}^2)}{2}\log(\beta T) - \alpha\frac{T^2}{2}\log(\beta T) + \frac{\alpha\, t_1{}^2}{2}\log(\beta\, t_1) + \frac{3\alpha}{4}(T^2 - t_1{}^2) + \frac{\emptyset\, \alpha}{4}(t_1{}^3 + t_1 T^2 - 2T\, t_1{}^2) \qquad \textbf{(7)}$$

Shortage cost S_c over $[0, t_1]$ will be

$$S_c = C_3 \int_0^{t_1} I_1(t)\, dt$$

$$S_c = C_3\{\frac{3\alpha\, t_1{}^2}{4} - \frac{\alpha\, t_1{}^2}{2}\log(\beta\, t_1)\} \qquad \textbf{(8)}$$

Quantity remembering deficiency in trading will be Q

$$Q = I_1(t_1) + I_2(t_1)$$

$$= 2\alpha t_1 + \alpha\left(T + \frac{\emptyset T^2}{2}\right)\log(\beta T) - \alpha\emptyset T t_1\log(\beta T) - 2\alpha t_1\log(\beta t_1) - \alpha T + \alpha\emptyset(T t_1 - \frac{T^2}{4} - \frac{3t_1{}^2}{4}) \qquad \textbf{(9)}$$

Total average inventory cost will be

$$TF(\,t_1) = \left[\frac{A + H_c + D_c + S_c}{T}\right]$$

$$TF(\,t_1) = \frac{1}{T}\left\{A + C_1\left\{\alpha\left(T + \frac{\emptyset T^2}{2}\right)\log(\beta T) - \alpha\emptyset T\,t_1\log(\beta T) - \alpha T\log(\beta T) + \alpha\emptyset\left(T\,t_1 - \frac{T^2}{4} - \frac{3\,t_1^{\,2}}{4}\right)\right\} + C_2\left\{(T - t_1)\left(\alpha\left(T + \frac{\emptyset T^2}{2}\right)\log(\beta T) - aT\right) - \alpha\emptyset\frac{(T^3 - T\,t_1^{\,2})}{2}\log(\beta T) - \alpha\frac{T^2}{2}\log(\beta T) + \frac{\alpha\,t_1^{\,2}}{2}\log(\beta\,t_1) + \frac{3\alpha}{4}(T^2 - t_1^{\,2}) + \frac{\emptyset\,\alpha}{4}(\,t_1^{\,3} + t_1T^2 - 2T\,t_1^{\,2})\right\} + C_3\left\{\frac{3\alpha\,t_1^{\,2}}{4} - \frac{\alpha\,t_1^{\,2}}{2}\log(\beta\,t_1)\right\}\right\} \quad \textbf{(10)}$$

4. NUMERICAL EXAMPLE

To encapsulate this system, consider that various parameters are α = 20 units, β = 0.2, c_1 = 1.4 per unit, c_2 = 2 per unit, C_3 = 2 per unit, $\emptyset$= 0.01 and T = 14 days . we get output parameters: t_1 = 4.675 days, optimal quantity Q = 183units, total inventory cost $\mathrm{TF}(t_1) = 282$

5. Effect of Parameter Neutrosophication in the proposed inventory model

$$TF^{\widetilde{NS}}(\,t_1) = \frac{1}{T}\left\{A + \widetilde{C_1}\left\{\alpha\left(T + \frac{\emptyset T^2}{2}\right)\log(\beta T) - \alpha\emptyset\,T\,t_1\log(\beta T) - \alpha T\log(\beta T) + \alpha\emptyset\left(T\,t_1 - \frac{T^2}{4} - \frac{3\,t_1^{\,2}}{4}\right)\right\} + \tilde{C_2}\left\{(T - t_1)\left(\alpha\left(T + \frac{\emptyset T^2}{2}\right)\log(\beta T) - aT\right) - \alpha\emptyset\frac{(T^3 - T\,t_1^{\,2})}{2}\log(\beta T) - \alpha\frac{T^2}{2}\log(\beta T) + \frac{\alpha\,t_1^{\,2}}{2}\log(\beta\,t_1) + \frac{3\alpha}{4}(T^2 - t_1^{\,2}) + \frac{\emptyset\,\alpha}{4}(\,t_1^{\,3} + t_1T^2 - 2T\,t_1^{\,2})\right\} + \widetilde{C_3}\left\{\frac{3\alpha\,t_1^{\,2}}{4} - \frac{\alpha\,t_1^{\,2}}{2}\log(\beta\,t_1)\right\}\right\} \quad \textbf{(11)}$$

Here, holding cost $\widetilde{C_1}$, deteriotion cost $\widetilde{C_2}$ and shortage cost $\widetilde{C_3}$ have been considered as tropezoidal neutrosophic fuzzy set. Thus, the parameters of neutrosophic numbers are:

$Then, \widetilde{C_1} = =<$ (1.5 ,2,2.5,3,3.5), (1,1.5,2,2.5,3), (2,2.5,3,3.5,4), 0.8,0.5,0.5 $>$,
$\widetilde{C_2}$ $=<$ (0.5,1.5,2.5,3.5), (0.3,1.3,2.2,3.2), (0.7,1.7,2.2,3.8)|0.8; 0.5; 0.5) $>$, *and*
$\widetilde{C_3}$ $=<$ (0.4,1.3,2.8,3.8), (0.6,1.5,2.5,3.5), (0.8,1.7,2.7,3.7)|0.8; 0.5; 0.5) $>$

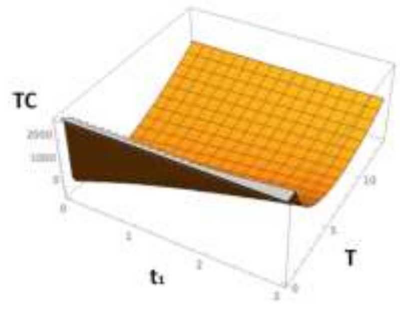

Figure 2

6. SENSITIVE ANALYSIS

In this segment, investigate however the enter parameters change significantly the resultant parameters. The amendment in one parameter and maintain different parameters invariant. The bottom information area unit got consequently to the computative example.

Table 1. Analysis of different parameter resulted.

Changes of Parameter	b	a	$\widetilde{C_1}$	$\widetilde{C_2}$	$\widetilde{C_3}$	$\emptyset$	T	t_1	$TF^{\widetilde{NS}}$	Q
	0.2	20	3.125	1.95	2.1	0.01	**10**	5.016	167.56	101
	0.2	20	3.125	1.95	2.1	0.01	**11**	4.875	166.11	110
	0.2	20	3.125	1.95	2.1	0.01	**12**	4.463	174.47	128
	0.2	20	3.125	1.95	2.1	0.01	**13**	3.858	195.58	143
T	0.2	20	3.125	1.95	2.1	0.01	**14**	2.984	228.43	149
	0.2	20	3.125	1.95	2.1	**0.01**	14	3.35	326.99	152
	0.2	20	3.125	1.95	2.1	0.0125	14	4.591	339.96	163
$\emptyset$	0.2	20	3.125	1.95	2.1	0.015	14	4.576	350.26	163
	0.2	20	3.125	1.95	2.1	0.0175	14	4.562	354.55	163
	0.2	20	3.125	1.95	2.1	0.02	14	4.548	367.85	163
	0.2	20	3.125	1.95	2.1	0.01	14	4.423	260.32	137
	0.2	20	3.125	1.95	**2.3**	0.01	14	4.855	383.29	154
$\widetilde{C_1}$	0.2	20	3.125	1.95	**2.5**	0.01	14	4.934	393.59	157
	0.2	20	3.125	1.95	**2.7**	0.01	14	5.157	438.88	159
	0.2	20	3.125	1.95	**2.9**	0.01	14	5.248	454.18	162
	0.2	20	3.125	**3**	2.1	0.01	14	3.215	277.68	152
	0.2	20	3.125	**5**	2.1	0.01	14	4.111	296.61	161
$\widetilde{C_2}$	0.2	20	3.125	**6**	2.1	0.01	14	4.309	308.94	162
	0.2	20	3.125	**7**	2.1	0.01	14	4.445	322.02	163
	0.2	20	3.125	**9**	2.1	0.01	14	4.62	349.36	163
	0.2	20	**0.8**	2	2	0.01	14	3.49	206.58	155
	0.2	20	**0.9**	2	2	0.01	14	3.246	217.26	152
$\widetilde{C_3}$	0.2	20	**1.2**	2	2	0.01	14	2.998	252.45	139
	0.2	20	**1.4**	2	2	0.01	14	3.457	278.96	125
	0.2	20	**1.5**	2	2	0.01	14	3.02	293.58	113
a	0.2	**25**	3.125	1.95	2.1	0.01	14	3.457	306.82	163
	0.2	**30**	3.125	1.95	2.1	0.01	14	3.455	334.69	201
	0.2	**35**	3.125	1.95	2.1	0.01	14	3.454	362.56	239
	0.2	**40**	3.125	1.95	2.1	0.01	14	3.453	390.43	278
	0.2	**45**	3.125	1.95	2.1	0.01	14	3.450	398.24	283

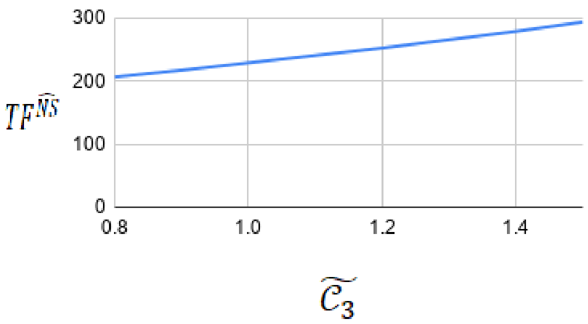

Figure 3

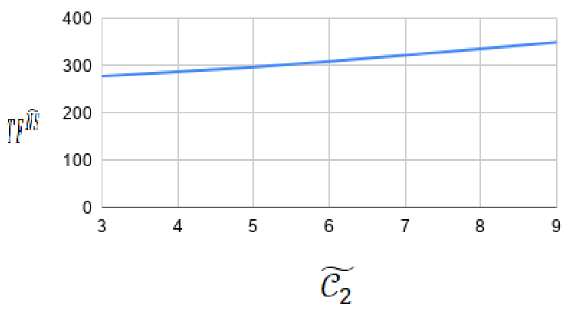

Figure 4

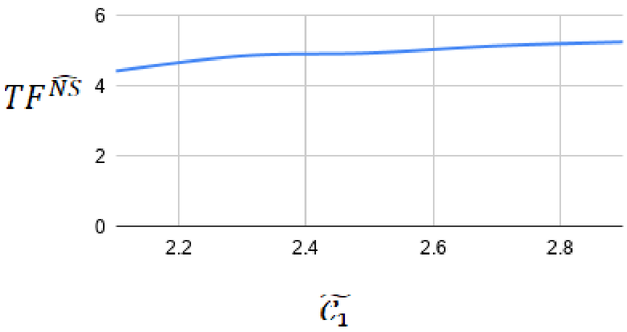

Figure 5

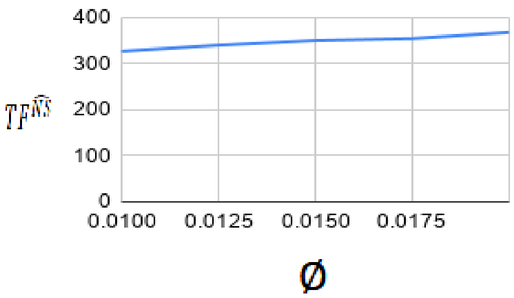

Figure 6

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7. OBSERVATIONS

1) Table 1 provides the behavior of total price with the variation in cycle time (T). From this table it is ascertained that because the worth of cycle time T increases, the total price of this model will increase.
2) Table 1 provides the variation in demand parameter (a),it's ascertained that increment in demand rate (a), total price of this model will increase.
3) Observe the behavior of total cost with the variation in deterioration rate ($\emptyset$), and it's ascertained that with the increment in decay rate ($\emptyset$), the total price of the supply chain will upwards.
4) The variation in parameter ($\widetilde{C_1}$) and it is ascertained that an increment in ($\widetilde{C_1}$) results an increment in total cost.
5) The variation in holding price ($\widetilde{C_2}$) is ascertained that the increment in($\widetilde{C_2}$), increase the total price of the logistics network.
6) The variation in shortage cost ($\widetilde{C_3}$) is ascertained that the increment in($\widetilde{C_3}$), increase the total price of the logistics network.

8. CONCLUSION

In this paper developed EOQ and total annual inventory cost in the crisp sense as well as neutrosophic sense. Shortage cost, holding cost, deterioration price are taken as trapezoidal neutrosophic set. This model discussed results and minimizing the entire inventory price. The expense for the demand is considered for progress of this model. Therefore this model is very successful in all situations. This model and demand pattern is applicable for patterned products, cosmetic products and backed items. The numerical example and sensitivity analysis is bestowed let's say this model and its important options. This model contains a more scope of extension with fractal method.

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