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Fuzzy Geometric Programming Approach to Food Supply Chain Model

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Abstract

The freedom of the general commercial enterprise and developing buyer requests upgrades the fine located nourishment technology. The present sustenance industry is improve and controlling the matters quality al thru the nourishment manufacturing network. Geometric Programming gives an integral asset to illuminating an assortment of designing development troubles. The motivation in the back of this paper is to decide the correct request amount utilising Fuzzy Geometric Programming. To decide the right request amount Fuzzy Geometric Programming is applied for price minimization and gain amplification with the attention of ecological protection value parameters, likewise utilizing Zadeh's growth rule, two primary projects are changed to more than one -stage of numerical tasks.

Keywords: *Inventory, Fuzzy Geometric Programming, Food Safety, Waste Management*

1. PRESENTATION

Buyer concerns fuse sustenance, sanitation, timeframe of practical usability just as social and natural views; anyway clients particularly expect nourishment traits. Quality matters preserve up purchaser faithfulness with unwavering first-rate and decline the danger. Presently a-days the nourishment commercial enterprise improve and controlling the nourishment high-quality for the duration of the nourishment inventory community. Stock version concentrateson the nature of the nourishment things with thought onenvironment problems. Stock fashions are defined to limit the all out pertinent costs with the lower of nourishment satisfactory misfortune. The stock fashions presenting the ecological issues are just deterministic in nature, however in this paper fluffy geometric programming model is applied to determine the suitable request amount as a way to confront the difficulties of the assembling regions. In the preceding works of Maurice, (Maurice, 2011) the pioneer of planning natural organized inventory models have utilized deterministic information charges parameters, yet in this paintings fluffy facts expenses parameters are applied to cope with the problems of vulnerability.

In this paper the hobby and the charges parameters are taken as fluffy factors. There are two primary variables for building up those fashions. The primary aspect is the usage of fluffy geometric programming to infer an appropriate arrangement. The Fuzzy Geometric Programming approach can be viably applied to this version, more than one two-degree clinical software is figured to check the top and lower limits of the target an incentive at plausibility degree. The participation capability of the fluffy goal esteem is inferred numerically by listing diverse qualities.

The remainder of this paper is taken care of out as follows: in section 2, the starters are given. In segment 3, the fluffy model with the all out fee minimization and advantage amplification.

At ultimate, a numerical model is given to show the version.

2. FUNDAMENTALS

2.1 Fuzzy set

A fluffy set A˜ is characterized by means of A˜=(x,μ_A˜ (x)):xϵX,μ_A˜ (x)∈[0,1] . In the pair (x,μ_A˜ (x)), the foremost aspect x have a place with the conventional set A , the second element μ_A˜ (x), have an area with the intervening time [0,1], referred to as participation capacity or evaluation of enrollment. The enrollment paintings is moreover a level of similarity or a stage of reality of x in A˜.

2.2 α-Cut

The association of additives that have an area with the fluffy set A˜ atleast to the degree α is referred to as the α level set or α-cut.$A(\alpha) = \{x \in X{:}\, \mu Ax \geq \alpha$

2.3 Generalized Fuzzy Number

Any fuzzy subset of the real line R, whose membership function satisfies the following conditions, is a generalized fuzzy number (Bellman 1970)

wherea_1, a_2,a_3 and a_4 are real numbers.

2.4 Trapezoidal Fuzzy Number

The fuzzy number $\tilde{A}(a_1, a_2, a_3, a_4)$ where $a_1 < a_2 < a_3 < a_4$ and defined on R is called the trapezoidal fuzzy number, its membership function $\tilde{A}$ is given by

$$\mu_{\tilde{A}}(x) = \begin{cases} 0 & \text{for } x < a_1 \\ \frac{x-a_1}{a_2-a_1} & \text{for } a_1 \leq x \leq a_2 \\ 1 & \text{for } a_2 \leq x \leq a_3 \\ \frac{a_4-x}{a_4-a_3} & \text{for } a_3 \leq x \leq a_4 \\ 0 & \text{for } x > a_4 \end{cases}$$

3. MODEL FORMULATION

3.1 Notations

Q	Order quantity
D	demand in fuzzy nature
R	manufacturing cost per unit
h	Inventory holding cost per unit
O	Procurement cost in fuzzy nature
S	Shortage cost per unit
F	Food Safety cost per unit
E	Waste Management cost per unit
a	Scaling constant for P
b	Scaling constant for R
α	Price elasticity with respect to demand
β	Degree of economics of sale

The Food Safety Cost (F) includes the quality loss, energy cost, fright cost and inspection cost. The waste management cost (E) includes the emission cost and waste disposal cost.

Minimizing Model

We have the accompanying numerical plan for the full an incentive in accordance with unit time (TC) with request sum (Q) transforms into the accompanying Fuzzy Geometric Programming.

Min (TC)˜(Q)=Procurement esteem predictable with unit time+Production charge in accordance with unit time + Inventory

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saving cost reliable with unit time + Shortage esteem predictable with unit time + Food security expense in accordance with

unit time + Waste cure cost per unit time.

$$\text{Min } \widetilde{TC}(\text{Q}) = \frac{\tilde{O}\tilde{D}}{Q} + R(D)\tilde{D} + iR(D)\frac{Q}{2} + \frac{\tilde{S}\tilde{D}}{2} + \frac{\tilde{F}\tilde{D}}{Q} + \frac{\tilde{E}\tilde{D}}{Q}$$

$$\text{Min } \widetilde{TC}(\text{Q}) = \tilde{O}\tilde{D}Q^{-1} + b\tilde{D}^{1-\beta} + 0.5ib\tilde{D}^{-\beta}Q + \tilde{S}\tilde{D}Q^{-1} + \tilde{F}\tilde{D}Q^{-1} + \tilde{E}\tilde{D}Q^{-1}$$

where Q is the decision variable and cost per unit is expressed as a power function of the demand per unit time displaying economics of scale (ie) R(D) = b$D^{-\beta}$

Optimal Solution Procedure

According to Fuzzy Geometric Programming objective function in this model is an unconstrained Polynomial with zero degree of difficulty by Guardiola (2009). So by above definition and assumption, we are facing by this mathematical formulation for the total fuzzy cost per unit time from the Fuzzy Geometric Programming perspective.

$$\text{Min } \widetilde{TC}(\text{Q}) = \tilde{O}\tilde{D}Q^{-1} + b\tilde{D}^{1-\beta} + 0.5ib\tilde{D}^{-\beta}Q + \tilde{S}\tilde{D}Q^{-1} + \tilde{F}\tilde{D}Q^{-1} + \tilde{E}\tilde{D}Q^{-1}$$

The objective function in this model is a fuzzy unconstrained polynomial with zero degree of difficulty. Now, in this part for solving, we use the duality Fuzzy Geometric Programming techniques.

Suppose $\tilde{O}, \tilde{S}, \tilde{F}, \tilde{E}$ and $\tilde{D}$ are trapezoidal fuzzy numbers.

Let$M = \left\{\left(\tilde{O}, \tilde{S}, \tilde{F}, \tilde{E}, \tilde{D}\right) \middle| O_\alpha^L \le \tilde{O} \le O_\alpha^U, S_\alpha^L \le \tilde{S} \le S_\alpha^U, F_\alpha^L \le \tilde{F} \le F_\alpha^U, E_\alpha^L \le \tilde{E} \le E_\alpha^U, D_\alpha^L \le \tilde{D} \le D_\alpha^U\right\}$

for each $\left(\tilde{O}, \tilde{S}, \tilde{F}, \tilde{E}, \tilde{D}\right) \in$ M.

We denote $TC\left(\tilde{O}, \tilde{S}, \tilde{F}, \tilde{E}, \tilde{D}\right)$ to be objective value of this model. Let TC^L and TC^U be the minimum and maximum of $TC\left(\tilde{O}, \tilde{S}, \tilde{F}, \tilde{E}, \tilde{D}\right)$ on M respectively, namely

$$Z^L = \min\{TC\left(\tilde{O}, \tilde{S}, \tilde{F}, \tilde{E}, \tilde{D}\right) | \left(\tilde{O}, \tilde{S}, \tilde{F}, \tilde{E}, \tilde{D}\right) \in M\}$$

$$Z^U = \max\{TC\left(\tilde{O}, \tilde{S}, \tilde{F}, \tilde{E}, \tilde{D}\right) | \left(\tilde{O}, \tilde{S}, \tilde{F}, \tilde{E}, \tilde{D}\right) \in M\}$$

which can be reformulated as the following pair of two level mathematical program.

$$TC^L = \min_{(\tilde{O}, \tilde{S}, \tilde{F}, \tilde{E}, \tilde{D}) \in M} \min_Q \{\tilde{O}\tilde{D}Q^{-1} + b\tilde{D}^{1-\beta} + 0.5ib\tilde{D}^{-\beta}Q + \tilde{S}\tilde{D}Q^{-1} + \tilde{F}\tilde{D}Q^{-1} + \tilde{E}\tilde{D}Q^{-1}\}$$

$$TC^U = \max_{(\tilde{O}, \tilde{S}, \tilde{F}, \tilde{E}, \tilde{D}) \in M} \max_Q \{\tilde{O}\tilde{D}Q^{-1} + b\tilde{D}^{1-\beta} + 0.5ib\tilde{D}^{-\beta}Q + \tilde{S}\tilde{D}Q^{-1} + \tilde{F}\tilde{D}Q^{-1} + \tilde{E}\tilde{D}Q^{-1}\}$$

So this model TC^L are transformed as

$$TC^L = \min_Q (O_\alpha)^L (D_\alpha)^L Q^{-1} + b[(D_\alpha)^L]^{1-\beta} + 0.5ib[(D_\alpha)^U]^{-\beta} + (S_\alpha)^L (D_\alpha)^L Q^{-1} + (F_\alpha)^L (D_\alpha)^L Q^{-1} + (E_\alpha)^L (D_\alpha)^L Q^{-1}$$

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Model TC^L is a conventional Geometric Programming problem.

For solving we use dual based algorithm so one can transform model TC^L and TC^U to the corresponding dual geometric program as follow:

$$TC^L = \max_u \left[\frac{(O_\alpha)^L(D_\alpha)^L}{u_1}\right]^{u_1} \left[\frac{0.5ib[(D_\alpha)^U]^{-\beta}}{u_2}\right]^{u_2} \left[\frac{(S_\alpha)^L(D_\alpha)^L}{u_3}\right]^{u_3} \left[\frac{(F_\alpha)^L(D_\alpha)^L}{u_4}\right]^{u_4} \left[\frac{(E_\alpha)^L(D_\alpha)^L}{u_5}\right]^{u_5}$$

s.t

$$u_1 + u_2 + u_3 + u_4 + u_5 = 1$$

$$-u_1 + u_2 - u_3 - u_4 - u_5 = 0$$

$$u_i > 0$$

$$TC^L = \max_{(\tilde{O},\tilde{S},\tilde{F},\tilde{E},\tilde{D})\in M} \left(\frac{\tilde{O}\tilde{D}}{u_1}\right)^{u_1} \left(\frac{0.5ib\tilde{D}^{-\beta}}{u_2}\right)^{u_2} \left(\frac{\tilde{S}\tilde{D}}{u_3}\right)^{u_3} \left(\frac{\tilde{F}\tilde{D}}{u_4}\right)^{u_4} \left(\frac{\tilde{E}\tilde{D}}{u_5}\right)^{u_5}$$

s.t

$$u_1 + u_2 + u_3 + u_4 + u_5 = 1$$

$$-u_1 + u_2 - u_3 - u_4 - u_5 = 0$$

$$u_i > 0$$

If we define the i^{th} term of the optimal primal objective function as U_i^*.

$$U_1^* = (O_\alpha)^L(D_\alpha)^L Q^{-1}$$

$$U_2^* = 0.5ib[(D_\alpha)^U]^{-\beta\frac{L}{Q}}$$

$$U_3^* = (S_\alpha)^L(D_\alpha)^L Q^{-1}$$

$$U_4^* = (F_\alpha)^L(D_\alpha)^L Q^{-1}$$

$$U_5^* = (E_\alpha)^L(D_\alpha)^L Q^{-1}$$

The optimal order quantity can be calculated from above as follows

$$Q^L = \sqrt{\frac{2D_\alpha^L[O_\alpha^L + S_\alpha^L + F_\alpha^L + E_\alpha^L]}{ib[(D_\alpha)^U]^{-\beta}}}$$

$$Q^U = \sqrt{\frac{2D_\alpha^U[O_\alpha^U + S_\alpha^U + F_\alpha^U + E_\alpha^U]}{ib[(D_\alpha)^L]^{-\beta}}}$$

Maximization Model

We are facing to formulation for the profit per unit time.

Max π(Q,D) = Revenue per unit time – {Procurement cost per unit time + Production cost

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per unit time + Inventory holding cost per unit time + Shortage cost per unit time + Food safety cost per unit time + Waste treatment cost per unit time}

Max π(Q,D) = P(D)D – $\left[\frac{\tilde{O}\tilde{D}}{Q} + R(D)\tilde{D} + iR(D)\frac{Q}{2} + \frac{\tilde{S}\tilde{D}}{2} + \frac{\tilde{F}\tilde{D}}{Q} + \frac{\tilde{E}\tilde{D}}{Q}\right]$

P(D) = a$D^{-\alpha}$ R(D) = b$D^{-\beta}$

Max π(Q,D) = a$\tilde{D}^{1-\alpha} - \tilde{O}\tilde{D}Q^{-1} - b\tilde{D}^{1-\beta} - 0.5ib\tilde{D}^{-\beta}Q - \tilde{S}\tilde{D}Q^{-1} - \tilde{F}\tilde{D}Q^{-1} - \tilde{E}\tilde{D}Q^{-1}$

Let $M = \left\{(\tilde{O},\tilde{S},\tilde{F},\tilde{E},\tilde{D}) \middle| O_\alpha^L \le \tilde{O} \le O_\alpha^U, S_\alpha^L \le \tilde{S} \le S_\alpha^U, F_\alpha^L \le \tilde{F} \le F_\alpha^U, E_\alpha^L \le \tilde{E} \le E_\alpha^U, D_\alpha^L \le \tilde{D} \le D_\alpha^U\right\}$

for each $(\tilde{O},\tilde{S},\tilde{F},\tilde{E},\tilde{D}) \in M$.

We denote $\pi(\tilde{O},\tilde{S},\tilde{F},\tilde{E},\tilde{D})$ to be the objective value of this model. So

$$\pi^L = \min\{\pi(\tilde{O},\tilde{S},\tilde{F},\tilde{E},\tilde{D}) \mid (\tilde{O},\tilde{S},\tilde{F},\tilde{E},\tilde{D}) \in M\}$$

$$\pi^U = \max\{\pi(\tilde{O},\tilde{S},\tilde{F},\tilde{E},\tilde{D}) \mid (\tilde{O},\tilde{S},\tilde{F},\tilde{E},\tilde{D}) \in M\}$$

which can be reformulated as the following pair of two level mathematical program.

$$\pi^L = \min_{(\tilde{O},\tilde{S},\tilde{F},\tilde{E},\tilde{D})\in M} \min_{D,Q}\{a^{-1}D^{\alpha-1} + Oa^{-1}Q^{-1}D^{\alpha} + ba^{-1}D^{\alpha-\beta} + 0.5iba^{-1}QD^{\alpha-\beta-1} + Sa^{-1}Q^{-1}D^{\alpha} + Fa^{-1}Q^{-1}D^{\alpha} + Ea^{-1}Q^{-1}D^{\alpha}\}$$

$$\pi^U = \max_{(\tilde{O},\tilde{S},\tilde{F},\tilde{E},\tilde{D})\in M} \max_{D,Q}\{a^{-1}D^{\alpha-1} + Oa^{-1}Q^{-1}D^{\alpha} + ba^{-1}D^{\alpha-\beta} + 0.5iba^{-1}QD^{\alpha-\beta-1} + Sa^{-1}Q^{-1}D^{\alpha} + Fa^{-1}Q^{-1}D^{\alpha} + Ea^{-1}Q^{-1}D^{\alpha}\}$$

For the model $\pi^L$and π^U. We use the dual problem which is usually easier to solve

First forπ^L:

$$Max d(u) = \left(\frac{1}{u_0}\right)^{u_0}\left(\frac{a^{-1}\lambda}{u_1}\right)^{u_1}\left(\frac{a^{-1}(O_\alpha)^L\lambda}{u_2}\right)^{u_2}\left(\frac{a^{-1}b\lambda}{u_3}\right)^{u_3}\left(\frac{0.5a^{-1}ib\lambda}{u_4}\right)^{u_4}\left(\frac{a^{-1}(S_\alpha)^L\lambda}{u_5}\right)^{u_5}\left(\frac{a^{-1}(F_\alpha)^L\lambda}{u_6}\right)^{u_6}\left(\frac{a^{-1}(E_\alpha)^L\lambda}{u_7}\right)^{u_7}$$

s.t

$$u_0 = 1$$

$$-u_0 + u_1 = 0$$

$$(\alpha-1)u_1 + \alpha u_2 + (\alpha-\beta)u_3 + (\alpha-\beta-1)u_4 + \alpha u_5 + \alpha u_6 + \alpha u_7 = 0$$

$$-u_2 + u_4 - u_5 - u_6 - u_7 = 0$$

$$u_i > 0 \qquad i = 1,2,3,4,5,6,7$$

Where $\lambda = u_1 + u_2 + u_3 + u_4 + u_5 + u_6 + u_7$

And for π^U:

$$Maxd(u) = \left(\frac{1}{u_0}\right)^{u_0}\left(\frac{a^{-1}\lambda}{u_1}\right)^{u_1}\left(\frac{a^{-1}(O_\alpha)^U\lambda}{u_2}\right)^{u_2}\left(\frac{a^{-1}b\lambda}{u_3}\right)^{u_3}\left(\frac{0.5a^{-1}ib\lambda}{u_4}\right)^{u_4}\left(\frac{a^{-1}(S_\alpha)^U\lambda}{u_5}\right)^{u_5}\left(\frac{a^{-1}(F_\alpha)^U\lambda}{u_6}\right)^{u_6}\left(\frac{a^{-1}(E_\alpha)^U\lambda}{u_7}\right)^{u_7}$$

s.t

$$u_0 = 1$$

$$-u_0 + u_1 = 0$$

$$(\alpha - 1)u_1 + \alpha u_2 + (\alpha - \beta)u_3 + (\alpha - \beta - 1)u_4 + \alpha u_5 + \alpha u_6 + \alpha u_7 = 0$$

$$-u_2 + u_4 - u_5 - u_6 - u_7 = 0$$

$$u_i > 0 \qquad i = 1,2,3,4,5,6,7$$

Where $\lambda = u_1 + u_2 + u_3 + u_4 + u_5 + u_6 + u_7$

So according to duality techniques,

We have

$$Q = \left[\frac{O+S+F+E}{a(V_2+V_5+V_6+V_7)}\right]\left[\frac{\alpha V_3}{b}\right]^{\left(\frac{\alpha}{\alpha-\beta}\right)}$$

$$D = \left[\frac{\alpha V_3}{b}\right]^{\left(\frac{1}{\alpha-\beta}\right)}$$

Such that $V_2 = a^{-1}\tilde{O}D^\alpha Q^{-1} V_6 = a^{-1}\tilde{F}D^\alpha Q^{-1}$

$$V_3 = a^{-1}bD^{\alpha-\beta} V_7 = a^{-1}\tilde{E}D^\alpha Q^{-1}$$

$$V_5 = a^{-1}\tilde{S}D^\alpha Q^{-1}$$

4. NUMERICAL ILLUSTRATION

Let $\widetilde{D}, \tilde{S}, \tilde{F}, \tilde{E}$ and $\tilde{O}$ be trapezoidal numbers.

$\widetilde{D}$ = (2000,2500,3500,4000)

$\tilde{O}$ = (10,15,25,30)

$\tilde{S}$ = (2,3,5,6)

$\tilde{F}$ = (30,40,60,70)

$\tilde{E}$ = (14,20,32,38)

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$\tilde{\mathcal{D}}$ = [2000+500α, 4000-500α]

$\tilde{\mathcal{O}}$ = [10+5α, 30-5α]

$\tilde{\mathcal{S}}$ = [2+α, 6-α]

$\tilde{\mathcal{F}}$ = [30+10α, 70-10α]

$\tilde{\mathcal{E}}$ = [14+6α, 38-6α]

$$Q^L = \sqrt{\frac{2(2000+500\alpha)[10+5\alpha+2+\alpha+30+10\alpha+14+6\alpha]}{ib\ \ [4000-500\alpha]^{-\beta}}}$$

$$Q^L = \sqrt{\frac{2(2000+500\alpha)[56+22\alpha]}{ib\ \ [4000-500\alpha]^{-\beta}}}$$

$$Q^U = \sqrt{\frac{2(4000-500\alpha)[30-5\alpha+6-\alpha+70-10\alpha+38-6\alpha]}{ib\ \ [2000+500\alpha]^{-\beta}}}$$

$$Q^U = \sqrt{\frac{2(4000-500\alpha)[144-22\alpha]}{ib\ \ [2000+500\alpha]^{-\beta}}}$$

Conclusion:

The matters with excessive weakening charge are constantly threatening to the retailer's the identical old aspect. This paper builds up the fluffy geometric programming model for nourishment things with the worry on natural troubles and sanitation. This version determined the request amount or the all out fee minimization and gain enhance version to trade for precept software in fashions into two stage geometric projects. This version is profoundly stable because it has been authorised with numerical version. It has a wide extension as it utilizes fluffy medical method. The result indicates that the proposed model is regularly suit to be achieved for coping with the acquirement of nourishment things.

Reference:

[1] Bharani, B., Praveen Prakash, A., "Fluffy Economic Production amount mode for a supportable framework by means of Geometric Programming", Journal of Global Research in Mathematical Archives, Vol.5, No. 6, 26-33.

[2] Bellman, R.E., Zadeh, L.A., (1970)., "Basic management in a Fuzzy area", Management Sciences, 17, B141-B164.

[3] Fauza, G., Amer, Y., and Lee, S., (2013)., "Model of an Integrated acquisition – creation framework for Food objects fusing great misfortune throughout ability time", International Journal of Materials, Mechanics and Manufacturing IJMMM, 17 – 21. Doi:10.7763/ijmmm.2013.V1.4.

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ISSN: 0193 - 4120 Page No. 7317 - 7324

[4] Jung. Hoon., M. Klein. Cerry., (2001)., "Ideal inventory preparations underneath diminishing cost capacities via geometric programming", European Journal of Operational Research., 132, 628-648.
[5] Kordi, A., (2010)., "Ideal fluffy inventory strategies through fluffy geometric programming", Industrial Engineering and Operations Management, 1-4.
[6] Kochenberger, G.A., "Stock fashions", Optimization through Geometric Programming", Decision Sciences, 2(1971), 193-205.
[7] Maurice Bonney.Et.Al., (2011)., "Earth capable stock fashions: Non-Classical fashions for a non-Classical time", International Journal of Production Economics, 133(1), 43-fifty three.
[8] Moore, J.C., Spink, J., and Lipp, M., (2012)., "Improvement and Application of a Database of Food Ingredient Fraud and Economically Motivated Adulterated from 1980 to 2010", Journal of Food Science, seventy seven(4). Doi:10.1111/j.17503841.2012.02657.X
[9] Nivetha Martin., Pandiammal, P., "Streamlining of a monetary green assembling stock version utilizing fluffy geometric programming", International Journal of Advanced Research (2016), Vol.Four, Issue 7, 211-216.
[10] Rajgopal, J., Bricker, D.L., (2002)., "Tackling Posynomial geometric programming troubles by means of summed up immediately programming", Computational Optimization and Applications 21, 95-109.
[11] Rajgopal, J., Bricker, D.L., (1990)., "Posynomial geometric programming as an unusual instance of semi-countless instantly programming", Journal of Optimization speculation and Applications, sixty six, 455-475.
[12] Ritha, W., Haripriya, S., (2016)., "An eco-accommodating inventory version for nourishment matters to reduce great misfortune with advantage amplification", International Journal of Computer Science and Mobile Computing, Vol.5, 489-497.
[13] Shiang-Tai Liu., (2006).,"Posynomial geometric programming with parametric vulnerability", European Journal of Operational Research, 168, 345-353.
[14] Shiang-Tai Liu., (2007).,"Geometric Programming with fluffy parameters in constructing enhancement", International Journal of tough wondering, 46, 484-498.
[15] Zadeh, L.A., "Fluffy Sets", Information and manage, Vol.Eight, 338-353 (1965).