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W-O-C model on Solid Transportation Problem over Fermatean Fuzzy Environment

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Abstract:

In this article, Manufacturing industry consider warehouses, outlets and conveyance in Solid Transportation Problem on Fermatean Fuzzy Environment. Three type of warehouses, three type of outlets and three type of transference are taken in Fermatean Fuzzy Environment. Fermatean Fuzzy numbers are taken as livestock to transmit warehouses to outlets through transference. Feremateanean Fuzzy values are changes as crisp values to get an optimal solution for the W-O-C model using Fermatean grade function. New algorithm is used in Zero Point method to get an optimal solution for the W-O-C mode**l.**

Key Words:

Fermatean Fuzzy Set, q-Rung Orthopair Fuzzy Set, Warehouse-Outlets-Conveyance, Fuzzy Set, Solid Transportation Problem.

1. Introduction

Operation research abides the discipline of coherent decision making, the investigation, plan and consolidation of convoluted circumstances and methodology with the aim of system actions and enhancing or evaluating system representation. Operation research has three necessary features. The answer process of STP is a development of the revised allocation method, familiarized by haley. m+n+l-2 significances of the determination variables are necessary for discovering an optimal answer to begin with a primary feasible answer. A mathematically ideal technique for solid transportation problem with varied restrictions is designed by Tripathy and Patel. Programming model under fuzzy for a MOSTP was designed by Bit. The optimum answer of a stable static control linear transportation issue, an algorithm is furnished by Basu. An technique for solving a BCSTP with fuzzy numbers was given by Gen. In 2020, Yager and Senapati fixed q=3 and untried q-ROFS is named as Fermatean fuzzy sets (FFS). Under this special idea, the decisiontakers possess more additional space since they reveal their opinions about belongingness and non-belongingness concerning the condition of a topic.

2.Preliminaries

2.1 Mapping of a Fuzzy set

Let E be filled-in elements and F be a non-empty fuzzy set which contain elements and that are mapped to unit interval [0,1] and the membership function of F is also mapped to unit interval[0,1] i.e, $(\mu_F(x): E \rightarrow [0,1])$

2.2 q-Rung Orthopair Fuzzy set

Q is a q-Rung in a limited universe of discourse E is defined by Yager

$$Q = \{\langle x, \mu_Q(x), \nu_Q(x)\rangle | x \in E\}$$

where DMF is betoken $\mu_{Q}: E \to [0,1] $and DNMF is betoken $\nu_Q: E \rightarrow [0,1](\forall x \in E)$, direct towards to q-ROF set Q, with the status that $0 \leq \left(\mu_Q(x)^q + \nu_Q(x)^q\right) \in 1, (q \geq 1)$

2.3 Grade function of Fermatean Fuzzy set

Let $\tilde{FS} = \langle \mu_{\tilde{FS}}, \nu_{\tilde{FS}}\rangle$ be any FS, the grade function is denoted by $G_{(\tilde{FS})}$ and is defined as

$$G_{(\tilde{FS})} = \left(\mu_{\tilde{FS}}^3 - \nu_{\tilde{FS}}^3\right)$$

The grade function defined senapati and yager [13],[14] , the grade value lies in the interval [-1,1]. i.e $G_{(\tilde{FS})} \in [-1,1]$. It is to be noted that the function is positive when $G_{(\tilde{FS})} \in [0,1]$ and negative when $G_{(\tilde{FS})} \in [-1,0)$. In the purpose of grade of FNs/FSs (either IFS or PFS) most of the researchers have considered grade functions whose grade values are lies in the interval 0 and 1. So to maintain the same we have proposed some grade functions for the ranking of FFSs.

$G_{(\tilde{FS})} = \frac{1}{2}\left(1 + \mu_{\tilde{FS}}^3 - \nu_{\tilde{FS}}^3\right)$

2.4 Algorithm of W-O-C on Solid Tansportation Problem over Fermatean Fuzzy

Lets we begin with new method of W-O-C on Solid Transportation Problem over Fermatean Fuzzy

Step 1: To verify the appropriate Fermatean fuzzy STP is balanced or not. If not then change as balanced STP.

Step 2: To convert the crisp value of the given Fermatean fuzzy STP using the grade function.

Step 3: Change the Fermatean fuzzy STP table to a row and column reduction table.

Step 4: Change W-O-C table to Warehouses-Outlets table and to check the Warehouses-Outlets satisfy the allocation of the Fermatean fuzzy supply and necessity. If yes, go to next step 6; otherwise, go to step 5.

Step 5: Use row and column reduced method to cross out the row and column, then take the smallest value in unmarked places. Add the smallest value in the intersection place and subtract the smallest value in the unmarked place of an appropriate table.

Step 6: To check the Outlets-Conveyances table to satisfy the allocation of Fermatean fuzzy necessity and transference. If yes, go to the next step 7; otherwise, go to step 5.

Step 7: To check the Conveyances-Warehouses table to satisfy transference and supply. If yes, then go to next step 8; otherwise, go to step 5.

Step 8: To check the Warehouses-Outlets table to satisfy supply and necessity. If yes, then go to step 9; otherwise, go to step 5.

Step 9: To check Warehouses-Outlets-Conveyance table satisfy Fermatean Fuzzy supply, necessity and transference. If yes then go to step 10; otherwise, go to step 5.

Step 10: To find the Solid Transportation Problem on Fermatean Fuzzy Environment ambiance on optimal solution from the appropriate table.

3. W-O-C model on Solid Transportation Problem using Fermatean Fuzzy

Manufacturing Industry can handle with Warehouses, Outlets and Conveyance to transmit goods. Solid transportation deals with three type of Warehouses, three type of Outlets and three type of Conveyance on Fermatean fuzzy environment.

Fuzzy solid transportation problem structure is defined given below,

$$Minimize\ Z = \sum_{r=1}^{l}\sum_{s=1}^{m}\sum_{t=1}^{n} \tilde{c}_{rst} x_{rst}^{\tilde{FS}}$$

$$\sum_{s=1}^{m}\sum_{t=1}^{n} x_{rst}^{\tilde{FS}} = a_r^{\tilde{FS}}$$

$$\sum_{r=1}^{l}\sum_{t=1}^{n} x_{rst}^{\tilde{FS}} = b_s^{\tilde{FS}}$$

$$\sum_{r=1}^{l}\sum_{s=1}^{m} x_{rst}^{\tilde{F}S} = c_t^{\tilde{F}S}$$

$\sum_{r=1}^{l} a_r^{\tilde{F}S}$ is total stock of the warehouses. $\sum_{s=1}^{m} b_s^{\tilde{F}S}$ is total order of the Outlets. $\sum_{t=1}^{n} c_t^{\tilde{F}S}$ is total conveyance. $x_{rst}^{\tilde{F}S}$ is amount of livestock transmit from r^{th} warehouses to s^{th} Outlets by virtue of t^{th} Conveyance which deals with $\mu_{\tilde{F}S}(x)$ represents number of products exported from r^{th} warehouses to s^{th} Outlets by virtue of t^{th} Conveyance and $\nu_{\tilde{F}S}(x)$ represents number of product not exported. Fermatean fuzzy subset $\tilde{F}S$ satisfy $0 \le \mu_{\tilde{F}S}(x)^3 + \nu_{\tilde{F}S}(x)^3 \le 1$ and also thereon degree of indeterminacy $\phi_{\tilde{F}S}(x) \in [0,1]$ which is of the form$\phi_{\tilde{F}S}(x) + \left(\mu_{\tilde{F}S}(x)\right)^3 + \left(\nu_{\tilde{F}S}(x)\right)^3 = 1$,If degree of indeterminacy $\phi_{\tilde{F}S}(x) =, Then\left(\mu_{\tilde{F}S}(x)\right)^3 \left(\nu_{\tilde{F}S}(x)\right)^3 = 1$

Using Fermatean fuzzy condition $\alpha^3 + \beta^3 = 1$ to make proper Fermatean Fuzzy STP.

Table 1: Solid Transportation Problem on Fermatean Fuzzy Environment

Conveyance	K1			K1			K1			0.16
		K2			K2			K2		0.36
			K3			K3			K3	0.49
Warehouses/Outlets	O1			O2			O3			Warehouses supply
W1	<0.6,0.92>	<0.8,0.78>	<0.3,0.99>	<0.9,0.64>	<0.7,0.86>	<0.6,0.92>	<0.5,0.95>	<0.4,0.97>	<0.9,0.64>	0.27
W2	<0.4,0.97>	<0.7,0.86>	<0.4,0.97>	<0.2,0.99>	<0.8.0.78>	<0.5,0.95>	<0.4,0.97>	<0.7,0.86>	<0.6,0.92>	0.49
W3	<0.7,0.86>	<0.5,0.95>	<0.6,0.92>	<0.7,0.86>	<0.4,0.97>	<0.7,0.86>	<0.6,0.92>	<0.5,0.95>	<0.8,0.78>	0.25
Outlets order	0.81			0.04						1.01

From step 2 use Fermatean grade function for the table 1 then the values are changed as crisp value.

Table 2: Crisp Value Solid Transportation Problem on Fermatean Fuzzy Environment

Conveyance	K1			K1			K1			0.16
		K2			K2			K2		0.36
			K3			K3			K3	0.49
Warehouses/Outlets	O1			O2			O3			Warehouses supply
W1	0.216	0.512	0.027	0.729	0.343	0.216	0.125	0.064	0.729	0.27
W2	0.064	0.343	0.064	0.008	0.512	0.125	0.064	0.343	0.216	0.49
W3	0.343	0.125	0.216	0.343	0.064	0.343	0.216	0.125	0.512	0.25
Outlets order	0.81			0.04			0.16			1.01

To reduce all stocked value by its lowest level of stocked value in each row.

Table 3: Reduced Solid Transportation Problem on Fermatean Fuzzy Environment

Conveyance	K1			K1			K1			0.16
		K2			K2			K2		0.36
			K3			K3			K3	0.49
Warehouses/Outlets	O1			O2			O3			Warehouses supply
W1	0.189	0.485	0	0.702	0.316	0.189	0.098	0.037	0.702	0.27
W2	0.056	0.335	0.056	0	0.504	0.117	0.056	0.335	0.208	0.49
W3	0.279	0.061	0.152	0.279	0	0.279	0.152	0.061	0.448	0.25
Outlets order	0.81			0.04			0.16			1.01

To verify W-O table satisfy 4 if not then go to step 5 until W-O table satisfy supply and demand value in zero point.

Table 4: Warehouses-Outlets of Solid Transportation Problem on Fermatean Fuzzy Environment

Warehouses/Outlets	O1			O2			O3			Warehouses supply
W1	0.245	0.485	0	0.758	0.316	0.189	0.117	0	0.665	0.27
W2	0.056	0.279	0	0	0.448	0.061	0.019	0.242	0.115	0.49
W3	0.335	0.061	0.152	0.335	0	0.279	0.171	0.024	0.411	0.25
Outlets order	0.81			0.04			0.16			1.01

Change livestock r^{th} warehouses to s^{th} Outlets by virtue of t^{th} conveyance of Warehouses-Outlets to Outlets-Conveyance with corresponding Outlets order and conveyance.

Table 5: Outlets-Conveyance of Solid Transportation Problem on Fermatean Fuzzy Environment

Outlets/Conveyance	K1			K2			K3			Outlets order
O1	0.245	0.056	0.335	0.485	0.279	0.061	0	0	0.152	0.81
O2	0.758	0	0.335	0.316	0.448	0	0.189	0.061	0.279	0.04
O3	0.117	0.019	0.171	0	0.242	0.024	0.665	0.115	0.411	0.16
Conveyance	0.16			0.36			0.49			1.01

To verify O-C table satisfy 6 if not then go to step 5 until O-C table satisfy outlet order and conveyance value in zero point.

Table 6: Outlets-Conveyance of Solid Transportation Problem on Fermatean Fuzzy Environment

Outlets/Conveyance	K1			K2			K3			Outlets order
O1	0.306	0.117	0.396	0.546	0.34	0.122	0	0	0.152	0.81
O2	0.758	0	0.335	0.316	0.448	0	0.128	0	0.218	0.04
O3	0.117	0.019	0.171	0	0.242	0.024	0.604	0.054	0.35	0.16
Conveyance	0.16			0.36			0.49			1.01

Change livestock r^{th} warehouses to s^{th} outlets by virtue of t^{th} conveyance of Outlets- Conveyance to Conveyance-Warehouses with conveyance and warehouses stock.

Table 7: Conveyance-Warehouses of Solid Transportation Problem on Fermatean Fuzzy Environment

Conveyance/Warehouses	W1			W2			W3			Conveyance
K1	0.306	0.758	0.117	0.117	0	0.019	0.396	0.335	0.171	0.16
K2	0.546	0.316	0	0.34	0.448	0.242	0.122	0	0.024	0.36
K3	0	0.128	0.604	0	0	0.054	0.152	0.218	0.35	0.25
Warehouses supply	0.27			0.49			0.25			1.01

Change livestock r^{th} warehouses to s^{th} outlets by virtue of t^{th} conveyance of Conveyance- Warehouses to Warehouses-Outlets and included with the conveyance, warehouses stock and outlets order.

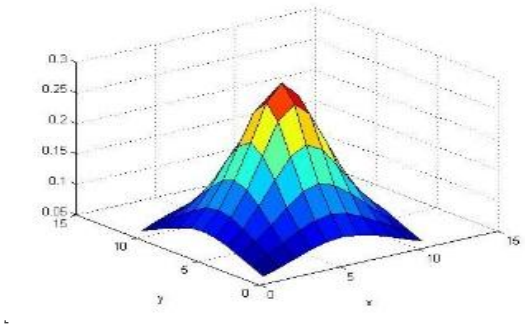
Table 8: Warehouses-Outlets-Conveyance of Solid Transportation Problem on Fermatean Fuzzy Environment

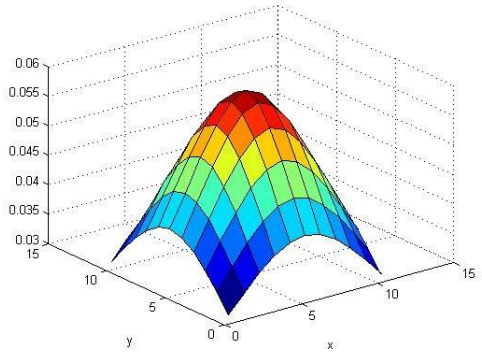
Conveyance	K1			K1			K1			0.16
		K2			K2			K2		0.36
			K3			K3			K3	0.49
Warehouses/Outlets	O1			O2			O3			Warehouses supply
W1	0.306	0.546	0(0.11)	0.758	0.316	0.128	0.117	0(0.16)	0.604	0.27
W2	0.117(0.11)	0.34	0(0.38)	0	0.448	0	0.019	0.242	0.054	0.49
W3	0.396(0.05)	0.122(0.16)	0.152	0.335	0(0.04)	0.218	0.171	0.024	0.35	0.25
Outlets order	0.81			0.04			0.16			1.01

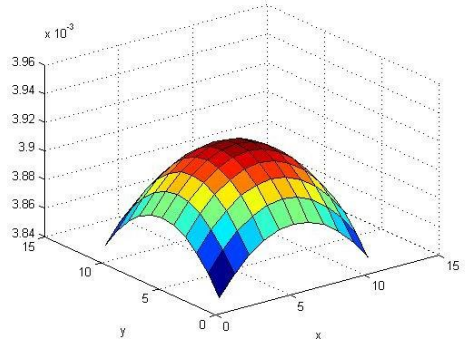
Optimal solution of Solid Transportation on Fermatean Fuzzy environment is $X_{113} = 0.11, X_{132} = 0.16$

, $X_{211} = 0.11, X_{213} = 0.38, X_{311} = 0.05, X_{312} = 0.16, X_{322} = 0.04$. Total minimum Solid Transportation Problem on Fermatean Fuzzy Environment cost is 0.05996.

4. Result







MATLAB Approach for STP outcome under Fermatean fuzzy environment

Matlab approach on Zero Point method based algorithm on the Fermatean Fuzzy used in Solid transportation problem with three warehouses, three outlets and three mode of conveyances are solved using grade function then the result is given in different dimensional.

5. Conclusion

We considered three type of warehouses, three type of outlets and three type of transference in the Manufacturing industry is evaluated using Solid transportation problem with Fermatean Fuzzy numerals. Fermatean fuzzy numerals are changed as crisp values using Fermatean grade function to appraise the W-O-C model. New algorithm is proposed using Zero Point method on W-O-C model. Optimal solution is obtained with the support of Zero Point method which is used on crisp value to evaluate the W-O-C model over Fermatean Fuzzy environment.

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