Grey Situation Decision-Making Theory Based New Method for Solving Multi-Objective Transportation

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Abstract— *The transportation problems are framed with multi-goals which are evaluated in various scales and in the meantime in conflict. The many-sided quality of the social and monetary atmosphere require express thought of criteria other than cost around then certifiable issues like delivering an item from a few supply origin to a few interest destination can be formulated as multi-objective transportation models. Grey situation decision making is alluding to the procedure of better choice and shortcoming disposal in which different countermeasure should be preferred according to the different events. This paper applied the grey situation decision making theory for the solution of multi-objective transportation problem.*

Keywords—*Multi-objective transportation, effect measure, efficient solution, decision weight, grey situation*

I. *Introduction*

Single objective transportation problem includes the target cost coefficients which can express normally the transportation cost. But, genuine circumstances required more than one goal into an account to reflect the problem more sensibly, and accordingly multi-objective transportation problem (MOTP) turns out to be more helpful. The amount of goods delivered, unfulfilled demand, average delivery time of the commodities, reliability of transportation, accessibility to the users, and product deterioration can be the different types of objectives [4]. Several researchers applied different approach to find the solution of MOTP. Lee and Moore (1973) applied goal programming to discover an answer of MOTP. Zimmermann (1978) used fuzzy set theory to find solutions of MOTP with the liner vector maximum problem. Isermann (1979) built an algorithm for recognizing all the non-dominated answers for a Linear MOTP. Diaz (1979) builds up an algorithm for finding the arrangement of MOTP. An algorithm for recognizing all the non-dominated solution for a linear MOTP was made by Isermann (1979). Leberling (1981) utilized hyperbolic membership function for finding the solution of MOTP. Slowinski (1986) introduced a strategy for tackling a multi-criteria linear programming where the coefficients of the objective function and constraints are fuzzy numbers of the L-R type. Ringuest and Rinks (1987) made two algorithms for handling MOTP [11] with non-linear membership functions, an exponential, quadratic and logarithmic. Bit et al. (1992), Bit and Alam (1993), Verma et al. (1997), Hussien (1998), Li and Lai (2000) have some significant contribution to find the solution of MOTP with fuzzy theory. Fuzzy programming approach first presented by Wahed and Sinna (2001) for finding the compromise solution of MOTP. The efficient solution of MOTP is obtained by Ammar and Youness (2005) with fuzzy coefficient. To determine the perfect compromise solution Wahed and Lee (2006), Zangiabadi and Maleki (2007) have developed fuzzy goal programming based method. Surapati and Roy (2008) has developed priority based fuzzy goal programming approach to obtain the solution of MOTP. Lau et al. (2009) used evolutionary algorithms to solve the MOTP that deals with the optimization of the vehicle routing. Lohgaonkar and Bajaj (2010) used fuzzy liner and non-linear membership function to obtain the compromise solution of a MOTP. P.K. De and Bharti Yadav (2011), J. Khan, D. K. Das (2012) used a fuzzy programming approach with different membership function to find an optimal compromise solution for MOTP. J. Khan, D. K. Das (2012) have developed the row maxim method with fuzzy theory to determine the solution of MOTP. Yousria Abo-Elnaga, Bothina El-Sobky and Hanadi Zahed (2012) used the trust-region globalization strategy to solve MOTP. M. Zangiabadi and H. R. Maleki (2013) used an exponential nonlinear membership functions to solve MOTP. Osuji, George, Okoli Cecilia, Opara, Jude (2014) used fuzzy programming algorithm to obtined the solution of MOTP. V. Vinoba and R. Palaniyappa (2014) [14] used Object Oriented Programming model (C++) to study on North east corner method in Transportation Problem. Kirti Patel, Jayesh M. Dhodiya (2016) [6] used fuzzy theory for the solution of multi objective resource allocation problem. Grey decision-making theory is one of the new theory resulting from the idea of the grey set developed by Deng Julong in 1982, [5]. Grey situation decision making model, an essential piece of grey system theory, is connected with decision-making method for multi-criteria and multi-countermeasure choice [12]. The significance of grey decision making is on the investigation of the issue of picking arrangements [13]. The Gray Situation Decision making theory as alluded to the technique for better choices in which diverse countermeasures ought to be picked by various occasions, therefore in this paper grey decision making theory tries to apply in multi-objective transportation field.

II. *TRANSPORTATION PROBLEM* WITH MULTIPLE *OBJECTIVES*

An uncommon sort of linear programming problem in which limitation are of correspondence sort and every one of the destinations are clashing with each other, are called transportation problem with multiple objective. In actual circumstances, all the transportation problems are not a single goal. A product is to be shipped from m origins to n destinations in MOTP. Moreover, there is a penalty connected with transporting a unit of item from origin to demand destination. This penalty might be an expense or conveyance time or wellbeing of conveyance or and so on. A variable speak to the obscure amount to be transported from source to destination. A mathematical structure of transportation problem with r objectives, m sources and n destinations can be composed as:

Minimize $Z_r = \sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij}^{r} x_{ij}$, $r = 1,2,....,k$

Subject to

$$\sum_{j=1}^{n} x_{ij} = a_i \ , \ i = 1,2,....,m$$

$$\sum_{i=1}^{m} x_{ij} = b_j , \ \ j = 1,2,....,n$$

$$x_{ij} \geq 0, \ \ \forall i, j$$

The r^{th} penalty criterion is correlated with the subscript on Z_r and superscript on c_{ij}^{r} . Without loss of generality, it may be assumed that $a_i \geq 0$, $b_j \geq 0 \ \forall i, j$ and the balance condition $\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j$ is fulfilled [1].

The general table for multi-objective transportation problem is given below [3]:

III. TABLE I

GENERAL MULTI-OBJECTIVE TRANSPORTATION PROBLEM

Destinations → Resources ↓	B_1	B_2	$\cdots$	B_n	Supply
A_1	c_{11}^{1} c_{11}^{2} $\vdots$ c_{11}^{l}	c_{12}^{1} c_{12}^{2} $\vdots$ c_{12}^{l}	$\cdots$	c_{1n}^{1} c_{1n}^{2} $\vdots$ c_{1n}^{l}	a_1
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
A_m	c_{m1}^{1} c_{m1}^{2} $\vdots$ c_{m1}^{l}	c_{m2}^{1} c_{m2}^{2} $\vdots$ c_{m2}^{l}	$\cdots$	c_{mn}^{1} c_{mn}^{2} $\vdots$ c_{mn}^{l}	a_m
Demand	b_1	b_2	$\cdots$	b_n	

For find the solution of MOTP here we have applied grey situation decision making theory.

IV. *GREY SITUATION DECISION-MAKING THEORY WITH MULTIPLE OBJECTIVES*

Assume that $A = \{a_1, a_2, ..., a_n\}$ is the set of events and $B = \{b_1, b_2, ..., b_m\}$ the countermeasure set, $S = A \times B = \{(a_i, b_j) \mid a_i \in A, b_j \in B\}$ the situation set and u_{ij}^{k} , $i = 1,2,...,n,\ j = 1,2,...,m,$ is the effect value of situation $s_{ij} \in S$ with objective k. Then to measure the effect we have upper effect measure, lower effect measure.

The maximum deviation data accomplish from the upper effect measure and it can be denoted and defined as $r_{ij}^{k} = u_{ij}^{k} \Big/ \max_i \max_j \{u_{ij}^{k}\}$.

Similarly, the minimum deviation data accomplish from the lower effect measure which can be denote and defined as $r_{ij}^{k} = \min_i \min_j \{u_{ij}^{k}\} \Big/ u_{ij}^{k}$.

The effect measures r_{ij}^{k} , $i = 1,2,...,n,$ $j = 1,2,...,m,$ $k = 1,2,...,s$ must satisfy

(1) r_{ij}^{k} has no dimension

(2) $r_{ij}^{k} \in [0,1]$

(3) The more ideal the effect is, the greater r_{ij}^{k} is.

Let, the decision weight of objective k is $\eta_k, k = 1,2,...,s$, satisfying $\sum_{k=1}^{s} \eta_k = 1$ .So the comprehensive effect measure of situation s_{ij} is $r_{ij} = \sum_{k=1}^{s} r_{ij}^{k} \cdot \eta_k$ and comprehensive effect measure matrix is [1]

$$R = \left[r_{ij}\right] = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix}$$

In grey situation decision making theory weight of the objective are deciding as follows

V. *THE OPTIMIZATION MODEL OF OBJECTIVE WEIGHT*

To obtain weight of objective function the developed theory [1] is utilized with positive $v_i^{k+} = \max_j r_{ij}^{k}$, negative $v_i^{k-} = \max_j r_{ij}^{k}$ ideal effect measures and Structure Lagrange function

$$L(\eta_i, \lambda) = \mu \sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{s} d^{+}(r_{ij}^{k}, v_i^{k+})\,\eta_k - \mu \sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{s} d^{-}(r_{ij}^{k}, v_i^{k-})\,\eta_k$$
$$+ (1-2\mu) \sum_{i=1}^{s} \eta_k \ln \eta_k - \lambda\left(\sum_{k=1}^{s} \eta_k - 1\right) \qquad (1)$$

Then

$$\begin{cases} \dfrac{\partial L}{\partial \eta_k} = \mu \sum_{i=1}^{n}\sum_{j=1}^{m} d^{+}\left(r_{ij}^{k}, v_i^{k+}\right) - \mu \sum_{i=1}^{n}\sum_{j=1}^{m} d^{-}\left(r_{ij}^{k}, v_i^{k-}\right) \\ \qquad + \left(1-2\mu\right)\left(\ln \eta_k + 1\right) - \lambda = 0 \\ \qquad \dfrac{\partial L}{\partial \lambda} = \sum_{k=1}^{s} \eta_k - 1 = 0 \end{cases} \qquad (2)$$

By using this weight can be obtained by equation as [2]

$$\eta_k = \frac{\exp\left\{\left[\mu \sum_{i=1}^{n}\sum_{j=1}^{m} d^{-}\left(r_{ij}^{k}, v_i^{k-}\right) - \mu \sum_{i=1}^{n}\sum_{j=1}^{m} d^{+}\left(r_{ij}^{k}, v_i^{k+}\right)\right] \Big/ \left(1-2\mu\right) - 1\right\}}{\sum_{k=1}^{s} \exp\left\{\left[\mu \sum_{i=1}^{n}\sum_{j=1}^{m} d^{-}\left(r_{ij}^{k}, v_i^{k-}\right) - \mu \sum_{i=1}^{n}\sum_{j=1}^{m} d^{+}\left(r_{ij}^{k}, v_i^{k+}\right)\right] \Big/ \left(1-2\mu\right) - 1\right\}} \qquad (3)$$

VI. *DEVELOPED METHOD TO SOLVE MULTI-OBJECTIVE TRANSPORTATION PROBLEM*

Consider the case set $A = \{a_1, a_2, ..., a_n\}$ as production facilities (origin) of company, counter set $B = \{b_1, b_2, ..., b_m\}$ as destinations and the situation set $S = \{s_{ij} = (a_i, b_j) \mid a_i \in A, b_j \in B\}$ as transporting a product from supply origin to demand destination. $u_{ij}^{k}, i = 1,2,...,n, j = 1,2,...,m,$ is the effect value of situation $s_{ij} \in S$ with objective $k=1,2,...s$ identified as the data of decision making goals for transporting a product.

Now, find the upper effect measure and lower effect measure and achieve the consistent matrix of effect measure. Subtract each data from 1 of the consistent matrix of effect measure with objective weight *k*.

To obtain the objective weights, first of all find the positive and negative ideal vector of effect measure $v_i^{k+} = \max_j r_{ij}^{k}$ and $v_i^{k-} = \min_j r_{ij}^{k}$ respectively thereafter achieve comprehensive matrix of effect measure and the solution of this single objective optimization problem using standard technique and thereafter compromise solution is obtained for MOTP. Here we have utilized LINGO software to obtain the solution.

The process algorithm is described below.

VII. *DEVELOPED* ALGORITHM

Step 1: Structure situation set $S = \{s_{ij} = (a_i, b_j) \mid a_i \in A, b_j \in B\}$ according to case set $A = \{a_1, a_2, ..., a_n\}$ and counter set $B = \{b_1, b_2, ..., b_m\}$.

Step 2: Find the lower effect measure and upper effect measure for objective $k = 1,2,....,s$ and consistent matrix of effect measure.

Step 3: Subtract each value from 1 of consistent matrix of effect measure under target $k = 1,2,....,s$.

Step 4: Find the positive and negative ideal vector of effect measure

Step 5: Find the deviation $d^{+}\left(r_{ij}^{k} - v_i^{k+}\right)$ and $d^{-}\left(r_{ij}^{k} - v_i^{k-}\right)$ for objective $k = 1,2,....,s$.

Step 6: Give the balance coefficient μ $(1 < \mu < 1/2)$ between the objectives and calculate the weight of objectives.

Step 7: Get the comprehensive effect measure matrix using $r_{ij} = \sum_{k=1}^{s} \eta_k r_{ij}^{k}$;

Step 8: Find solutions from a comprehensive matrix of effect measure.

VIII. *ILLUSTRATIVE EXAMPLES*

To demonstrate the proposed method, consider the following example of multi-objective transportation problems.

EXAMPLE 1: A company has three production facilities A_1, A_2 and A_3 with production capacity of 8, 19 and 17 units of a product, respectively. These units are to be shipped to four warehouses B_1, B_2, B_3 and B_4 with requirement of 11, 3, 14 and 16 units, respectively. The transportation costs and transportation time between companies to warehouses are given below [15].

$$U^{1} = \begin{bmatrix} 1 & 2 & 7 & 7 \\ 1 & 9 & 3 & 4 \\ 8 & 9 & 4 & 6 \end{bmatrix} \qquad U^{2} = \begin{bmatrix} 4 & 4 & 3 & 4 \\ 5 & 8 & 9 & 10 \\ 6 & 2 & 5 & 1 \end{bmatrix}$$

SOLUTION:

Step 1: Construct case set, counter set and situation set. Production facilities of company are the case. $T = \{A_1, A_2, A_3\}$ is the case set and A_1, A_2, A_3 on the behalf of the three production facilities of companies (sources). Destination is the counter. $B = \{B_1, B_2, B_3, B_4\}$ is the counter set and B_1, B_2, B_3, B_4 on behalf of the four destinations. Situation set $S = \{s_{ij} = (a_i, d_j) \mid a_i \in T, d_j \in D\}$ is structured by T and D and construct effect measure matrix under two decision-making goals such as time and cost are given below.

$$U^{1} = \begin{bmatrix} 1 & 2 & 7 & 7 \\ 1 & 9 & 3 & 4 \\ 8 & 9 & 4 & 6 \end{bmatrix} \qquad U^{2} = \begin{bmatrix} 4 & 4 & 3 & 4 \\ 5 & 8 & 9 & 10 \\ 6 & 2 & 5 & 1 \end{bmatrix}$$

Step 2: For transporting a product, time, cost and product defectiveness are less than it's the batter, so use lower effect measure. So the lower effect measure for first data $r_{11}^{1} = \dfrac{\min_1 \min_1 (u_{11})}{u_{11}} = \dfrac{1}{1} = 1$. Similarly obtain lower effect measure for each data. Therefore the consistent matrices of effect measure are given below.

$$R^{1} = \begin{bmatrix} 1 & 0.5 & 0.142857 & 0.142857 \\ 1 & 0.11111 & 0.333333 & 0.25 \\ 0.125 & 0.22222 & 0.75 & 0.666667 \end{bmatrix}$$

$$R^2 = \begin{bmatrix} 0.75 & 0.5 & 1 & 0.25 \\ 0.8 & 0.25 & 0.33333 & 0.1 \\ 0.16667 & 0.5 & 0.2 & 1 \end{bmatrix}$$

Step 3: Subtract each value from 1 of consistent matrix of effect measure under target *k*=1, 2.

$$R^1 = \begin{bmatrix} 0 & 0.5 & 0.857143 & 0.857143 \\ 0 & 0.888889 & 0.666667 & 0.75 \\ 0.875 & 0.777778 & 0.25 & 0.333333 \end{bmatrix}$$

$$R^2 = \begin{bmatrix} 0.25 & 0.5 & 0 & 0.75 \\ 0.2 & 0.75 & 0.666667 & 0.9 \\ 0.83333 & 0.5 & 0.8 & 0 \end{bmatrix}$$

Step 4: The negative and the positive ideal vector of effect measure for three objectives are given below:

The negative ideal vector of effect measure for three objectives	The positive ideal vector of effect measure for three objectives
For first objective k=1	
$v_1^{1-} = \min_j (r_{1j}^1) = 0$	$v_1^{1+} = \max_j (r_{1j}^1) = 0.857143$
$v_2^{1-} = \min_j (r_{2j}^1) = 0$	$v_2^{1+} = \max_j (r_{2j}^1) = 0.888889$
$v_3^{1-} = \min_j (r_{3j}^1) = 0.25$	$v_3^{1+} = \max_j (r_{3j}^1) = 0.875$
For first objective k=2	
$v_1^{2-} = \min_j (r_{1j}^2) = 0$	$v_1^{2+} = \max_j (r_{1j}^2) = 0.75$
$v_2^{2-} = \min_j (r_{2j}^2) = 0.2$	$v_2^{2+} = \max_j (r_{2j}^2) = 0.9$
$v_3^{2-} = \min_j (r_{3j}^2) = 0$	$v_3^{2+} = \max_j (r_{3j}^2) = 0.833333$

Step 5:

$$\sum_{i=1}^{4}\sum_{j=1}^{5} d^-(r_{ij}^1 - v_i^{1-}) = 5.75595, \quad \sum_{i=1}^{4}\sum_{j=1}^{5} d^+(r_{ij}^1 - v_i^{1+}) = 3.728175$$

$$\sum_{i=1}^{4}\sum_{j=1}^{5} d^-(r_{ij}^2 - v_i^{2-}) = 5.35, \quad \sum_{i=1}^{4}\sum_{j=1}^{5} d^+(r_{ij}^2 - v_i^{2+}) = 3.783333$$

Step 6: Give the equilibrium coefficient $\mu = 1/3$, and establish the weight of the objectives $\eta_1, \eta_2, ..., \eta_s$ using equation (3). The weights of the objective are $\eta_1 = 0.613278$, $\eta_2 = 0.386722$.

Step 7: The comprehensive matrix of effect measure is got according to $r_{ij} = \sum_{k=1}^{s} \eta_k r_{ij}^k$;

$$r_{ij} = \begin{bmatrix} 0.096675 & 0.5 & 0.525686 & 0.815711 \\ 0.07734 & 0.835181 & 0.66667 & 0.808005 \\ 0.858888 & 0.670361 & 0.462685 & 0.204433 \end{bmatrix}$$

Step 8: Solutions of comprehensive matrix of effect measure using LINGO package.

$$x_{12} = 3, x_{13} = 5, x_{21} = 11, x_{23} = 8, x_{33} = 1, x_{34} = 16$$

$$U^1 = 3\times 2 + 5\times 7 + 11\times 1 + 8\times 3 + 1\times 4 + 16\times 6 = 176$$

$$U^2 = 3\times 4 + 5\times 3 + 11\times 5 + 8\times 9 + 1\times 5 + 16\times 1 = 175$$

COMPARISON

Wang Zheng-Xin, Chen Bing [15]	M. I. Moussa [8]	Developed Method
170	160	176
190	195	175

EXAMPLE 2: The data is collected by a person who supplies a product to different companies after taking it from different origins. There are four different suppliers named as A_1, A_2, A_3 and A_4 and four demand destinations namely B_1, B_2, B_3 and B_4. How much amount of material is supplied from different origins to all other demand destinations so that total cost of transportation and time of transportation is minimum? [10].

Supplies: $a_1 = 21, a_2 = 24, a_3 = 18, a_4 = 30$

Demands: $b_1 = 15, b_2 = 22, b_3 = 26, b_4 = 30$

$$U^1 = \begin{bmatrix} 24 & 29 & 18 & 23 \\ 33 & 20 & 29 & 32 \\ 21 & 42 & 12 & 20 \\ 25 & 30 & 19 & 24 \end{bmatrix} \quad U^2 = \begin{bmatrix} 14 & 21 & 18 & 13 \\ 24 & 13 & 21 & 23 \\ 12 & 30 & 9 & 11 \\ 13 & 22 & 19 & 14 \end{bmatrix}$$

SOLUTION:

Solution of comprehensive matrix of effect measure using LINGO package.

$$x_{13} = 6, x_{14} = 15, x_{22} = 22, x_{23} = 2, x_{33} = 18, x_{41} = 15, x_{44} = 15$$

$$U^1 = 6\times 18 + 15\times 23 + 22\times 20 + 2\times 29 + 18\times 12 + 15\times 25 + 15\times 24 = 1902$$

$$U^2 = 6\times 18 + 15\times 13 + 22\times 13 + 2\times 21 + 18\times 9 + 15\times 13 + 15\times 14 = 1198$$

COMPARISON

M. Zangiabadi and H. R. Maleki [10]	M. Zangiabadi and H. R. Maleki [10]	Developed Method
1900	1898	1902
1279	1286	1198

EXAMPLE 3: The data is accumulated by a person who supplies a product to different companies after taking it from different origins. There are three different suppliers namely T_1, T_2, T_3 and three destinations namely D_1, D_2, D_3. How much quantity of material is supplied from different supply origin to all other demand destinations so that total cost of

transportation and time of transportation is minimum? [2].

Supplies: $a_1 = 14, a_2 = 16, a_3 = 12$

Demands: $d_1 = 10, d_2 = 15, d_3 = 17$

$$U^1 = \begin{bmatrix} 16 & 19 & 12 \\ 22 & 13 & 19 \\ 14 & 28 & 8 \end{bmatrix} \quad U^2 = \begin{bmatrix} 9 & 14 & 12 \\ 16 & 10 & 14 \\ 8 & 20 & 6 \end{bmatrix}$$

SOLUTION:

Solutions of comprehensive matrix of effect measure using LINGO package.

$x_{11} = 10, x_{13} = 4, x_{22} = 15, x_{23} = 1, x_{33} = 12$

$U_1 = 10\times16 + 15\times13 + 4\times12 + 1\times19 + 12\times8 = 518.$

$U_2 = 10\times9 + 15\times10 + 4\times12 + 1\times14 + 12\times6 = 374.$

COMPARISON

M. Zangiabadi and H. R. Maleki [9]	M. Zangiabadi and H. R. Maleki [10]	Proposed Method Results
517.5	517.5	518
376.5	376.5	374

EXAMPLE 4: A company has four production facilities T_1, T_2, T_3 and T_4 with production capacity of 5, 4, 2 and 9 units of a product, respectively. These units are to be transported to five warehouses D_1, D_2, D_3, D_4 and D_5 with requirement of 4, 4, 6, 2 and 4 units, respectively. The transportation costs, transportation time and product defectiveness between companies to warehouses are given below [7].

$$U^1 = \begin{bmatrix} 9 & 12 & 9 & 6 & 9 \\ 7 & 3 & 7 & 7 & 5 \\ 6 & 5 & 9 & 11 & 3 \\ 6 & 8 & 11 & 2 & 2 \end{bmatrix} U^2 = \begin{bmatrix} 2 & 9 & 8 & 1 & 4 \\ 1 & 9 & 9 & 5 & 2 \\ 8 & 1 & 8 & 4 & 5 \\ 2 & 8 & 6 & 9 & 8 \end{bmatrix} U^3 = \begin{bmatrix} 2 & 4 & 6 & 3 & 6 \\ 4 & 8 & 4 & 9 & 2 \\ 5 & 3 & 5 & 3 & 6 \\ 6 & 9 & 6 & 3 & 1 \end{bmatrix}$$

SOLUTION:

Solutions of comprehensive matrix of effect measure using LINGO package.

$x_{12} = 2, x_{14} = 2, x_{15} = 1, x_{21} = 4, x_{32} = 2, x_{43} = 6, x_{45} = 3$

$U_1 = 2\times12 + 2\times6 + 1\times9 + 4\times7 + 2\times5 + 6\times11 + 2\times3 = 155$

$U_2 = 2\times9 + 2\times1 + 1\times4 + 4\times1 + 2\times1 + 6\times6 + 2\times8 = 90$

$U_3 = 2\times4 + 2\times3 + 1\times6 + 4\times4 + 2\times3 + 6\times6 + 2\times1 = 80$

COMPARISON

Yinyan Wang et. al. (Trust Region Algorithm) [16]	Developed Method
144	155
104	90
73	80

IX. CONCLUSIONS

The grey situation decision making theory based approach for the solution of multi objective transportation problem is an alternative approach to acquire the solution. This approach also provides efficient solution.

ACKNOWLEDGMENT

We express our gratitude to the referee for the valuable suggestions and positive comments.

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