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ON SINGLE OBJECTIVE LINEAR MODEL IN CONTROLLING COMMUNICABLE DISEASES BASED ON FUZZY LINEAR PROGRAMMING PROBLEM

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Abstract:

Fuzzy Single objective optimization is the process of optimizing systematically and simultaneously a collection of objective functions with fuzzy variable. In this paper, fuzzy single objective linear model is developed based on fuzzy linear programming to minimize the overall treatment cost, curing time and dosage of medicine by distributing the various treatments to the disease population in order to minimize the human productivity loss. This model will help to the health department in controlling the communicable diseases with minimum cost, time and dosage of medicine.

Key Words: Single Objective Linear Model, Fuzzy Linear Programming Problem, Fuzzy Number & Communicable Diseases

1. Introduction:

Optimization is the act of achieving the best possible result under given circumstances. In design, construction, maintenance etc, professionals have to take decisions. The goal of all such decisions is either to minimize effort or to maximize benefit. The effort or the benefit can be usually expressed as a function of certain design variables. Hence, optimization is the process of finding the conditions given the maximum or the minimum value of the function. In the last three decades many optimization techniques have been invented and successfully applied to optimizations problems in Computer Sciences, Information Technology, Engineering, Chemistry, Biology, Biochemistry, Medicine, Economics etc.

Different modeling techniques are developed to meet the requirements of different types of optimization problems. Major categories of modeling approaches are classical optimization techniques, linear programming, non-linear programming, geometric programming, dynamic programming, integer programming etc. Transportation problem refers to a special class of linear programming problem. Since ancient day, the transportation problem is placing an important role in optimization problems to keep the balance in economic world. Transportation problem was developed in earlier days with single objective and with assumption that supply, demand and cost parameters are exactly known, where as in real life situations, the transportation problem with single-objective and the parameters are not defined precisely. The necessity to optimize more than one objective or goal while satisfying the physical limitations led to the development of single-objective programming methods. Fuzzy single-objective programming satisfies all the requirements of real life situation to optimize the effort and benefit.

In recent years there has been a dramatic increase in the application to optimize techniques to the study the medical problems and the delivery of health care. To indicate the wide spread scope of the subject, some special typical applications in medical discipline are as follows: In 2008, Caetano et al [9] discussed optimal medication in HIV seropositive patient treatment using fuzzy cost function, Crina Grosan et al [3] developed Single-Criteria programming model for medical diagnosis and treatment. In 2009, Denton et al [4] developed the optimization model to optimize the start time of strain therapy for patients with diabetes, Lee et al [7] have discussed about modeling and optimizing the public health infrastructure for emergency response. In 2010, Zhao Jingwei [16] discussed Fuzzy Single-Objective Routing Inventory Problem in recycling infectious medical waste. In 2012, Mason et al [10] developed the revised optimization model to optimizing strain treatment decisions for diabetes patients in the presence of uncertain future adherence. In 2013, Persi Pamela et al [11] proposed a fuzzy optimization technique for the prediction of coronary Heart Disease using Decision Tree. Recently, in 2014, Lee et al [8] developed optimization modeling for emergency department workflow.

This paper proposes Fuzzy Single Objective Linear Programming Model to minimize the overall treatment cost and curing time of a disease population who have to be cured by the various treatments. The main aim of this paper is to develop the single objective optimization model based on Fuzzy Single Objective Linear Programming technique to minimize the human productivity loss by distributing the various treatments to the different disease population so as to minimize the overall treatment cost and to minimize the overall curing time.

2. Preliminaries:

In this section, some basic definitions, generalized triangular fuzzy number, generalized trapezoidal fuzzy numbers and defuzzification, are presented.

Definition 1:

Let R be the set of all real numbers. We assume a fuzzy number $\tilde{A}$ that can be expressed for all $x \in R$ in the form

$$\mu_{\tilde{A}}(x) = \begin{cases} \mu_{\tilde{A}_L}(x) & a \le x \le b \\ w & b \le x \le c \\ \mu_{\tilde{A}_R}(x) & c \le x \le d \\ 0 & \text{otherwise} \end{cases}$$

Where $0 \le w \le 1$ is a constant, a, b, c, d are real numbers, such that $a < b \le c < d$, $\mu_{\tilde{A}_L}(x):[a,b] \to [0,w], \mu_{\tilde{A}_R}(x):[c,d] \to [0,w]$ are two strictly monotonic and continuous functions from R to the close interval $[0,w]$.

Since $\mu_{\tilde{A}_L}(x)$ is continuous and strictly increasing, the inverse function of $\mu_{\tilde{A}_L}(x)$ exists. Similarly $\mu_{\tilde{A}_R}(x)$ is continuous and strictly decreasing, the inverse function of $\mu_{\tilde{A}_R}(x)$ also exist. The inverse functions of $\mu_{\tilde{A}_L}(x)$ and $\mu_{\tilde{A}_R}(x)$ can be denoted by $\mu_{\tilde{A}_L^{-1}}(x)$ and $\mu_{\tilde{A}_R^{-1}}(x)$, respectively. $\mu_{\tilde{A}_L^{-1}}(x)$ and $\mu_{\tilde{A}_R^{-1}}(x)$ are continuous on [0,w] that means both $\int_0^w \mu_{\tilde{A}_L^{-1}}(x)$ and $\int_0^w \mu_{\tilde{A}_R^{-1}}(x)$ exist.

Definition 2:

A fuzzy number $\tilde{A}$ = (a, b, c, d; w) is said to be generalized trapezoidal fuzzy number if its membership function is given by

$$\mu_{\tilde{A}}(x) = \begin{cases} w\left(\dfrac{x-a}{b-a}\right) & a \le x \le b \\ w & b \le x \le c \\ w\left(\dfrac{x-d}{c-d}\right) & c \le x \le d \\ 0 & \text{otherwise} \end{cases}$$

Definition 3:

A fuzzy number $\tilde{A}$ = (a, b, c; w) is said to be generalized triangular fuzzy number if its membership function is given by

$$\mu_{\tilde{A}}(x) = \begin{cases} 0 & x \le a \\ w\left(\dfrac{x-a}{b-a}\right) & a \le x \le b \\ w\left(\dfrac{c-x}{c-b}\right) & b \le x \le c \\ 0 & x > c \end{cases}$$

Defuzzification 4:

The process of converting the fuzzy output to a crisp value is said to be defuzzification. A number of defuzzification techniques are known, including centre-of-area, centre of gravity, and mean of maximums. A common and useful defuzzification technique is center of gravity. This technique was developed by Sugeno in 1985. This is the most commonly used technique and is very accurate. In 2011 and 2012, Phani Bushan Rao and others [12], [14], [15] have proposed a centroid formula for defuzzfication using circumcenter of centroids, orthocenter of centroids, and centroid of centroids. In 2014, Hari Ganesh & Jayakumar [6] have proposed a centroid by using radius of gyration of centroid for ranking of fuzzy numbers. Herewith, a new centroid is proposed for defuzzification based on centroid of centroid which is presentedin Fig. 1.

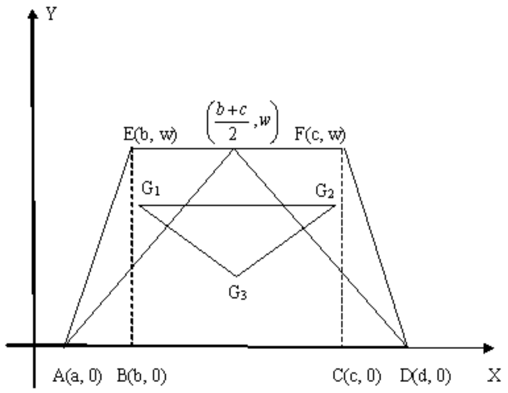

Figure 1: Centroid of centroids

We define the centroid $G(\bar{x}_0, \bar{y}_0)$ of the triangle with vertices G_1, G_2 and G_3 of the generalized trapezoidal fuzzy number $\tilde{A} = (a, b, c, d; w)$ as

$$G(\bar{x}_0, \bar{y}_0) = \left(\frac{4a + 5b + 5c + 4d}{18}, \frac{5w}{9} \right) \tag{1}$$

Its Ranking Function is defined as $$R(\tilde{A}) = \frac{4a + 5b + 5c + 4d}{18} \tag{2}$$

As a special case, for triangular fuzzy number $\tilde{A} = (a, b, d; w)$, i.e., $c = b$ the centroid of Centroids is given by

$$G(\bar{x}_0, \bar{y}_0) = \left(\frac{2a + 5b + 2d}{9}, \frac{5w}{9} \right) \tag{3}$$

Its Ranking Function is defined as

$$R(\tilde{A}) = \frac{2a + 5b + 2d}{9} \tag{4}$$

3. Proposed Single Objective Linear Model in Controlling Communicable Diseases:

In this section, a Fuzzy Single Objective Linear Programming Model is proposed based on single objective fuzzy transportation model for computing minimum treatment cost and curing time of a disease population affected by various communicable diseases in order to minimize the human productivity loss.

This model is concerned with finding the overall minimum treatment cost and curing time of a disease population affected by various communicable diseases which are to be cured by various treatments in a region. The data of the model include

- ✓ The size of patients affected by each disease to be taken the treatment and the total availability of various treatments in a particular region.
- ✓ The unit treatment cost and curing time (i.e. treatment cost and curing time per patient) of the disease.

The objective is to determine how the various treatments may be distributed to the different disease population so as to minimize the overall treatment cost and to minimize the curing time. Therefore, the decision variables are:

x_{ij} = the affordability of the j^{th} treatment to the i^{th} disease, where i = 1, 2, ……., m and j = 1, 2, ……., n.

That is a set of m × n variables.

In order to minimize the treatment cost and period, the following problems must be solved

Definition 5: The Objective Function

Consider the size of patients to be taken the treatment i who have been affected by disease j. For any i and any j, the unit treatment cost is c_{ij}, unit curing time t_{ij}, unit dosage d_{ij}, affordability of the treatment to the disease x_{ij}. Since we assume that the cost and time functions are linear, the total treatment cost, total curing time and total dosage is given by $c_{ij}x_{ij}$, $t_{ij}x_{ij}$ and $d_{ij}x_{ij}$ respectively. Summing over all i and all j now yields the overall treatment cost, curing time and dosage for all disease – treatment combinations. That is, our objective functions are

$$\text{Minimize } \tilde{Z} = \sum_{i=1}^{m}\sum_{j=1}^{n}\tilde{c}_{ij}x_{ij}$$

$$\text{Minimize } \tilde{Z} = \sum_{i=1}^{m}\sum_{j=1}^{n}\tilde{t}_{ij}x_{ij}$$

$$\text{Minimize } \tilde{Z} = \sum_{i=1}^{m}\sum_{j=1}^{n}\tilde{d}_{ij}x_{ij}$$

Definition 6: The Constraints

Consider treatment i, total affordability of this treatment for the various given diseases in the region is the sum $x_{i1} + x_{i2} + \ldots\ldots\ldots + x_{in}$. Since the availability of this treatment for various diseases in the region is a_i, the affordability of this treatment for the various given diseases cannot exceed a_i.

$$\text{(i.e.) } \sum_{j=1}^{n} x_{ij} \le a_i \text{ for i = 1,2,……,m}$$

Consider disease j. the total affordability of various given treatments for this disease in the region is the sum $x_{1j} + x_{2j} + \ldots\ldots + x_{mj}$. Since the total size of patients affected by this disease to be taken the treatment is b_j, the total affordability of various treatments should not be less than b_j.

$$\text{(i.e.) } \sum_{i=1}^{m} x_{ij} \ge b_j \text{ for j = 1,2,……,n}$$

where $x_{ij} \ge 0$ for all i and j

The above implies that the total availability of various given treatments for various given diseases $\sum_{i=1}^{m} a_i$ is greater than or equal to the total number of patients affected by the various given diseases $\sum_{j=1}^{n} b_j$. When the total availability of various given treatments is equal to the total number of patients affected by the various given diseases (i.e. $\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j$) then the model is said to be balanced. In a balanced model, each of the constraints is an equation:

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

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

A model in which total availability of various given treatments and total number of patients affected by the various given diseases are unequal is called unbalanced. It is always possible to balance an unbalanced problems.

The fuzzy problems, in which the treatment cost c_{ij} , curing time t_{ij}, dosage d_{ij} total availability of treatment a_i and total number of patients to be taken the treatment b_j quantities are fuzzy quantities, can be formulated as follows:

$$\text{Minimize } \tilde{Z} = \sum_{i=1}^{m}\sum_{j=1}^{n}\tilde{c}_{ij}x_{ij}$$

$$\text{Minimize } \tilde{Z} = \sum_{i=1}^{m}\sum_{j=1}^{n}\tilde{t}_{ij}x_{ij}$$

$$\text{Minimize } \tilde{Z} = \sum_{i=1}^{m}\sum_{j=1}^{n}\tilde{d}_{ij}x_{ij}$$

Subject to $\sum_{j=1}^{n} x_{ij} \leq \tilde{a}_i$ for i = 1,2,……,m

and $\sum_{i=1}^{m} x_{ij} \geq \tilde{b}_j$ for j = 1,2,……,n

where $x_{ij} \geq 0$ for all i and j

This fuzzy problems is explicitly represented in Table I

4. Application:

Communicable diseases are diseases that are as a result of the causative organism spreading from one person to another. They are among the major causes of illnesses in many countries. These diseases affect people of all ages but more so children due to their exposure to environmental conditions that support the spread. Communicable diseases are preventable base on interventions placed on various levels of transmission of the disease. Health Departments have an important role to play in the control of these diseases by applying effective and efficient management, prevention and control measures.

In Thanjavur Region, the availability of various treatments like Allopathy (T_1), Ayurvedic (T_2), Homeopathy (T_3) and Unani (T_4) for all type of diseases are (50000,52000,55000), (31000,34000,37000), (10500,12500,14500), and (5500,7500,9500) respectively. Moreover, the size of patients affected by the communicable diseases in winter season like Dengue (D_1), Malaria (D_2) and Tuberculosis (D_3) are (21500,22500,25500), (14250,17250,19500), and (10250,12450,15500) respectively. Treatment cost and curing time for all above said treatment - disease combination per patient are given in Table II. The data are collected from the Department of Medical and Rural Health Services at Thanjavur District.

Table 1: Fuzzy Model for Optimization of Cost and Time of Treatment of Diseases

Treatments / Diseases	D_1	D_2	.....	D_j	.....	D_n	Supply (availability of treatment T_i)
T_1	$\tilde{c}_{11}$	$\tilde{c}_{12}$	.....	$\tilde{c}_{1j}$	.....	$\tilde{c}_{1n}$	$\tilde{a}_1$
T_2	$\tilde{c}_{21}$	$\tilde{c}_{22}$	.....	$\tilde{c}_{2j}$	.....	$\tilde{c}_{2n}$	$\tilde{a}_2$
⋮			⋮		⋮		⋮
T_i	$\tilde{c}_{i1}$	$\tilde{c}_{i2}$	.....	$\tilde{c}_{ij}$	.....	$\tilde{c}_{in}$	$\tilde{a}_i$
⋮			⋮		⋮		⋮
T_m	$\tilde{c}_{m1}$	$\tilde{c}_{m2}$	.....	$\tilde{c}_{mj}$	.....	$\tilde{c}_{mn}$	$\tilde{a}_m$
Demand (no. of patients affected by the disease D_j to be taken the treatment)	$\tilde{b}_1$	$\tilde{b}_2$	.....	$\tilde{b}_j$	.....	$\tilde{b}_n$	

Treatments / Diseases	D_1	D_2	.....	D_j	.....	D_n	Supply (availability of treatment T_i)
T_1	$\tilde{t}_{11}$	$\tilde{t}_{12}$	.....	$\tilde{t}_{1j}$	.....	$\tilde{t}_{1n}$	$\tilde{a}_1$
T_2	$\tilde{t}_{21}$	$\tilde{t}_{22}$	.....	$\tilde{t}_{2j}$	.....	$\tilde{t}_{2n}$	$\tilde{a}_2$
⋮			⋮		⋮		⋮
T_i	$\tilde{t}_{i1}$	$\tilde{t}_{i2}$	.....	$\tilde{t}_{ij}$	.....	$\tilde{t}_{in}$	$\tilde{a}_i$
⋮			⋮		⋮		⋮
T_m	$\tilde{t}_{m1}$	$\tilde{t}_{m2}$	.....	$\tilde{t}_{mj}$	.....	$\tilde{t}_{mn}$	$\tilde{a}_m$
Demand (no. of patients affected by the disease D_j to be taken the treatment)	$\tilde{b}_1$	$\tilde{b}_2$	.....	$\tilde{b}_j$	.....	$\tilde{b}_n$	

Treatments / Diseases	D_1	D_2	.....	D_j	.....	D_n	Supply (availability of treatment T_i)
T_1	$\tilde{d}_{11}$	$\tilde{d}_{12}$	.....	$\tilde{d}_{1j}$	.....	$\tilde{d}_{1n}$	$\tilde{a}_1$
T_2	$\tilde{d}_{21}$	$\tilde{d}_{22}$	.....	$\tilde{d}_{2j}$	.....	$\tilde{d}_{2n}$	$\tilde{a}_2$
⋮			⋮		⋮		⋮
T_i	$\tilde{d}_{i1}$	$\tilde{d}_{i2}$	.....	$\tilde{d}_{ij}$	.....	$\tilde{d}_{in}$	$\tilde{a}_i$
⋮			⋮		⋮		⋮
T_m	$\tilde{d}_{m1}$	$\tilde{d}_{m2}$	.....	$\tilde{d}_{mj}$	.....	$\tilde{d}_{mn}$	$\tilde{a}_m$
Demand (no. of patients affected by the disease D_j to be taken the treatment)	$\tilde{b}_1$	$\tilde{b}_2$	.....	$\tilde{b}_j$	.....	$\tilde{b}_n$	

Table 2: Treatment Cost & Time per Patient

Treatment	Disease	Treatment Cost per Patient (in Rupees)	Curing Time per Patient (in days)	Dosage per Patient (in gms) (per course)
Allopathy	Dengue	(2700,3500,3600)	(31,35,37)	(5, 6, 7)
	Malaria	(2100,2500,2800)	(20,22,25)	(8, 10, 12)
	Tuberculosis	(8300,8500,9100)	(250,270,300)	(450, 500, 550)
Ayurvedic	Dengue	(1700,2000,2300)	(19,20,24)	(100, 300, 500)
	Malaria	(2900,3200,3400)	(29,30,34)	(500, 550, 600)
	Tuberculosis	(4600,4800,5100)	(90,120,130)	(1000, 1500, 2000)
Homeopathy	Dengue	(4000,4200,4500)	(70,90,110)	(0.5, 0.7, 1.0)
	Malaria	(4400,4800,5000)	(55,75,95)	(1, 1.5, 2)
	Tuberculosis	(3700,4100,4300)	(325,345,355)	(40, 45, 50)
Unani	Dengue	(3500,3800,4000)	(100,120,130)	(200, 300, 400)
	Malaria	(3800,4100,4400)	(60,90,120)	(400, 470, 500)
	Tuberculosis	(5300,5500,5700)	(400,420,450)	(1000, 1250, 1500)

Table 3: Unbalanced Table with Fuzzy Treatment Cost, Fuzzy Curing Time and Fuzzy dosage

Treatments / Diseases	Dengue (D_1)	Malaria (D_2)	Tuberculosis (D_3)	Supply (availability of treatment T_j)
Allopathy (T_1)	(2700,3500,3600)	(2100,2500,2800)	(8300,8500,9100)	(50000,52000,55000)
Ayurvedic (T_2)	(1700,2000,2300)	(2900,3200,3400)	(4600,4800,5100)	(31000,34000,37000)
Homeopathy (T_3)	(4000,4200,4500)	(4400,4800,5000)	(3700,4100,4300)	(10500,12500,14500)
Unani (T_4)	(3500,3800,4000)	(3800,4100,4400)	(5300,5500,5700)	(5500,7500,9500)
Demand (no. of patients affected by the disease D_i to be taken the treatment)	(21500,22500,25500)	(14250,17250,19500)	(10250,12450,15500)	

Treatments / Diseases	Dengue (D_1)	Malaria (D_2)	Tuberculosis (D_3)	Supply (availability of treatment T_j)
Allopathy (T_1)	(31,35,37)	(20,22,25)	(250,270,300)	(50000,52000,55000)
Ayurvedic (T_2)	(19,20,24)	(29,30,34)	(90,120,130)	(31000,34000,37000)
Homeopathy (T_3)	(70,90,110)	(55,75,95)	(325,345,355)	(10500,12500,14500)
Unani (T_4)	(100,120,130)	(60,90,120)	(400,420,450)	(5500,7500,9500)
Demand (no. of patients affected by the disease D_i to be taken the treatment)	(21500,22500,25500)	(14250,17250,19500)	(10250,12450,15500)	

Treatments / Diseases	Dengue (D_1)	Malaria (D_2)	Tuberculosis (D_3)	Supply (availability of treatment T_j)
Allopathy (T_1)	(5, 6, 7)	(8, 10, 12)	(450, 500, 550)	(50000,52000,55000)
Ayurvedic (T_2)	(100, 300, 500)	(500, 550, 600)	(1000, 1500, 2000)	(31000,34000,37000)
Homeopathy (T_3)	(0.5, 0.7, 1.0)	(1, 1.5, 2)	(40, 45, 50)	(10500,12500,14500)
Unani (T_4)	(200, 300, 400)	(400, 470, 500)	(1000, 1250, 1500)	(5500,7500,9500)
Demand (no. of patients affected by the disease D_i to be taken the treatment)	(21500,22500,25500)	(14250,17250,19500)	(10250,12450,15500)	

Table 4: Unbalanced Table with Treatment Cost, Curing Time and dosage

Treatments / diseases	Dengue (D_1)	Malaria (D_2)	Tuberculosis (D_3)	Supply (availability of treatment T_j)
Allopathy (T_1)	3344	2478	8589	52222
Ayurvedic (T_2)	2000	3178	4822	34000
Homeopathy (T_3)	4222	4756	4056	12500
Unani (T_4)	3778	4100	5500	7500
Demand (no. of patients affected by the disease D_i to be taken the treatment)	22944	17083	12639	

Treatments / diseases	Dengue (D_1)	Malaria (D_2)	Tuberculosis (D_3)	Supply (availability of treatment T_j)
Allopathy (T_1)	35	22	272	52222
Ayurvedic (T_2)	21	31	116	34000
Homeopathy (T_3)	90	75	343	12500
Unani (T_4)	118	90	422	7500
Demand (no. of patients affected by the disease D_i to be taken the treatment)	22944	17083	12639	

Treatments / diseases	Dengue (D_1)	Malaria (D_2)	Tuberculosis (D_3)	Supply (availability of treatment T_j)
Allopathy (T_1)	6	10	500	52222
Ayurvedic (T_2)	300	550	1500	34000
Homeopathy (T_3)	0.7	1.5	45	12500
Unani (T_4)	300	461	1250	7500
Demand (no. of patients affected by the disease D_i to be taken the treatment)	22944	17083	12639	

Table 5: Balanced Table with Treatment Cost and Curing Time

Treatments / Diseases	Dengue (D_1)	Malaria (D_2)	Tuberculosis (D_3)	(D_4)	Supply (availability of treatment T_j)
Allopathy (T_1)	3344	2478	8589	0	52222
Ayurvedic (T_2)	2000	3178	4822	0	34000
Homeopathy (T_3)	4222	4756	4056	0	12500
Unani (T_4)	3778	4100	5500	0	7500
Demand (no. of patients affected by the disease D_i to be taken the treatment)	22944	17083	12639	53556	106222

Treatments / Diseases	Dengue (D_1)	Malaria (D_2)	Tuberculosis (D_3)	(D_4)	Supply (availability of treatment T_j)
Allopathy (T_1)	35	22	272	0	52222
Ayurvedic (T_2)	21	31	116	0	34000
Homeopathy (T_3)	90	75	343	0	12500
Unani (T_4)	118	90	422	0	7500
Demand (no. of patients affected by the disease D_i to be taken the treatment)	22944	17083	12639	53556	106222

Treatments / Diseases	Dengue (D_1)	Malaria (D_2)	Tuberculosis (D_3)	(D_4)	Supply (availability of treatment T_j)
Allopathy (T_1)	6	10	500	0	52222
Ayurvedic (T_2)	300	550	1500	0	34000
Homeopathy (T_3)	0.7	1.5	45	0	12500
Unani (T_4)	300	461	1250	0	7500
Demand (no. of patients affected by the disease D_i to be taken the treatment)	22944	17083	12639	53556	106222

Let us consider a optimization problems in Table III with rows representing treatments Allopathy (T_1), Ayurvedic (T_2), Homeopathy (T_3) and Unani (T_4) and column representing communicable diseases Dengue (D_1), Malaria (D_2) and Tuberculosis (D_3) which are affected in the winter season at Thanjavur Region.

Using the ranking function in equation (4), the values of $R(\tilde{c}_{ij})$, $R(\tilde{t}_{ij})$, $R(\tilde{a}_i)$ and $R(\tilde{b}_j)$ for all i and j are calculated and given in Table IV. The problems in Table IV is unbalanced. For make it as a balanced one, the dummy column is introduced and is given in Table V.

The crisp single-objective transportation problems given in Table V is converted into the following crisp linear programming problems

Using TORA software, the crisp linear programming problems is solved to find the optimum solution which is as follows:

The overall minimum fuzzy treatment cost and fuzzy curing time and dosage are obtained as follows:

Overall Minimum Fuzzy Treatment Cost

= ₹ (135434900, 152470800, 165312300)

Overall Minimum Fuzzy Curing Time

= (5006353, 5300550, 5587048) days

Overall Minimum Dosage

= (11474900, 17049850, 22624800) gms

After defuzzification, by using the ranking function in eqn. (4), the overall minimum treatment cost and curing time respectively are ₹ 151538711, 5298839 days and overall minimum dosage is 17049850 gms.

5. Conclusion:

In single-objective optimization problems, the problems of minimizing the total cost and time of transportation is studied as single-objective transportation problems since long time and is well known in which time – cost minimization problems has been studied by many authors. In 1977, Bhatia [1] and others have given a procedure for time minimization in transportation problem. In 1981, Prakash [13] introduced transportation problem with objectives to minimize total cost and duration of transportation. Recently, in 2010, Chakraborty Ananya [2] has proposed a method for the minimization of transportation cost as well as time of transportation when the demand, supply and transportation cost are fuzzy. In 2014, Hari Ganesh [5] proposed a fuzzy linear programming model for minimizing agricultural production cost. Hence, in this paper, Fuzzy Single Objective Linear Programming Model has been developed in order to distribute the various treatments to the different disease population so as to minimize the overall treatment cost, curing time and dosage by employing the supply, demand, cost and time parameters as triangular fuzzy numbers. As minimizing the overall treatment cost, curing time and dosage, the human productivity loss may be minimized. This work will be an innovative application of fuzzy single objective linear programming technique in healthcare.

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