International Journal of Current Research and Modern Education (IJCRME)
Impact Factor: 6.725, ISSN (Online): 2455 - 5428
(www.rdmodernresearch.com) Volume 2, Issue 1, 2017

ON FUZZY OPTIMIZATION MODELING IN HEALTHCARE ANALYSIS BASED ON LINEAR PROGRAMMING PROBLEM

Dr. A. Venkatesh* & G. Sivakumar**
Department of Mathematics, A.V.V.M Sri Pushpam College (Autonomous), Poondi, Thanjavur, Tamilnadu

Cite This Article: Dr. A. Venkatesh & G. Sivakumar, "On Fuzzy Optimization Modeling in Healthcare Analysis Based on Linear Programming Problem", International Journal of Current Research and Modern Education, Volume 2, Issue 1, Page Number 124-131, 2017.

Abstract:

In most of the developing countries particularly in India, there are a limited number of health care facilities, especially medicines, per head of population. The Indian population has been exposed to a range of communicable diseases, nutritional issues, and medical care facilities. In this paper, fuzzy optimization model is developed based on linear programming problem 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.

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

1. Introduction:

In most of the developing countries particularly in India, there are a limited number of health care facilities, especially medicines, per head of population. The Indian population has been exposed to a range of communicable diseases, nutritional issues, and medical care facilities. Other than allopathic medicine, different forms of scientifically appropriate and acceptable systems of indigenous medicine, such as the Ayurveda, Unani, Siddha, and Homeopathy system, are practiced in different parts of the Indian nation. These systems of medicines are help to meet the challenge of the shortage of health care facilities and to strengthen the health care service delivery system.

In recent years there has been a dramatic increase in the application to optimize techniques to the study the health care facilities and to strengthen the health care service delivery system. To indicate the wide spread scope of the subject, some special typical applications in healthcare analysis are given below:

In 1994, Mangasarian et al [11] developed linear programming model for breast cancer diagnosis and prognosis. In 1994, Street [22] has used linear programming based machine learning techniques to increase the accuracy and objectivity of breast cancer diagnosis and prognosis. In 1995, Huang and Thomson [9] have addressed a linear programming problem for patient's waiting time. In 1997, Kwak and Lee [10] proposed a linear goal programming model for human resource allocation in a healthcare organization. In 2002, Earnshaw et al. [3] designed a linear programming model to select interventions for preventing complications of Type-2 diabetes and maximising the quality-adjusted life years subject to budget and equity constraints. In 2003, Flessa [5] developed a linear-programming model to analyse the optimum allocation of budget to a set of healthcare resources (Prevention, Dispensaries, Health Centres, District Hospitals and Regional Hospital) in Tanzania. In 2004, Holder [8] gave a comprehensive discussion of linear- and non-linear programming models for Intensity Modulated Radiotherapy Treatment (IMRT). In 2006, Harris [7] used a non-linear optimization model to determine resource allocation in a multiple-site needle exchange programme to achieve the largest possible reduction in new HIV infections at a minimum cost. In 2007, Earnshaw et al. [4] addressed a resource allocation problem for HIV prevention and developed a linear-programming model for improving on past allocation strategies. In 2012, salami [19] has compared the solution methodologies of both the linear and multi objective model in arriving at policy guided decision making in health care industry. In 2013, Ming Liu and Jing Liang [14] proposed a dynamic optimization model for allocating medical resources in epidemic controlling. In 2014, Satheesh Kumar et al. [20] has analyzed the nurse scheduling process in practice, and proposed linear programming models and heuristics to improve both the process and the quality of the resulting nurse schedule. In 2014, K. Boah [2] has analyzed nurse scheduling at Navrongo War Memorial Hospital in Ghana using linear programming and discuss how the hospital could schedule its nurses for better health care delivery. In 2015, Agarana [1] applied linear programming technique to healthcare pathways in order to maximize healthcare delivery. In 2015, Safiye Turgay and Harun Tas_kın [18] proposed fuzzy goal programming model using exponential membership function to solve health care system for optimal efficient management. Subsequently, the model has been illustrated using the data provided by a healthcare organization in Turkey-Sakarya private hospital.

Moreover, there are many studies which are focused on balance diet and chronic disease such as diet planning for humans using linear programming technique. In 1993, Sklan and Dariel [21] have done a research about human diet planning using mixed-integer linear programming. In 2011, Mamat et al. [12] has used fuzzy linear programming technique for optimizing human diet problem with fuzzy price and in 2012 they [13] have also used the same technique for diet planning and nutrient requirements. In 2012, Mustafa Mamat et al. [15] developed a fuzzy linear programming model for a balanced diet planning corresponding to each user takes a variety of foods for a few times per day.

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

2. Preliminaries:

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

A. Definition:

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.

B. Definition:

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

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

C. Definition:

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

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

D. Defuzzification:

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 [16], [17], [23] 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 presented in Fig. 1.

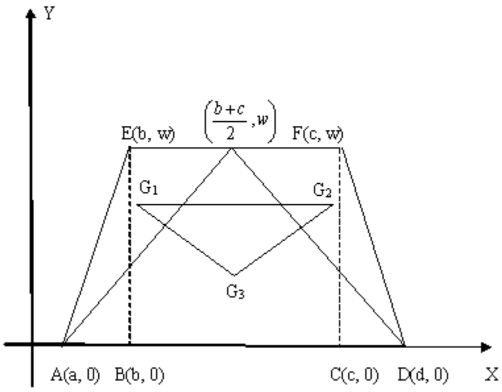

Figure 1: Centroid of centroids

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

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

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

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

Its Ranking Function is defined as

$$R(\tilde{A}) = \frac{2a + 5b + 2d}{9} \qquad \text{------}\rightarrow \ (4)$$

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

In this section, a Fuzzy Multi Objective Linear Programming Model is proposed based on multi 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 problem must be solved

E. 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

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

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

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

Then it is a two objective transportation using the weights of the objectives which consider the priorities of the objective.

$$\tilde{Z} = w_1\sum_{i=1}^{m}\sum_{j=1}^{n}\tilde{c}_{ij}x_{ij} + w_2\sum_{i=1}^{m}\sum_{j=1}^{n}\tilde{t}_{ij}x_{ij} + w_3\sum_{i=1}^{m}\sum_{j=1}^{n}\tilde{d}_{ij}x_{ij}$$

F. The constraints:

Consider treatment i, total affordability of this treatment for the various given diseases in the region is the sum $x_{i1} + x_{i2} + \ldots\ldots\ldots\ldots + x_{in}$. 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 problem.

The fuzzy problem, 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:

$$\text{Minimize } \tilde{Z} = w_1 \sum_{i=1}^{m} \sum_{j=1}^{n} \tilde{c}_{ij} x_{ij} + w_2 \sum_{i=1}^{m} \sum_{j=1}^{n} \tilde{t}_{ij} x_{ij} + w_3 \sum_{i=1}^{m} \sum_{j=1}^{n} \tilde{d}_{ij} x_{ij}$$

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

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

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

This fuzzy problem 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_j)
T_1	$\tilde{c}_{11}; \tilde{t}_{11}; \tilde{d}_{11}$	$\tilde{c}_{12}; \tilde{t}_{12}; \tilde{d}_{12}$	…..	$\tilde{c}_{1j}; \tilde{t}_{1j}; \tilde{d}_{1j}$	…..	$\tilde{c}_{1n}; \tilde{t}_{1n}; \tilde{d}_{1n}$	$\tilde{a}_1$
T_2	$\tilde{c}_{21}; \tilde{t}_{21}; \tilde{d}_{21}$	$\tilde{c}_{22}; \tilde{t}_{22}; \tilde{d}_{22}$	…..	$\tilde{c}_{2j}; \tilde{t}_{2j}; \tilde{d}_{2j}$	…..	$\tilde{c}_{2n}; \tilde{t}_{2n}; \tilde{d}_{2n}$	$\tilde{a}_2$
T_i	$\tilde{c}_{i1}; \tilde{t}_{i1}; \tilde{d}_{i1}$	$\tilde{c}_{i2}; \tilde{t}_{i2}; \tilde{d}_{i2}$	….	$\tilde{c}_{ij}; \tilde{t}_{ij}; \tilde{d}_{ij}$	…..	$\tilde{c}_{in}; \tilde{t}_{in}; \tilde{d}_{in}$	$\tilde{a}_i$
: ⋮			: ⋮		: ⋮		: ⋮
T_m	$\tilde{c}_{m1}; \tilde{t}_{m1}; \tilde{d}_{m1}$	$\tilde{c}_{m2}; \tilde{t}_{m2}; \tilde{d}_{m2}$	…..	$\tilde{c}_{mj}; \tilde{t}_{mj}; \tilde{d}_{mj}$	…..	$\tilde{c}_{mn}; \tilde{t}_{mn}; \tilde{d}_{mn}$	$\tilde{a}_m$
Demand (no. of patients affected by the disease D_i 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 and Fuzzy Curing Time

Treatments / Diseases	Dengue (D_1)	Malaria (D_2)	Tuberculosis (D_3)	Supply (availability of treatment T_j)
Allo-pathy (T_1)	(2700,3500,3600) (31,35,37) (5, 6, 7)	(2100,2500,2800) (20,22,25) (8, 10, 12)	(8300,8500,9100) (250,270,300) (450, 500, 550)	(50000,52000, 55000)
Ayur-vedic (T_2)	(1700,2000,2300) (19,20,24) (100, 300, 500)	(2900,3200,3400) (29,30,34) (500, 550, 600)	(4600,4800,5100) (90,120,130) (1000, 1500, 2000)	(31000,34000, 37000)
Homeo-pathy (T_3)	(4000,4200,4500) (70,90,110) (0.5, 0.7, 1.0)	(4400,4800,5000) (55,75,95) (1, 1.5, 2)	(3700,4100,4300) (325,345,355) (40, 45, 50)	(10500,12500, 14500)
Unani (T_4)	(3500,3800,4000) (100,120,130) (200, 300, 400)	(3800,4100,4400) (60,90,120) (400, 470, 500)	(5300,5500,5700) (400,420,450) (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 and Curing Time

Treatments / diseases	Dengue (D_1)	Malaria (D_2)	Tuberculosis (D_3)	Supply (availability of treatment T_j)
Allopathy (T_1)	3344 35 6	2478 22 10	8589 272 500	52222
Ayurvedic (T_2)	2000 21 300	3178 31 550	4822 116 1500	34000
Homeopathy (T_3)	4222 90 0.7	4756 75 1.5	4056 343 45	12500
Unani (T_4)	3778 118 300	4100 90 461	5500 422 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 35 6	2478 22 10	8589 272 500	0 0 0	52222
Ayurvedic (T_2)	2000 21 300	3178 31 550	4822 116 1500	0 0 0	34000
Homeopathy (T_3)	4222 90 0.7	4756 75 1.5	4056 343 45	0 0 0	12500
Unani (T_4)	3778 118 300	4100 90 461	5500 422 1250	0 0 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 an optimization problem 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 problem 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 multi-objective transportation problem given in Table V is converted into the following crisp linear programming problem

Minimize $(688.1)x_{11} + (509.6)x_{12} + (2003.8)x_{13} + (0)x_{14} + (500.5)x_{21} + (816.1)x_{22} + (1472.4)x_{23} + (0)x_{24} + (889.61)x_{31} + (989.15)x_{32} + (996.2)x_{33} + (0)x_{34} + (904.6)x_{41} + (1003.3)x_{42} + (1686)x_{43} + (0)x_{44}$.

Subject to: $x_{11} + x_{21} + x_{31} + x_{41} = 22944$ $\quad x_{12} + x_{22} + x_{32} + x_{42} = 17083$

$x_{13} + x_{23} + x_{33} + x_{43} = 12639$ $\quad x_{14} + x_{24} + x_{34} + x_{44} = 53556$

$x_{11} + x_{12} + x_{13} + x_{14} = 52222$ $\quad x_{21} + x_{22} + x_{23} + x_{24} = 34000$

$x_{31} + x_{32} + x_{33} + x_{34} = 12500$ $\quad x_{41} + x_{42} + x_{43} + x_{44} = 7500$

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

x_{12}=17083, x_{21}=22944, x_{33}=12500, x_{14}=35139, x_{23}=139, x_{24}=10917, x_{44}=7500.

The overall minimum fuzzy treatment cost and fuzzy curing time 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:

This paper has developed Fuzzy Multi Objective Linear Programming Model 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 multi objective linear programming technique in healthcare.

6. References:

1. Agarana, M.C., Optimization of health care pathways in covenant university health care using linear programming model, Far east journal of applied mathematics, Vol. 91, No.3, pp.215 – 228, 2015.
2. Boah, D. K., Nurse Scheduling at Navrongo War Memorial Hospital in Ghana Using Linear Programming, Journal of Innovative Technology and Education, Vol.1, No. 1, pp. 25 – 33, 2014.
3. Earnshaw, S.R., et. al., Optimal allocation of resources across four interventions for type 2 diabetes. Medical Decision Making, Vol. 22, No. 5, pp. 80 – 91, 2002.
4. Earnshaw, S.R., Hicks, K., Richter, A., Honeycutt, A., A linear programming model for allocating HIV prevention funds with state agencies: A pilot study. Health Care Management Science, Vol. 10, pp. 239–252, 2007.
5. Flessa, S., Priorities and allocation of health care resources in developing countries: A case-study from the Mtwara region, Tanzania. European Journal of Operational Research, Vol. 150, No. 1, pp. 67–80, 2003.
6. Hari Ganesh, A. and Jayakumar, S., (2014), Ranking of Fuzzy Numbers Using Radius of Gyration of Centroids, International Journal of Basic and Applied Sciences, Vol. 3, No. 1, pp 17 – 22, 2014.
7. Harris, Z.K., Efficient allocation of resources to prevent HIV infection among injection drug users: The Prevention Point Philadelphia (PPP) needle exchange program. Health Economics, Vol. 15, No. 2, pp. 147–158, 2006.
8. Holder, A., Radiotherapy treatment design and linear programming, A Handbook of Methods and Applications. Kluwer's International Series, Dordrecht, pp. 741 – 774, 2004.
9. Huang X.M. and Thompson A., Setting up waiting-time targets to satisfy Patients: an application of mathematical programming, IMA Journal Mathematical Medicine and Biology, Vol. 12, No. 304, pp. 235 -247, 1995,.
10. Kwak, N. K., & Lee, C., A linear goal programming model for human resource allocation in a health-care organization, Journal of Medical Systems, Vol. 21, No. 3, 1997.
11. Mangasarian, O. L., et al., Breast Cancer diagnosis and prognosis via linear programming, Mathematical Programming Technical Report, pp 1 – 9, 1994.
12. Mamat, M., Rokhayati, Y., Noor N.M.M. and Mohd, I., Optimizing human diet problem with fuzzy price using fuzzy linear programming approach, Pakistan Journal of Nutrition, Vol. 10, pp. 594-598, 2011.
13. Mamat, M., Rokhayati, Y., Noor N.M.M. and Mohd, I., Diet Problem and Nutrient Requirement using Fuzzy Linear Programming Approaches. Asian Journal of Applied Sciences, Vol. 5, No. 1, pp. 52-59, 2012.
14. Ming Liu & Jing Liang, Dynamic optimization model for allocating medical resources in epidemic controlling, Journal of Industrial Engineering and Management, Vol. 6, No. 1, pp. 73-88, 2013.
15. Mustafa Mamat et al., Fuzzy Linear Programming Approach in Balance Diet Planning for Eating Disorder and Disease-related Lifestyle, Applied Mathematical Sciences, Vol. 6, No. 103, pp. 5109 – 5118, 2012.

16. Phani Bushan Rao & Ravi Shankar, N., Ranking Fuzzy Numbers with a Distance Method using Circumcenter of centroids and an Index Modality, Advances in Fuzzy Systems, pp. 1 -7, 2011.
17. Ravi Shankar. N., et al., Fuzzy Risk Analysis based on A New Approach of Ranking Fuzzy Numbers using Orthocenter of Centroids, International Journal of Computer Applications, Vol. 42, No. 3, 24 – 36, 2012.
18. Safiye Turgay and Harun Tas_kın, Fuzzy goal programming for healthcare organization, Computers & Industrial Engineering, pp.1 – 15, 2015.
19. Salami, A. O., Comparative analysis of linear and multi-objective model application in a private hospital healthcare planning in Nigeria, American Journal of Social and Management Sciences, Vol. 3, No. 1, pp. 1-7, 2012.
20. Satheesh Kumar, B. et al., A Shift Sequence for Nurse Scheduling Using Linear Programming Problem, IOSR Journal of Nursing and Health Science (IOSR-JNHS), Vol. 3, No. 6, pp. 24-28, 2014.
21. Sklan D. and Dariel I., Diet planning for humans using mixed-integer linear programming, British Journal of Nutrition, Vol. 70, pp. 27-35, 1993.
22. Street, W. N. Cancer Diagnosis and Pronsosis via linear programming based machine learning, Ph.D. Thesis, University of Wisconsin – Madison, 1994.
23. Suresh Babu. S., et al., Ranking Generalized Fuzzy Numbers using centroid of centroids, International Journal of Fuzzy Logic Systems (IJFLS), Vol2, No.3, 17 – 32, 2012.