Section: Research Paper
ISSN 2063-5346

FUZZY TRANSPORTATION PROBLEM METHODOLOGY USING TRAPEZOIDAL FUZZY NUMBERS TO SELECTION THE BEST TREATMENT FOR BLOOD CANCER

Mrs. S.KIRUPAVATHI
Guest Lecturer, Department of Mathematics
Government Arts and Science College, Thennangur, Vandavasi
Email ID : kirupavathiseetharaman@gmail.com.
Dr.M.ARTHI
Assistant Professor Department of Mathematics
Vels Institute of Science and Technology Advanced Studies (VISTAS)
Chennai. Email ID: marthi.sbs@velsuniv.ac.in
DOI: 10.48047/ecb/2023.12.7.298

Abstract

A fuzzy logic can be situated quantitatively represented by conveying a evaluation of relationship in the fuzzy set to each potential speaker in the discourse universe. Any discipline of science, engineering, medicine, or administration cannot eliminate the element of uncertainty. According to research, the built environment has a variety of effects on blood cancer, including direct effects like physical activity as well as indirect effects like housing affordability, job accessibility, social capital, etc. Transportation-related strategies and policies influence the built environment. Such programmes and regulations have a big impact on blood cancer. The implications of mobility choices a blood cancer is gaining more and more attention. Recently, transportation planners and blood cancer specialists started looking for methods to cooperate. To include health in transportation design, two key issues regarding the effects of transportation and blood cancer must be addressed. First, it is impossible to determine with precision how transportation affects human health (Kjelstrom, Kerkhof, Bamer, & McMichael, 2003). Second, because it is subjective and inherently ambiguous, physical, social, and mental well-being cannot be simply measured (Massad, Baros, & Struchinner, 2009). Two different approaches to dealing with uncertainty are mentioned by Goodchild (1999); the first is the use of statistical and probability theory, and the usage of fuzzy sets or fuzzy logic is the second. First method requires an in-depth knowledge of statistical theory. (G.child, 1999, p. 5). In addition, because statistical methods are based on Boolean logic, they do not discourse the uncertainty in the idiosyncratic assessment of strength state (Masad, Baros, & Struchinner, 2009). The primary area of operation research, transportation problem, focuses on the distribution of commodities and services from various supply origins to various demand destinations. Real-world transportation planning frequently involves imprecise/fuzzy decision-making due to insufficient or unavailable knowledge regarding input data and related characteristics, such as supply availability and predicted demand. The treatment for blood cancer has been approximatively solved utilizing the fuzzy transportation issue in this article using fuzzy trapezoidal numbers.

Keywords: Fuzzy, Trapezoidal, FNWCM, FLCM, FVAM, Fuzzy Optimization, Fuzzy LPP & Blood Cancer Ailments

I. INTRODUCTION:

Optimization is a relatively new field of study in mathematics. It has gotten better over the past few decades because of its potential for use in solving problems in the real world. The goal of optimization is to identify and compare all possible solutions in order to identify the optimal one(s). In the 1940s, George Dantzig created linear programming, the first optimization method. In industry, human anatomy, and the natural sciences, fuzzy sets and fuzzy logic are the most crucial mathematical tools for modelling and controlling uncertain systems. When Lotfi A. Zadeh gave his seminar work on fuzzy sets in 1965, he made the initial Fuzzy system proposal. It is possible to distinguish between classical set theory and fuzzy set theory, which states that an object either belongs to a set or it does not. Any set that allows for varying levels of membership in the range [0,1] is said to be fuzzy. In the areas of engineering, business, health-related sciences, natural sciences, computing sciences, etc., fuzzy sets can be used successfully to obtain picture-perfect solutions. We are given a meaningful and effective representation of measuring uncertainties by fuzzy set theory, as well as a meaningful representation of hazy conceptions conveyed in natural languages.

Hutton, B. [HU] and Rodabaugh, SE [Rod] introduced fuzzy numbers in 1975. Fuzzy numbers are the true cornerstone of applied fuzzy set theory. A function with a precise set as its domain can be used to represent any fuzzy integer. [11]A particular "degree of membership" is given to each value in the domain. Decision-making, optimization, and approximative reasoning frequently use fuzzy numbers. Calculations that use fuzzy numbers enable the inclusion of ambiguity in terms of parameters, characteristics, geometry, initial circumstances, etc.

II. PRELIMINARY OF FUZZY TRANSPORTATION

Generalized triangular fuzzy numbers, comprehensive trapezoidal fuzzy figures, and defuzzification are some of the core definitions that are discussed in this section.

Definition: 2.1(Fuzzy Figure)

If the membership function of the fuzzy figure A well-defined on the set of real figure possesses the ensuing characteristics, the relationship occupation $\mu_A: X \to [0,1]$ is said to be fuzzy.

1. A is normal. It resources that there occurs a $x \in X$, such that $\mu_A(x) = 1$.
2. A is curved it resources that for every $p_1, p_2 \in X$
3. $\mu_A(Ap_1 + (1-\lambda)p_2) \geq min(\mu_A(p_1), \mu_A(p_2)), \lambda \in [0,1]$
4. $\mu_A$is superior semi continuous.
5. Supp (A) is constrained, where $max(a) = \{x \in X: \mu_A(x) > [0,1]\}$

ISSN 2063-5346

Definition: 2.2(Triangular fuzzy)

A triangular fuzzy S is a fuzzy number fully quantified by 3-tuples (s_1, s_2, s_3) such that $s_1 \leq s_2 \leq s_3$, with relationship function demarcated as

$$\mu A(x) = \begin{cases} 0, & if\ x \leq s1 \\ \frac{x-s1}{s2-s1}, & if\ 1 \leq x \leq s2 \\ \frac{x-s3}{s3-s2}, & if\ s2 \leq x \leq s3 \\ 0, & if\ x \geq s3 \end{cases} \quad \ldots (2.1)$$

Definition: 2.3(trapezoidal fuzzy figure)

A trapezoidal fuzzy figure Ã is a fuzzy number fully quantified by 4-tuples (s_1, s_2, s_3, s_4) such that $s_1 \leq s_2 \leq s_3 \leq s_4$ with relationship function demarcated as

$$\mu A(x) = \begin{cases} 0, & otherwise \\ \frac{x-s1}{s2-s1}, & if\ s1 \leq x \leq s2 \\ 1 & ,\ if\ s2 \leq x \leq s3 \\ \frac{x-s4}{s4-s3}, & if\ s3 \leq x \leq s4 \end{cases}$$

Definition:2.4(Defuzzification)

Defuzzification is the process of extracting useful information from a fuzzy set. It entails mapping an existing fuzzy package to a new package. We have a thorough set of rules that transform different considerations into confusing choices, such as how to represent involvement in obscure collections. Rules can be created to specify the difference in temperature between a room that is 25° C (cooler) and one that is 38° C for the purpose of cooling (hot). It describes the members of ambiguous sets as a particular outcome or real value.

III. MATHEMATICAL FORMULATION OF FUZZY TRANSPORTATION PROBLEM METHODOLOGY USING TRAPEZOIDAL FUZZY NUMBERS TO SELECTION THE BEST TREATMENT FOR BLOOD CANCER:

This section presents a mathematical formulation of a transportation prototypical with fuzzy time and uncertain cost. Transporting varied quantities of a same homogenous article of trade that are to begin with kept at distinct sources to dissimilar end point while keeping the overall cost of fuzzy transportation to a minimum is the general goal of fuzzy transportation. Let us say there are n end point (n may or may not be equal to m), and destination j requirements fuzzy demand units. There are m suppliers, each of which has fuzzy stream units of a certain article of trade. It is known, directly or indirectly, how much it will cost to send a particular thing from each of the m fonts to each of the n end point in terms of detachment, shipping time, etc. It is considered a fuzzy multi-objective transference problem when the goal of a transference challenge is to reduce fuzzy cost and fuzzy time.

All the restrictions in the Transportation Problem are of the equality kind.

One equation for a transportation issue is as follows:

Section: Research Paper
ISSN 2063-5346

Minimize

$$Z = \sum_{i=1}^{m}\sum_{j=1}^{n} R_{ij}E_{ij} \dots\dots (3.1)$$

subject to

$$Z = \sum_{j=1}^{m} E_{ij} = pi \qquad j = 1,2,3 \dots n$$

$$Z = \sum_{i=1}^{m} E_{ij} = qi \qquad i = 1,2,3 \dots n \qquad \dots\dots\dots\dots(3.2)$$

$E_{ij} \geq 0$ for all i,j

Where the price of moving a unit beginning the i[th] source to the j[th] journey's end is given, and the amount being moved from the i[th] origin to the j[th] end point must be either a positive integer or zero. The existence of a solution to the specified linear programming problem in (1) is clearly a necessary and sufficient condition.

$$\sum_{i=1}^{n} p_i = \sum_{j=1}^{m} q_j \qquad ------(3.3)$$

Uncertainty in Transportation

- The goals of the transportation problems are frequently illogical and incoherent. Furthermore, because of the incomplete information and ambiguity in the many prospective suppliers and settings, cost coefficients in targets are usually illogical.
- Most of these values are determined using a straightforward forecasting process. Hence, using fuzzy rather than crisp algorithms to solve such transportation problems with single and multiple objectives is more effective.
- A fuzzy TP can be pronounced mathematically as surveys:

Minimize

$$z = \sum_{i=1}^{m}\sum_{j=1}^{n} r_{ij}E_{ij} \qquad ------(3.4)$$

Subject to

$$\left.\begin{aligned} &\sum_{j=1}^{n} E_{ij} = \tilde{p}_i && j = 1,2,\dots,n \\ &\sum_{i=1}^{m} E_{ij} = \tilde{q}_j && i = 1,2,\dots,m \\ &E_{ij} \geq 0 && i = 1,2,\dots,m,\ \ j = 1,2,\dots,n\} \end{aligned}\right\} \dots\dots(3.5)$$

Where the supply and demand quantities are ambiguous due to the transit costs. For the fuzzy LPP described mathematically issue stated to have a solution, there is an evident necessary and Sufficient condition that

Section: Research Paper
ISSN 2063-5346

$$\sum_{i=1}^{n} p_i = \sum_{j=1}^{m} q_j \qquad \text{------(3.6)}$$

IV. Suggested Fuzzy Model for Blood Cancer Therapy Planning:

In order to reduce the loss of human productivity, a Fuzzy Multi Detached LP Model is proposed in this section based on a Multi Detached Fuzzy TP Model for calculating the shortest cure time and treatment remedy of a the illness population affected by various Blood cancers. The goal of this model is to determine the total minimum treatment duration and prescription for a disease population affected by different types of blood cancer and need to get various treatments in each area.

- The size of individuals precious by each illness who need to receive treatment and the total number of therapies available in each area are among the model's inputs.
- The disease's unit treatment time and prescription (that is, the treatment time and prescription for each patient).
- The objective is to determine how the various treatments may be distributed to the different disease population to minimize the overall curing time and to minimize the treatment prescription.

Therefore, the decision variables are:

E_{ij} = the affordability of the j^{th} dealing to the i^{th} disease,

That is a set of m × n variable quantity.

The following issue must be resolved in order to reduce the prescription and curing time

The Objective Function:

Consider the number of patients with disease j who will be receiving therapy. For slightly i and any j, the unit dealing time is K_{ij}, the unit prescription time is dij, and the unit cost of the disease's treatment is E_{ij}. The total cure time and total prescription are given by t_{ij} E_{ij} and $d_{ij}E_{ij}$, respectively [9]. The overall cure time and dose for all disease-treatment combinations are now obtained by adding up all i and all j. In other words, our primary goals are

Minimize $Z = w_1 \sum \sum k_{ij} x_{ij} + w_2 \sum \sum d_{ij} x_{ij}$

The Constraints:

Consider treatment i. The total cost of this treatment for all the specified ailments in the area is equal to the sum of $\mathbf{E_{i1} + E_{i2} + \ldots\ldots + E_{in}}$ .The affordability of this treatment for the numerous supplied ailments cannot be greater than p_i due to the availability of this treatment for various diseases in the area.

$$\text{(i.e.)} \sum_{j=1} E_{ij} \leq p_i \text{ for i = 1,2,……,m}$$

Take disease j as an example. The total cost of the available therapies for this condition in the area is equal to the sum of $E_{1j} + E_{2j} + \ldots.. + E_{mj}$. Considering there are b_j total individuals with

Section: Research Paper
ISSN 2063-5346

this disease who need to receive therapy, the total cost of all available treatments should not be less than b_j.

(i.e.) $\sum E_{ij} \geq q_j$ for j = 1,2,......,n Where $E_{ij} \geq 0$ for all i and j

The information above suggests that there are numerous available therapies for numerous ailments.

The total figure of patients exaggerated by the different illnesses listed in $\sum q_j$ is higher than or equal to $\sum p_i$. [6]The model is said to be balanced when the entire figure of patients affected by all the different diseases listed is equal to the total number of treatments available (i.e.$\sum p_i = \sum q_j$). Each constraint in a balanced model is represented by an equation:

.

$$\text{(i.e.) } \sum_{j=1} E_{ij} \leq p_i \text{ for i = 1,2,......,m}$$

$$\text{(i.e.) } \sum E_{ij} \geq q_j \text{ for j = 1,2,......,n Where } E_{ij} \geq 0 \text{ for all i and j}$$

The fuzzy problem, in which the curing time k_{ij}, treatment prescription S_{ij}, total convenience of treatment p_i and total number of patients to be taken the dealingfollows:

$$\text{Min } Z = w_1 \sum\sum k_{ij} x_{ij} + w_2 \sum\sum d_{ij} x_{ij}$$

$$\text{Subject to (i.e.) } \sum E_{ij} \leq p_i$$

$$\text{(i.e.) } \sum E_{ij} \geq q_j \text{ for j = 1,2,......,n Where } E_{ij} \geq 0$$

The following table clearly illustrates this fuzzy situation.

Table 4.1: Fuzzy Model for Optimization of Time and prescription of Treatment of Diseases

Treatments /Diseases	D_1	D_2	…..	D_j	…..	D_n	Supply (availability of treatment K_j)
K_1	$\tilde{K}_{11}; \tilde{d}_{11}$	$\tilde{K}_{12}; \tilde{d}_{12}$	…..	$\tilde{K}_{1j}; \tilde{p}_{1j}$	…..	$\tilde{K}_{1n}; \tilde{p}_{1n}$	$\tilde{p}_1$
K_2	$\tilde{K}_{21}; \tilde{d}_{21}$	$\tilde{K}_{22}; \tilde{d}_{22}$	…..	$\tilde{K}_{2j}; \tilde{d}_{2j}$	…..	$\tilde{K}_{2n}; \tilde{d}_{2n}$	$\tilde{p}_2$
⋮			⋮		⋮		⋮

K_i	$\tilde{K}_{i1}; \tilde{d}_{i1}$	$\tilde{K}_{i2}; \tilde{d}_{i2}$	….	; $\tilde{K}_{ij}; \tilde{d}_{ij}$	…..	$\tilde{K}_{in}; \tilde{d}_{in}$	$\tilde{p}_i$
⋮			⋮		⋮		⋮
K_m	$\tilde{K}_{m1}; \tilde{d}_{m1}$	$\tilde{K}_{m2}; \tilde{d}_{m2}$	…..	$\tilde{K}_{mj}; \tilde{d}_{mj}$	…..	$\tilde{K}_{mn}; \tilde{d}_{mn}$	$\tilde{p}_m$
Demand (no. of patients affected by the disease D_i to betaken the treatment)	$\tilde{q}_1$	$\tilde{q}_2$	…..	$\tilde{q}_j$	…..	$\tilde{q}_n$	

V. ALGORITHM FUZZY TRANSPORTATION PROBLEM IN BLOOD CANCER DISEASE:

The stages to fixing the transportation issue are as follows:

Step 1: First, determine whether the transportation problem is balanced. Go on to the next stage if it is balanced.

Step 2: Using the ranking function, change the fuzzy values in the Transportation problem to crisp values.

Determine the Harmonic mean for each row and column in step three.

Step 4: Choose the row or column with the highest Harmonic mean value, and then choose the cell in that row or column with the lowest cost.

Step 5: The cell with the lowest cost value receives the maximum assignment. Remove the row or column where supply or demand has run out.

Step 6: Continue from steps 5 to 7 until all supply and demand are met.

Step 7: Estimate the total cost. $TC = \sum\sum R_{ij} E_{ij}$

Case Study

Blood cancers are illnesses brought on by the organism that causes them. In many nations, they are one of the main causes of disease. All ages are affected, but children are particularly vulnerable because of their exposure to supportive environments. Based on actions made at different levels of the disease's propagation, blood cancer can be prevented. By implementing effective and efficient administration, prevention, and control methods, health departments can play a significant role in the control of these diseases.

In Thanjavur Section, the convenience of various dealings like Stem cell transplantation (K_1), Chemotherapy (K_2) and Radiation Therapy (K_3) for Blood Cancer diseases are (6,7,8), (1,2,3) and (7,8,9) respectively.

Additionally, the size of patients precious by the Blood cancer like Leukemia (D_1), lymphoma (D_2) and myeloma (D_3) are (6,7,8), (7,8,9) and (1,2,3) respectively. Curing time for all above said treatment - disease combination per patient are as follows:

Section: Research Paper
ISSN 2063-5346

Table 5.1: Curing Time per Patient

Treatment	Disease	Curing Time per Patient (in days)
Stem cell transplantation	Leukemia	[5,6,7]
	lymphoma	[4,5,6]
	Myeloma	[7,8,9]
Chemotherapy	Leukemia	[2,3,4]
	lymphoma	[5,6,7]
	Myeloma	[5,6,7]
Radiation Therapy	Leukemia	[6,7,8]
	lymphoma	[7,8,9]
	Myeloma	[1,2,3]

Table 5.2: Balanced Table with Fuzzy Curing Stint and Uncertain Blood cancer Disease with Therapy treatment

Treatments / Diseases	Leukemia (D_1)	lymphoma (D_2)	Myeloma (D_3)	Supply (availability of treatment T_j)
Stem cell transplantation	[5,6,7]	[4,5,6]	[7,8,9]	[6,7,8]
Chemotherapy	[2,3,4]	[5,6,7]	[5,6,7]	[1,2,3]
Radiation Therapy	[6,7,8]	[7,8,9]	[2,3,4]	[7,8,9]
Demand (no. of patients exaggerated by the disease D_i to be engaged the treatment)	[6,7,8]	[7,8,9]	[1,2,3]	

SOLUTION

The following mathematical programming form can be used to model the fuzzy transportation problem:

Min $Z = R(5,6,7)x_{11} + R(4,5,6)x_{12} + R(7,8,9)x_{13} + R(2,3,4)x_{21}+R(5,6,7)x_{22} +R(5,6,7)x_{23}+ R(6,7,8)x_{31}+R(7,8,9)x_{32} +R(2,3,4)x_{33}$

$R(5,6,7) = \frac{5+4*6+7}{6} = \frac{5+24+7}{6}$ $\quad$ $R(7,8,9) = \frac{7+4*8+9}{6} = 8$

$R(5,6,7) = \frac{36}{6} = 6$ $\quad$ $R(4,5,6) = \frac{4+4*5+6}{6} = 5$

$R(2,3,4) = \frac{2+12+4}{6} = \frac{18}{6} = 3$ $\quad$ $R(5,6,7) = \frac{5+4*6+7}{6} = \frac{5+24+7}{6}$

$R(5,6,7) = \frac{36}{6} = 6$ $\quad$ $R(6,7,8) = \frac{6+28+8}{6} = \frac{42}{6} = 7$

$R(7,8,9) = \frac{7+4*8+9}{6} = 8$ $\quad$ R (2,3,4) solution $= \frac{2+12+4}{6} = \frac{18}{6} = 3$

ISSN 2063-5346

R (6,7,8) $= \frac{6+28+8}{6} = \frac{42}{6} = 7$ R (7,8,9) $= \frac{7+32+9}{6} = \frac{48}{6} = 8$

R (1,2,3) $= \frac{1+8+3}{6} = \frac{12}{6} = 2$ R (6,7,8) $= \frac{6+28+8}{6} = \frac{42}{6} = 7$

R (1,2,3) $= \frac{1+8+3}{6} = \frac{12}{6} = 2$ R (7,8,9) $= \frac{7+32+9}{6} = \frac{48}{6} = 8$

Table 5.3: After Ranking

Treatments / Diseases	Leukemia (D_1)	lymphoma (D_2)	Myeloma (D_3)	Supply (availability of treatment T_j)
Stem cell transplantation	6	5	8	7
Chemotherapy	3	6	6	2
Radiation Therapy	7	8	3	8
Demand (no. of patients exaggerated by the disease D_i to be engaged the dealing)	7	8	2	

Table 5.4:-Harmonic Mean

Treatments / Diseases	Leukemia (D_1)	lymphoma (D_2)	Myeloma (D_3)	Supply (availability of treatment T_j)	***Row - Harmonic mean***
Stem cell transplantation	6	5	8	7	6.1
Chemotherapy	2 3	6	6	~~2~~	4.5
Radiation Therapy	7	8	3	8	4.9
Demand (no. of patients exaggerated by the disease D_i to be engaged the dealing)	~~7~~ 5	8	2		
Column - Harmonic mean	4.6	6.1	4.8		

Table 5.5:-Harmonic Mean

Treatments / Diseases	Leukemia (D_1)	lymphoma (D_2)	Myeloma (D_3)	Supply (availability of treatment T_j)	***Row - Harmonic mean***
Stem cell transplantation	6	5	8	7	6.1

ISSN 2063-5346

Radiation Therapy	7	8	2 3	~~8~~ 6	4.9
Demand (no. of patients exaggerated by the disease D_i to be engaged the dealing)	5	8	~~2~~		
Column - Harmonic mean	6.4	6.1	4.3		

Treatments / Diseases	Leukemia (D_1)	lymphoma (D_2)	Supply (availability of treatment T_j)	***Row - Harmonic mean***
Stem cell transplantation	5 6	5	~~7~~ 2	5.4
Radiation Therapy	7	8	6	7.4
Demand (no. of patients exaggerated by the disease D_i to be engaged the dealing)	~~5~~	8		
Column - Harmonic mean	6.4	6.1		

Table 5.6:-Harmonic Mean

Section: Research Paper
ISSN 2063-5346

Table 5.7:-Harmonic Mean

Treatments / Diseases	lymphoma (D_2)	Supply (availability of treatment T_j)	***Row - Harmonic mean***
Stem cell transplantation	2 / 5	~~2~~	5
Radiation Therapy	8	6	8
Demand (no. of patients exaggerated by the disease D_i to be engaged the dealing)	~~8~~ 6		
Column - Harmonic mean	6.1		

Table 5.8:-Harmonic Mean

Treatments / Diseases	lymphoma (D_2)	Supply (availability of treatment T_j)	***Row - Harmonic mean***
Radiation Therapy	6 / 8	~~6~~	8
Demand (no. of patients exaggerated by the disease D_i to be engaged the dealing)	~~6~~		
Column - Harmonic mean	8		

Table 5.9:-Harmonic Mean

Treatments / Diseases	Leukemia (D_1)	lymphoma (D_2)	Myeloma (D_3)	Supply (availability of treatment T_j)	***Row - Harmonic mean***
Stem cell transplantation	5 / 6	2 / 5		7	6.1
Chemotherapy	2 / 3			~~2~~	4.5
Radiation Therapy		6 / 8	2 / 3	8	4.9

Demand (no. of patients exaggerated by the disease D_i to be engaged the dealing)	~~7~~ 5	8	2		
Column - Harmonic mean	4.6	6.1	4.8		

As a result, (3+3-1)=5 cells are allotted, and we have our workable soln. The overall cost is then calculated, together with the allotted value of supply and demand, which is displayed in the table above.

Total Cost = (5 * 6) +(2 * 5) +(2 * 3) +(6 * 8) +(2 * 3)

= 30+10+06+48+06

= 100

Results:

The greatest therapies for fuzzy blood cancer disease are Chemotherapy (lymphoma) D2, Stem cell transplantation (leukaemia) D1, and Radiation therapy (myeloma) D3, respectively. The overall minimum curing period is 100 days.

VI. Conclusion:

The multi-objective TP, which is widely known and has been premeditated in which the time-cost minimization problem has been studied by many authors, is the problem of minimizing the overall cost and time of transference. Bhatia [1] and others presented a method for minimizing time in a TP in 1977. In order to reduce overall cost and travel time, Prakash[13] introduced the transportation problem in 1981. When demand, supply, and transportation costs are ambiguous, C. Ananya [2] recently proposed an approach for minimising both the cost and time of transportation. In order to reduce the cost of agricultural productivity, H.G and Jaya. k [5][6] presented a fuzzy LPM in 2014. As a result, in this paper, a fuzzy multi-objective LPM has been created to distribute the different dealings to the various disease populations in order to reduce the prescription and overall healing time by using triangular fuzzy numbers for the supply, demand, time, and prescription parameters. It may be possible to reduce the human productivity loss by reducing the inclusive cure time and preparation.

References:

1) Bhat., H.L., et al. (1977), “A procedure for time minimizing transportation problem”, Indian Journal of Pure and Applied Mathematics, 8, pp. 920-929.
2) C. Ananya and Chakraborty M., (2010), Cost-time Minimization in a Transportation Problem with Fuzzy Parameters: A Case Study, Journal of Transportation Systems Engineering and Information Technology, 10(6), pp. 53−63.
3) C.G et al., (2008), Multi Criteria Programming in Medical Diagnosis and Treatment, Applied Soft Computing, 8(4), pp. 1407 – 1417.
4) Denton, B., (2009), Optimizing the Start time of Statin Therapy for Patients with Diabetes. Med Decis Making, 29(3), pp.351 – 367.
5) Hari .G, A. and Jayakumar, S., (2014), A Fuzzy Linear Programming Model for

Section: Research Paper
ISSN 2063-5346

Optimizing Agricultural Production Cost, International Journal of Applied Mathematical Sciences, 7(1), pp. 59-70.

6) Hari .G, A. and Jaya.K, S., (2014), Ranking of Fuzzy Numbers Using Radius of Gyration of Centroids, International Journal of Basic and Applied Sciences, 2014 Vol. 3, No. 1, pp 17 – 22.
7) Le., E.K. et al., (2009) Modeling and optimizing the public health infrastructure for emergency response. Interfaces – The Eaniel H. Wagner Prize for Excellence in Operations Research Practice; 39(5), 476 – 490.
8) Le., E.K. et al., (2014) Systems analytics: Modeling and optimizing emergency department workflow. In: Y Hui, EK Lee, eds. Healthcare Data Analytics. Wiley Series in Operations Research and Management Science. John Wiley & Sons, Inc.
9) Mar. A.L. Caetano et al., (2008) Optimal Medication in HIV Seropositive Patient Treatment using Fuzzy Cost Function, Proceedings of American Control Conference, IEEE Xplore, Washington, USA.
10) Mason J.E., et al., (2012), Optimizing Statin Treatment Decisions for Diabetes Patients in the Presence of Uncertain Future Adherence. Med Decis Making, 32(1), pp.154 – 156.
11) Persi .P. I. et al., (2013), A Fuzzy Optimization Technique for the Prediction of Coronary Heart Disease Using Decision Tree, International Journal of Engineering and Technology, 5(3), pp. 2506 – 2514.
12) Phani B. Rao & R.Shankar, N. (2011), Ranking Fuzzy Numbers with a Distance Method using Circumcenter of centroids and an Index Modality, Advances in Fuzzy Systems, pp. 1 -7.
13) Praka., S., (1981), "A transportation problem with objective to minimize cost and duration of transportation", Opsearch, 18, pp. 235-238.
14) R.Shankar. N., et al., (2012), 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.
15) S. Babu. S., et al., (2012), Ranking Generalized Fuzzy Numbers using centroid of centroids, International Journal of Fuzzy Logic Systems (IJFLS), Vol2, No.3, 17 – 32.
16) Z., Jingwei, et al., (2010), Fuzzy Multi-objective Location – Routing – Inventory Problem in Recycling Infectious Medical Waste, Proceedings of International Conference on E – Business and E – Government, pp. 4069 – 4073.