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# AN APPLIED INTELLIGENT FUZZY ASSIGNMENT APPROACH FOR SUPPLY CHAIN FACILITIES

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**ABSTRACT**

Nowadays, all industrial private and governmental sectors are making the effort to finde suitable location for their new facilities under practical restrictions such as uncertain traveling time/distance. In the throes of these restrictions, the applied intelligent-based approaches such as fuzzy logic are indispensable for dealing with the uncertainties. This paper extends beyond the previous studies by introducing the fuzzy logic into the facility assignment problem in which the uncertain traveling factors are handled by means of a distance matrix. To aid the managerial judgement on operational research decisions, here a fuzzy assignment model is used. Thus, the model determines which one of the production facilities have to be moved in light of making a better stream of transportation. The stream is optimized by minimizing the total traveling time/distance to cover the customers. Using the creditably theory, the cession of the most appropriate fuzzy assignment would be selected. The numerical results shows the effectiveness of the proposed approach in finding the appropriate location for facilities.

***KEYWORDS***: Applied Intelligent System, Fuzzy Assignment, Supply Chain, Credibility Theory.

## 1. INTRODUCTION

Supply chain is a set which includes all the related activities with commodities stream from raw materials to final product. By the stream side, there are two other streams known as information stream as well as financial and credit resources stream (Giannoccaro & Pontrandolfo, 2002). The supply chain management (SCM) is a collection of some methods that is used to integrate effectively the suppliers, producers, warehouses and stores to produce the necessary products in certain amounts on their due dates and at the precise location and to be delivered to the customers with the aim of minimizing the total chain cost and estimating the customers' need with high level service (Cohen & Moon, 1991). According to the concept of supply chain, introduced in the late 1980s, logistics includes planning, execution and control to send some initial materials to production centers to reach the production to customer (Hugos, 2003; Gilmour, 1993). The supply chain includes all the direct and indirect steps which are involved in the completion of the customers' order. The supply chain is not just related to manufacturers and suppliers but it is also applicable to transportation, warehouses, retailers and even the customers.

Supply chain design can be evaluated based on different aspects. Many reseaches have investigated the design problem of a supply chain with regard to various considerations. Pirkul & Jayaraman (1998) presented a mixed-integer programing model so as to to minimize the supply chain total cost including fixed cost, operations and warehouses, production and distribution variable cost, transportation cost of raw materials from the faclities to the production centers and finally transportation cost of the final products to the customers through warehouses. Some researches considered capacity constraint for resources and warehouses in a supply chain management (Liu & Liu, 2002; Liu, 2004). Cohen & Moon (1991) tried to optimize the material stream,

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production and combination of production in a supply chain network by presenting mixed-integer programming model. Sabri & Benita (2000) demonstrated an integrated multi-objective model for strategic and operational planning in supply chain which attempts to minimize the total cost of the chain. These complexities added new aspects to the supply chain design problems. In other words, by considering limitations in a number of storage places, determining the optimum quantity of these places and locating them in best place can be taken into account as a new aspect in supply chain design problem.

Nowadays, assignment problem is a well known subject in production and management processes which was first studied by Kuhn (1955). An assignment problem is a kind of optimization problem with different goals. In some assignment problems n jobs are assigned to n persons at a minimum (maximum) time (benefit). In other problems of this type, attempts are made to find the best place for locating a facility, distribution center, service center, and etc. to satisfy costumers' requirements. Based on various conditions of assignment problems, many authors have proposed different models (Burkard, 1984; Tang et al., 2006; Yang et al., 2008).

Pentico (2007) presented a comprehensive survey of different variations of the assignment problems that have been proposed in the literature over the last decades.

One of the most popular kind of these problems is finding suitable storage centers in a supply chain. As shown in Fig. 1, the square signs are customers' places and their numbers are seven. Now the question is: which one of the service centers is allocated to the customers to travel the minimum distance, totally. In fact, a supply chain does not include only the manufacturers and providers but it also includes transportation, warehouses and even customers sections (Jain et al., 2004). On the other hand, the assignment issues challenge geometric and combination subjects. The concentration on assignment issues of service centers need many studies on different fields such as operation management, industrial engineering, geography (geology, climatology), economics, mathematics, urban design and development and etc. Hence, in designing network systems such as supply and distribution the place of servicer center and their assignment have direct effect on the region request.

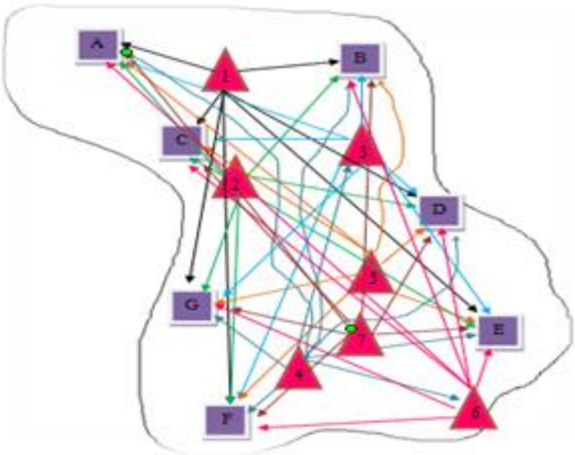


**Fig. 1.** Assignment model schematic figure in a supply chain

Analysis of facility location problems can be based on qualitative procedures in which the possible alternatives for location have been prepared and the suitable criteria and their importance have been defined by allocating some weights. Then, the benefit of every alternative is gained by evaluating each one of them and they are identified through the correct alterative taking the priorities into consideration. From qualitative approaches perspectives, storage location assignment problem has been discussed by many researchers, recently. Muppani & Adil (2008) considered a metaheuristic approach for locating storage centers as an assignment problem in which storage centers are classified into different categories. Park & Seo (2009) evaluated a mathematical model for storage location assingment problem and proposed a solution procedure for the problem at hand. Pan et al. (2012) also considered a storage assignment problem in a supply chain from transportation distance perspective.

In real world situations uncertainty can be considered in the problems. Fuzzy theory can properly take into account uncertainty in assignement problems. Fuzzy set and its applications take into account a scientific revolution in mathematics. The fuzzy set theory was introduced for the first time by Zadeh (1965) and it has had many useful and effective applications in real world. Therefore, considering a fuzzy assignment problem to locate a storage center in a supply chain is more realistic. Li et al. (2012) investigated different solution methods for fuzzy assignment problems. Yang et al. (2019) embedded value-at-risk criterion into a fuzzy-based facility location problem. It was shown that the fuzzy-based risk facility location problems were performing similar to its robust counterpart. Shavarani et al. (2019) conidered the uncertainty of a congested capacitated multi-level facility location problem by fuzzy varianbles. They focused on delivering the products to the customers with optimizing fuel costs. Arana-Jiménez et al. (2020) modeled a fully fuzzy mixed-integer programming assocaited with maximal covering problem. Their solution method was based on the Tchebyche-based method.

In this research, we follow to develop an assignment model to select the best location for storage of products, suppliers, and distribution centers in supply chain with fuzzy distances. To achieve this goal, we present a fuzzy assignment model procedure for the centers' assignment. Then, we have a preview to make distance matrix and generate a numerical example.

The article is organized as follows: Section 2 is devoted to the literature of the research area. Section 3 provides the problem with fuzzy set and fuzzy mathematical operators. Section 4 applies fuzzy linear assignment model and examines its application in the selection of storage centers of the production, supply and distribution in supply chain and solving numerical example and finally the last section is devoted to the conclusion.

## 2. Fuzzy Set & Fuzzy Mathematical Operations

By development of the fuzzy assignment theory and its capability in modeling approximate information, a new route for industrial engineering and management scientists and researchers was provided in order to increase the accuration of systems modeling and analysis capabilities in interfering human. Fuzzy numbers are introduced to appropriately express linguistic variables. In the following sections, some basic definitions of fuzzy set theory is reviewed briefly (Kaufmann & Gupta, 1985; Raj & Kumar, 1999; Lin & Liu, 2008). The fuzzy set theory introduced by Zadeh (1965) is suitable for dealing with the uncertainty and imprecision associated with information concerning various parameters. Some notions of fuzzy sets and fuzzy numbers are reviewed by Wang et al. (2008) and Liu & Wang (2009). In a universal set of discourse $X$, a fuzzy sub-set $A$ of $X$ is defined by a membership function $f_A(X)$ where $f_A(X), \forall x \in X$ indicates the degree of $x$ in $A$. The degree to which an element belongs to a set is defined by the value between 0 and 1. If $x$ really belongs to $A$, $f_A(X)=1$, and clearly not, $f_A(X)=0$. The higher is $f_A(X)$, the greater is the grade of membership for $x$ in $A$.

### 2.1. *Fuzzy ranking*

The fuzzy numbers have an important role in formulating fuzzy variables and the fuzzy variables could be speech variables. Most of the decisions are made based on alternatives' ranking. The ranking has many vague numbers both in random and fuzzy environments. If there are un-certainty conditions, organizing the results will be accompanied by vague numbers. In fuzzy state like certain state, Two fuzzy numbers cannot be judged deterministically but we could calculate the correctness of a fuzzy number that is bigger than the other. Suppose that there are two fuzzy numbers $\tilde{I}$ and $J$. The correctness of fuzzy number $\tilde{I}$ from $J$ is calculated in Eq. (1). By using the methods' concept, we have two triangle fuzzy numbers $A_1=(l_1,m_1,u_1)$ and $A_2=(l_2,m_2,u_2)$:

$$m_1 \geq m_2 : T(A_1 \geq A_2) = 1 \tag{1}$$

$$m_1 \leq m_2 :\ T\left(A_1 \geq A_2\right) = \frac{u_1 - l_2}{(u_1 - l_2) + (m_2 - m_1)}$$

### 2.2. *Mathematical operations in fuzzy numbers*

Suppose that the sign "*" explains each one of the four mathematical main operations and the fuzzy numbers $A$ and $B$ stands for real number. Then the equation of $A*B$ is explained below:

$$\left(A*B\right)\left(Z\right) = SUP_{Z=x*y} \min\min\left\{\mu_A\left(x\right), \mu_B\left(y\right)\right\} \tag{2}$$

So, for four mathematical main operations we have:

$$\left(A+B\right)\left(Z\right)=SUP_{Z=x+y}\min\min\left\{\mu_A\left(x\right),\mu_B\left(y\right)\right\} \quad (3)$$

$$\left(A-B\right)\left(Z\right)=SUP_{Z=x-y}\min\min\left\{\mu_A\left(x\right),\mu_B\left(y\right)\right\} \quad (4)$$

$$\left(A\times B\right)\left(Z\right)=SUP_{Z=x\times y}\min\min\left\{\mu_A\left(x\right),\mu_B\left(y\right)\right\} \quad (5)$$

$$\left(A/B\right)\left(Z\right)=SUP_{Z=x/y}\min\min\left\{\mu_A\left(x\right),\mu_B\left(y\right)\right\} \quad (6)$$

### 2.3. Credibility theory

Suppose (ξ) is a fuzzy variable with membership function ($\mu$). For each set of ($B$), Lin & Liu (2008) credits the feature size by the average size and size requirements can be expressed as follows:

$$Cr(\{\xi\in B\})=\frac{1}{2}(\{\sup\mu(x)_{x\in B}+1\}-\{\sup\mu(x)_{x\in B^c}\}) \quad (7)$$

$$Pos(\{\xi\in B\})=\sup\mu(x)_{x\in B} \quad (8)$$

$$Nec(\{x\in B\})=1-\sup\mu(x)_{x\in B^c} \quad (9)$$

$$\mu(x)=\begin{cases}\frac{X-a}{b-a} & a\le X\le b\\ \frac{X-c}{b-c} & b\le X\le c\\ 0 & otherwise\end{cases} \quad (10)$$

The defining features of validity, credibility ($\xi \ge X$) and credibility ($\xi \le X$) are as follows:

$$Cr(\{\xi\ge x\})=\begin{cases}1 & \mathrm{X}\le \mathrm{a}\\ \frac{a-2b+X}{2(a-b)} & \mathrm{a}\le \mathrm{X}\le \mathrm{b}\\ \frac{X-c}{2(b-c)} & \mathrm{b}\le \mathrm{X}\le c\\ 0 & \mathrm{c}\le \mathrm{X}\end{cases}$$

$$Cr(\{\xi\le x\})=\begin{cases}0 & \mathrm{X}\le \mathrm{a}\\ \frac{X-a}{2(b-a)} & \mathrm{a}\le \mathrm{X}\le \mathrm{b}\\ \frac{X+c-2b}{2(c-b)} & \mathrm{b}\le \mathrm{X}\le \mathrm{c}\\ 1 & \mathrm{c}\le \mathrm{X}\end{cases} \quad (11)$$

Assume $\xi_i$ are fuzzy variables with membership functions $\mu_i$, and assume ui are real numbers, $i=1,2,...,n$ respectively.

Suppose that $f : R^n \to R$ is a function. Then, the credibility of the fuzzy event characterized by Kaufmann & Gupta (1985).

$$f(\xi_1, \xi_2, \ldots, \xi_n) \geq 0$$

$$Cr\{f(\xi_1, \xi_2, \ldots, \xi_n) \geq 0\} = \frac{1}{2}\Big(\sup_{u1,u2,\ldots,un \in R} \{\min_{1 \le i \le n} \mu_{\xi_i}(u_i) \mid f(u_1, u_2, \ldots, u_n) \geq 0\} + 1 - \sup_{u1,u2,\ldots,un \in R} \{\min_{1 \le i \le n} \mu_{\xi_i}(u_i) \mid f(u_1, u_2, \ldots, u_n) \leq 0\}\Big) \tag{12}$$

Assume ξ is a fuzzy variable. Then its expected value is defined as:

$$E[\xi] = \int_0^{\infty} Cr(\{\xi \geq X\})dr - \int_{-\infty}^{0} Cr(\{\xi \leq X\})dr \tag{13}$$

Provided that at least one of the two integrals shown above is finite. The expected value is one of the most important concepts for fuzzy variables, which shows the center of its distribution (Liu & Liu, 2002). For example, the expected value of the triangular fuzzy variable $\xi = (a_1, a_2, a_3)$ is:

$$E[\xi] = \frac{a_1 + 2a_2 + a_3}{4} \tag{14}$$

and for trapezoidal fuzzy variable $\xi = (a_1, a_2, a_3, a_4)$ is as:

$$E[\xi] = \frac{a_1 + a_2 + a_3 + a_4}{4} \tag{15}$$

## 3. THE ASSIGNMENT FUZZY MODEL

In this section, a methodology to select a storage location to reserve the production, supply and distribution centers is presented. The development of fuzzy set theory models in industrial and management engineering models have progressed and now most of the models have developed with fuzzy structures. Of course, the field is lacking research into the way the industrial and management engineering scientists apply the models and analysis to reality by using fuzzy set capabilities and increase the model effectiveness and usability.

The aim of facilities location issues is finding one node or the following node in network to establish a service center as the maximum travel time is minimized. It is simply understandable that the location problem could model in real world, for example the travel time between nodes is expressed as fuzzy numbers and the solution of the problem, and determines the boundaries of the service location. The subject is very important, for instance in productive flexible systems in which they use automatic transportation vehicles to transfer materials and parts to the production stations. Although we could not design a certain place for the automatic transportation vehicles, determining an approximate area for the location of automatic transportation vehicles in the systems could be useful and effective. In the presented model, the total distance which is between service center and customer center have been considered as fuzzy. The applied steps in the model are as follows:

- **Step 1:** Assume that *N* is a service center (storage centers of production, supply and distributionand columns) and *N* is applied to customer (lines), we make the following decision matrix in which the numbers are distance or arrival time between centers.

$$\tilde{D} = \begin{matrix} A_1 \\ A_2 \\ \vdots \\ An \end{matrix} \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \cdots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \cdots & \tilde{x}_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ \tilde{x}_{n1} & \tilde{x}_{n2} & \cdots & \tilde{x}_{nn} \end{bmatrix}, \quad i = 1, 2, \ldots, n; \quad j = 1, 2, \ldots, n$$

- **Step 2:** Subtract the smallest number of every cost matrix row based on Eq. (1) from other numbers of the corresponding row based on Eq. (4).
- **Step 3:** Subtract the smallest number of every cost matrix column based on Eq. (1) from other numbers of the corresponding row based on Eq. (4). (You could exchange the second and third steps)
- **Step 4:** Cover the zeros appearing in new matrix by horizontal and vertical lines. If the possible horizontal and vertical lines that have covered all matrix fuzzy zeros equals matrix (*N*), so the problem has been solved in Step 6.
- **Step 5:** If the possible horizontal and vertical lines that have covered all zeros are less than dimension (*N*) of the matrix, the matrix extension should continue under the below matrix operations:
  If the cover line number is (*N*), stop, the optimal solution is produced. If not, obtain the deducted cost matrix as follows: Select the smallest number on which you have not drawn a line based on Eq. (1).
- **Step 6:** find the suitable strategy (If we have got to the final matrix of the problem solution), first consider the columns and rows which have one fuzzy zero, actually the zeros determine the part of cession in the most suitable strategy, then select the rest of the cessions from exit fuzzy zeros in the final matrix which are appropriate for producing the solution to the problem.

## 4. Deterministic and Fuzzy States: An Example

### 4.1. *Model solution in deterministic stage*

Suppose that the numbers of storage centers of production, supply, distribution and customers' place is 3 and the distance in deterministic state for every one of the customer centers is as shown in the following matrix (3):

$$D = \begin{bmatrix} 471 \\ 365 \\ 294 \end{bmatrix} \xrightarrow{step1} \begin{bmatrix} 360 \\ 032 \\ 072 \end{bmatrix} \xrightarrow{step2} \begin{bmatrix} 330 \\ 002 \\ 042 \end{bmatrix} \Rightarrow Finish$$

Therefore, the allocation process showed that service center 1 is assigned to customer location 3 and the service center 2 is assigned to customer location 2 and the service center 3 is assigned to customer location 1. By considering the assignment, the total travel time or total distance are equated as:

Minimum total service time or total distance =2+6+1=9

Figure 2 indicates schematic configuration for the above mentioned problem before the assignment and Fig. 3, depicts schematic configuration for the problem after assignment by thicker arrays.

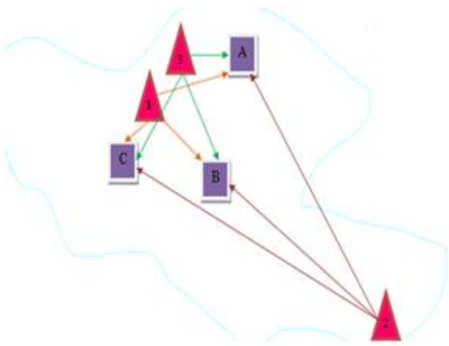


**Fig. 2.** Location model before assignment

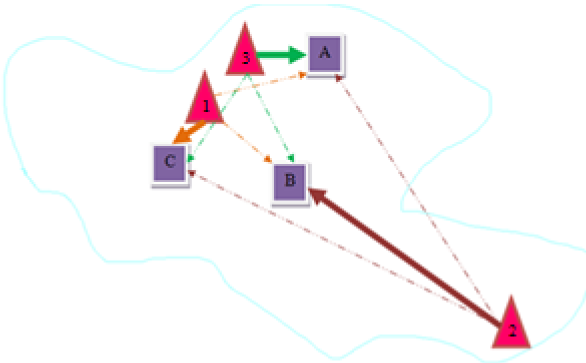


**Fig. 3.** Optimal location model after assignment

### *4.2. Model expression in fuzzy state*

$$\tilde{D} = \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \tilde{x}_{13} \\ \tilde{x}_{21} & \tilde{x}_{22} & \tilde{x}_{23} \\ \tilde{x}_{31} & \tilde{x}_{32} & \tilde{x}_{33} \end{bmatrix} = \begin{bmatrix} (1 \quad 4 \quad 5) & (3 \quad 7 \quad 6) & (0 \quad 1 \quad 2) \\ (0 \quad 3 \quad 4) & (4 \quad 6 \quad 7) & (4 \quad 5 \quad 6) \\ (1 \quad 2 \quad 4) & (8 \quad 9 \quad 10) & (0 \quad 4 \quad 5) \end{bmatrix}$$

In the matrix state, the distance is fuzzy and the distance between the centers of production, supply, distribution and customer place is considered as a triangle of fuzzy numbers:

*Step 1:* The smallest number of every line is as below based on Eq. (1):

Row 1:

$$T(x_{12} \geq x_{11}) = \frac{6-1}{(6-1)+(7-4)} = 0.625$$

$$T(x_{12} \geq x_{13}) = 0.5$$

$$T(x_{13} \geq x_{11}) = -0.5$$

As you see, the triangle of fuzzy numbers $x_{11}$ is the smallest one in the row.

Row 2:

$$T(x_{22} \geq x_{21}) = 0.7$$

$$T(x_{22} \geq x_{23}) = 0.75$$

$$T(x_{23} \geq x_{21}) = 0.75$$

As you see, the triangle of fuzzy numbers $x_{21}$ is the smallest one in the row.

Row 3:

$$T(x_{32} \geq x_{31}) = 0.5625$$

$$T(x_{32} \geq x_{33}) = 0.666$$

$$T(x_{33} \geq x_{31}) = 0.666$$

As you see, the triangle of fuzzy numbers $x_{31}$ is the smallest one in the row.

So, according to Eq. (4), we have:

$$\tilde{D}=\begin{bmatrix}(-4 & 0 & 4) & (-2 & 3 & 5) & (-5 & -3 & -3)\\ (-4 & 0 & 4) & (0 & 3 & 7) & (0 & 2 & 6)\\ (-3 & 0 & 3) & (4 & 7 & 9) & (-4 & 2 & 4)\end{bmatrix}$$

*Step 2:* The smallest number of every column based on Eq. (1) on the Step 1 of the matrix is as shown below:

Column 1:

$$T\left(x_{21}\geq x_{11}\right)=1$$

$$T\left(x_{21}\geq x_{31}\right)=0$$

$$T\left(x_{31}\geq x_{11}\right)=1$$

As you see, the triangle of fuzzy numbers $x_{11}$ is the smallest one in the row.

Column 2:

$$T\left(x_{22}\geq x_{12}\right)=\frac{7-(-2)}{7-(-2)+(3-3)}=1$$

$$T\left(x_{22}\geq x_{32}\right)=0.75$$

$$T\left(x_{32}\geq x_{12}\right)=0.7333$$

As you see, the triangle of fuzzy numbers $x_{12}$ is the smallest one in the row.

Column 3:

$$T\left(x_{23}\geq x_{13}\right)=0.6875$$

$$T\left(x_{23}\geq x_{33}\right)=1$$

$$T\left(x_{33}\geq x_{13}\right)=0.5833$$

As you see, the triangle of fuzzy numbers $x_{13}$ is the smallest one in the row.

Then, based on Eq. (4), we have changed the matrix:

$$\tilde{D}=\begin{bmatrix}(-4 & 0 & 4) & (-2 & 3 & 5) & (-5 & -3 & -3)\\ (-4 & 0 & 4) & (0 & 3 & 7) & (0 & 2 & 6)\\ (-3 & 0 & 3) & (4 & 7 & 9) & (-4 & 2 & 4)\end{bmatrix}\longrightarrow\begin{bmatrix}(-8 & 0 & 8) & (-7 & 0 & 7) & (-2 & 0 & -2)\\ (-8 & 0 & 8) & (-5 & 0 & 9) & (3 & 5 & 11)\\ (-7 & 0 & 7) & (-1 & 4 & 11) & (-1 & 5 & 9)\end{bmatrix}$$

*Steps 3, 4, and 5:* By considering Steps 3-5, the algorithms from entries $(x_{22}, x_{32})$ and $(x_{23}, x_{33})$, the gained matrix from Step 2, the smallest fuzzy number based on the amounts of *Cr* from Eq. (14), on covering line, the fuzzy number is calculated based on Eq. (1) as follows:

$$T(x_{22} \geq x_{32}) = 0.7142$$
$$T(x_{23} \geq x_{33}) = 1$$
$$T(x_{32} \geq x_{33}) = 0.92$$

The entry $x_{33}$ was gained as the smallest fuzzy number. Then, the entry $x_{33}$ from entries $(x_{22}, x_{32})$ and $(x_{23}, x_{33})$ based on Eq. (4) is subtracted and based on Eq. (3) is added in entry $x_{11}$. As a result, we have:

$$\tilde{D} = \begin{bmatrix} (-8 \quad 0 \quad 8) & (-7 \quad 0 \quad 7) & (-2 \quad 0 \quad -2) \\ (-8 \quad 0 \quad 8) & (-5 \quad 0 \quad 9) & (3 \quad 5 \quad 11) \\ (-7 \quad 0 \quad 7) & (-1 \quad 4 \quad 11) & (-1 \quad 5 \quad 9) \end{bmatrix} \longrightarrow \begin{bmatrix} (-9 \quad 5 \quad 17) & (-7 \quad 0 \quad 7) & (-2 \quad 0 \quad -2) \\ (-8 \quad 0 \quad 8) & (-14 \quad -5 \quad 10) & (-6 \quad 0 \quad 12) \\ (-7 \quad 0 \quad 7) & (-1 \quad 4 \quad 11) & (-10 \quad 0 \quad 10) \end{bmatrix}$$

In the step, after calculating fuzzy zeros based on *Cr* from Eq. (14) and drawing the covering lines that are *N*=3, the fuzzy assignment is done as follows:

$$\tilde{D} = \begin{bmatrix} \tilde{x}_{11} = 0 & \tilde{x}_{12} = 1 & \tilde{x}_{13} = 0 \\ \tilde{x}_{21} = 1 & \tilde{x}_{22} = 0 & \tilde{x}_{23} = 0 \\ \tilde{x}_{31} = 0 & \tilde{x}_{32} = 0 & \tilde{x}_{33} = 1 \end{bmatrix}$$

Thus, total minimum service time or total travel fuzzy distance equals (3,7,6)+(0,3,4)+(0,4,5)=(3,14,15)

## 5. Conclusion

Nowadays location of the storage places of productions, suppliers, as well as the allocation of distribution centers from factories to the customers considering their applicable constraints are significant issue. Since minimizing the logistic costs is an important factor in supply chain management, the role of fuzzy assignment in determining the storage places of production, suppliers, and distribution centers in order to manage the uncertainities is more crucial. On the one hand, the centers could be in operation by using their possibilities and abilities concepts providing possibilities theory to fuzzy optimal assignment. Therefore, in this research, we tried to shed light on the effects of assigning the storage places of productions, suppliers, and distribution centers of the factories in the centralized regions to decrease assignment costs of the supply chain. On the other hand, the decisions are taken based on the director's subjective judgments. To achieve this goal, the triangle of fuzzy distances was exploited and according to it, a fuzzy assignment model was developed. For the future researches, the assignment could be done to minimize time, service distance or any other factors, simultaneously. Moreover, we can formulate the multi-objective problem and apply the Pareto-based optimization algorithms to solve it.

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