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Augmentation of Transportation Problems in Neutrosophic Climate

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Abstract:

This paper proposes a concept "Neutrosophic Set" in mathematical modeling. Application of this technique in mathematical modeling leads to arriving at "least cost" or "cost minimum" in a real life transportation problem even with uncertainty in data gathered and which is more practical and adequate than Fuzzy Set and Intuitionistic Fuzzy Set. On the go, a short theme about mathematical modeling was discussed in the introduction. In mathematical modeling, through Fuzzy Set Theory and Intuitionistic Fuzzy Set Theory, degree of truth and falsity are determined respectively. Followed by this, the emerging of Neutrosophic Set through Fuzzy Set Theory and Intuitionistic Fuzzy Set Theory and it is apart from Fuzzy Set Theory and Intuitionistic Fuzzy Set Theory is explained. Neutrosophic set can be considered as the degree of indeterminacy and it constitutes with the above named two degrees, so the set in the universe is in three degrees. As a result, the budding and importance of Neutrosophic sets in the occasion of uncertainty data is outlined by the researcher. With some review of literature, the objectives of this present proposal are recorded with the operational definition of Neturosophic set. Finally in the part of conclusion multiple applications are route lined for further studies by means of uncertainty in mathematical modeling.

Keywords: **Fuzzy set, Neutrosophic set, Transportation problems, Intuitionistic fuzzy sets, Mathematical modeling.**

I. INTRODUCTION

Mathematical modeling is a mathematical relation that describes some real-life situation. For a mathematical model, a researcher needs to unite mathematics with the model since the model provides a framework for conceptualizing researcher's ideas about the behavior of a particular system or reality. As applying the model in mathematics, mathematical modeling will provide: underlying causes for a complex phenomenon, predicting the future and predicting the impact of interventions. Also mathematical models allow us to find structure in a complex system and to investigate how different factors interact.

It is an experimental approach where a word problem is solved and continually refined over time in order to be more efficient, faster and more accurate. It helps in shaping the real life problems into mathematical models and then solving them accordingly. In every process of mathematical modeling, the real world problem is modeled or converted into mathematical equations, and it can be attempted to solve and interpret its solution. Finally the researcher focuses to what extent the solution is valid in the context of the reality. So the stages involved in the mathematical modeling are formulation, solution, interpretation and validation.

II. EMERGING OF NEUTROSOPHIC SET

In day by day life problems there is a need to transport a product from a choice of sources to a distinct destination. Operations Research (OR) uses suitable techniques or tools available to manipulate such situations. In physical distribution of products some of the techniques that are commonly overviewed are mathematical procedure, statistical procedure and cost analysis. However, OR analysts have given special impulsion to the development and use of techniques like *linear programming, transportation problem, game theory, inventory control models and simulation.* In those, the transportation problems meet the needs and it is referred as one of the most important to solve business problems and has served as the best in the physical distribution of products to arrive at the cost minimum. For this minimum cost in real life transportation problem, uncertainty of data acts as a vital hindrance due to several uncontrolled factors. To contribute solutions for these uncontrolled factors in real life transportation problems, Zadeh (1965) attempted to incorporate uncertainty into mathematical modeling through fuzzy set theory.

A fuzzy set (FS) is a set where each element of the universe belongs to some degree of belongingness which lies between 0 and 1 and such grades are called membership value of the element in that set. This graduation concept is very well suited for applications involving *imprecise data* such as language processing or artificial intelligence, handwriting and speech recognition etc.

Although a fuzzy set is very useful when dealing with uncertainties, it cannot handle certain cases when it is hard to depict the membership degree using one specified value or incomplete information about a set. To overcome the lack of knowledge of non-membership degree, intuitionistic fuzzy set (IFS) was proposed by Atanassov (1986), as an extension of fuzzy set. In IFS each element in the set is attached with two grades, as membership and non-membership grades where the sum of the two grades is equal to less or equal to unity. Therefore IFS have the ability to handle imprecise data of both complete and incomplete nature. Additionally FST and IFST are dealing with multiple sorts of uncertainty in different areas and still lack of general framework, where the indeterminacy knowledge is unable to be managed. For example, an opinion by an expert regarding a particular statement, one says that the possibility in which the statement is true is 0.6, for false is 0.5 and the statement is not sure is 0.2. This issue is beyond the scope of fuzzy set and IFS and therefore dealing with this type of indeterminate situation undoubtedly becomes a true challenge.

Recently, a generalized form of FS and IFS is the Neutrosophic set that was introduced by Florentin Smarandache (1995). It provides a more general structure and very suitable form to overcome the mentioned issues. The term "neutrosophy" means the knowledge of neutral thought and this neutral represents the primary distinction between fuzzy and intuitionistic fuzzy set and this set is established based on logic in which the elements of the universe is presented by three degrees namely, degree of truth (T), degree of indeterminacy (I) and falsity degree (F).

III. OBJECTIVE OF THE STUDY

The main objective of the study is to find out the minimum cost of transportation problems in a neutrosophic environment.

1. To design a transportation model for the real life transportation problems in a neutrosophic environment.
2. To find innovative methods for getting an initial basic feasible solution and optimal solution for transportation problems in a neutrosophic environment.
3. To extend the concept into different types of neutrosophic numbers, this can be more applicable in modeling with uncertainty.

IV. REVIEW OF LITERATURE

The Transportation Problem is almost a Linear Programming Problem in which the straightforward idea is to apply the existing fuzzy linear programming techniques to the Fuzzy Transportation Problems.

In 1941 – 1951, The Transportation Problem was a well-known basic network problem which was originally proposed by F. L. Hitchcook in 1941, was developed separately by T. C. Koopmans in 1947, and was finally placed in the framework of linear programming and was solved by simplex method in 1951. Since then, improved methods of solutions have been developed and the range of applications has been steadily widened.

In 1970, Bellmann and Zadeh initially proposed the basic model of fuzzy decision making on the theory of fuzzy mathematics. Bellmann and Zadeh suggested the Max- Min criterion for fuzzy transportation problem and it can be treated as mixed integer non-linear programming problem.

In 1978, Zimmermann introduced an algorithm for solving this problem which provides effective solutions. Zimmermann showed that solutions obtained by fuzzy linear programming methods are always efficient. Subsequently, Zimmermann's fuzzy linear programming has been developed into several fuzzy optimization methods for solving the transportation problems.

In 1983-1984, Li et al. considered the situation where all parameters are fuzzy. Chanas, Kolodziejckzy, Machaj presented a fuzzy linear programming model for solving transportation problems.

In 1995-1996, Oh Eigeartaigh proposed an algorithm for solving transportation problems where the capacities and requirements are fuzzy sets with linear or triangular membership functions. Chanaset al. developed an algorithm determining the optimal integer solution of a more general fuzzy transportation problem. The intuitionistic fuzzy set has received more and more attention since its appearance. Several authors introduced the concept of a vague set. But Bustince and Burillo showed the vague sets are intuitionistic fuzzy sets. Shu, Cheng and Chang have the definition and operational laws of triangular intuitionistic fuzzy numbers and proposed an algorithm of the intuitionistic fuzzy set fault-tree analysis.

In 1998-1999, Das et al. introduced a method, called fuzzy technique, to solve ITP by considering the right bound and the midpoint of the interval. Chanas and Kuchta proposed the concept of the optimal solution for the transportation with fuzzy coefficients expressed as fuzzy numbers.

In 2003-2006, Sengupta and Pal proposed a new fuzzy oriented method to solve ITP by considering the midpoint and width of the interval in the objective function. Shiang-Tai Liu and Chiang Kao, Liu and Kao described a method to solve a Fuzzy Transportation Problem based on extension principle. Nagoor Gani and Abdul Razak obtained a fuzzy solution for a two stage cost minimizing fuzzy transportation problem in which supplies and demands are trapezoidal fuzzy numbers.

In 2010-2011, Pandian and Natarajan proposed a fuzzified zero point method to find the fuzzy optimal solution for the Fuzzy Transportation Problem where all parameters are trapezoidal fuzzy numbers. Pandian and Anuratha proposed a new method namely, split and bound method for finding an optimal solution to fully integer interval transportation problems with additional impurity constraints which has been developed without considering the midpoint and width of the intervals and is based on a floating point method.

In 2012, Thangaraj Beaula and M. Priyadharsini introduced the fuzzified zero point method for finding a fuzzy optimal solution for a fuzzy transportation problem in a single stage and the fuzzy membership function of the objective function is obtained.

Edward Samuel et al. proposed a new method for solving a special type of fuzzy transportation problem by assuming that a decision maker is uncertain about the precise values of transportation cost only but there is no uncertainty about the supply and demand of the product. **In 2014-2015,** Ye, introduced simplified NSs, and Peng et al. defined their novel operations and aggregation operators. Thangaraj Beaula and M. Priyadharsini, established the destination choice based method in solving fuzzy transportation problems using intuitionistic trapezoidal fuzzy numbers and is compared with the previously developed method.

Fuzzy maximum network flow approach is developed that seeks to maximize the flow through the flow network from a single source to a single sink by minimizing the cost of the flow. Zero cost, Iterative method to find the fuzzy optimal solution for fuzzy transportation problem is suggested, and this method develops the procedure which is a systematic one. Apex Base Least Cost Method is proposed to solve the fuzzy transportation problem using a new ranking method for generalized trapezoidal fuzzy numbers.

Florentin Smarandache generalized the intuitionistic fuzzy logic and other logics to neutrosophic logic. Also the differences between IFL and NL are pointed out. Although many researchers and scientists have worked in the recently developed neutrosophic method, and applied it in the field of decision making, there is, however, still some viewpoints regarding defining neutrosophic numbers in different forms and their corresponding de-impreciseness is very important. Montaz Ali contributed to the field of optimization and modeling of real world problems as well as development of innovative optimization techniques for handling such problems. Dalbinder Kour discussed fuzzy linear programming and crisp linear programming for the neutrosophic transportation problems.

In 2016-2018, Thamaraiselvi and Santhi introduced a mathematical representation of a transportation problem in neutrosophic numbers. Avishek introduced the de- neutrosophication concept for neutrosophic numbers for triangular neutrosophic numbers. It helps us to convert a neutrosophic number into a crisp number. Single-valued neutrosophic sets are an extension of NSs which were introduced by Wang et al. There are different extensions of NSs, such as interval neutrosophic sets, bipolar neutrosophic sets, and multi-valued neutrosophic sets.

V. RESEARCH METHODOLOGY

In this juncture the Neutrosophic set, a new concept in modeling, was successfully focused on overcoming the crisis of uncertainty of data. This concept was introduced by Florentin Smrandache in1995. It can be defined as a set where each element of the universe has a degree of truth, indeterminacy and falsity. Followed by the definition, the operational of Neutrosophic set be, *A set S_{neu} in the universal discourse X, is said to be a neutrosophic set if*

$S_{neu} = \{(x; [\pi S_{neu}(x), \mu S_{neu},(x), \theta S_{neu}(x)]): x \in X\}$, *where* $\pi S_{neu}(x): X \to [0,1]$ *is called the truth membership function which represents the degree of confidence,* $\mu S_{neu},(x): X \to [0,1]$ *is called the indeterminacy membership function which represents the degree of uncertainty, and* $\theta S_{neu}(x) = X \to [0,1]$ *is called the falsity function which represents the degree of skepticism on the decision given the decision maker.*

$\pi S_{neu}(x), \mu S_{neu},(x), \theta S_{neu}(x)$ exhibits the following relation:

$0 \leq \pi S_{neu}(x) + \mu S_{neu},(x) + \theta S_{neu}(x) \leq 3.$

Some more words about this set can be that it is more practical and adequate than FS and IFS in commerce, which are uncertain, incomplete and inconsistent in sequence.

VI. CONCLUSION

The theory of uncertainty plays a vital role in applied mathematical modeling such as transportation problems, fuzzy sets and probability theory etc. For this described area with uncertainty of data, the recent emerging concept neutrosophic set assists to reach long milestones. Although the merits of the neutrosophic set are addressing needs to be specified from a technical point of view, especially when dealing with real applications. In future, neutrosophic model is to be addressed for reducing the cost of transportation of edible oils, petroleum products, sugarcane, paddy and medicational drugs etc which increase the trades of our country. Also, the loss due to accidents in transportation may be quantified. Because, the transportation cost is calculated on the basis of distance traveled between the sources (Fields) and the destination (Factory). But, if in case of an accident or the transported route has some defects and this leads to loss in mileage, there will be an additional loss and this loss should be incorporated with the transportation cost. Therefore potential research can be concentrated on developing generalized frame work using a neutrosophic set that is suitable for different practical problems other than transportation problems in Operations Research. From the above discussion neutrosophic sets act as an important concept to study the uncertainty as it opens the closed door. Since the world is full of indeterminacy, then the neutrosophic set found their place in research.

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