A Novel Approach to Solve Gaussian Valued Neutrosophic Shortest Path Problems

Ranjan Kumar, S A Edalatpanah, Sripati Jha, Ramayan Singh

Abstract: ***We have exhibited a novel method for finding the neutrosophic shortest path problem (NSSPP) consid- ering Gaussian valued Neutrosophic number. We have used linear programming approach for finding the NSS- PP for Gaussian valued Neutrosophic number which is as per best of our information, hasn't been used till date for any other research work. In this article, we have introdu- ced a novel method which deals Gaussian shaped neutro- sophic problem easily without using any ranking method. We have used this method to solve uncertain network pro-blems to find the shortest path which can help in taking crucial uncertain decisions. Finally, some numerical con- siderations are provided to show the effectiveness of the proposed model.***

Keyword: Neutrosophic fuzzy numbers; shortest path pro- blem; gaussian valued neutrosophic number; network; programming method.

I. INTRODUCTION

A tool representing the partnership or relationship function is called a Fuzzy Set (FS) and handle the real world problems in which generally some type of uncertainty exists [1]. This concept was generalized by Atanassov [2] to intuitionistic fuzzy set (IFS) which is regarding membership function (MF) and non-membership function (NMF), the characteristic functions of the set. Moreover, Dutta and Ali [[3]] introduced gaussian fuzzy membership function. In 2017, Dutta and Limboo [4]extended this concept into soft set theory which is known as bell shaped fuzzy soft set. Beside this, several theories have been developed for uncertainties, including: Generalized orthopair FSs [5],Pythagorean FSs [6], picture FSs [7], Hesitant interval based neutrosophic linguistic sets [8], N-valued interval neutrosophic sets (NVINS) [9], Generalized Interval-Valued Triangular Intuitionistic FS [10], interval-valued Pythagorean FS [11], interval type 2 FSs [12].In 1995, Smarandache [13] premised the theme of Neutrosophic sets (NS) and this is generalized from the FS [1] and IFS [2]. The NS are set of elements having a membership degree indeterminate-membership and also non membership with the criterion less than or equal to 3. Some extensions of NSs, including, bipolar NS [14], interval NS [15] single-valued NS [17], neutrosophic linguistic set [18], neutrosophic trapezoidal set [20], and triangular fuzzy neutrosophic set [21], are brought into picture to solve various problems. The neutrosophic number is an exceptional type of neutrosophic sets that extend the domain of numbers from those of real numbers to neutrosophic numbers.

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By generalizing SVNSs [22], Wang et al. [22] premised the idea of IVNS. The IVNS [23] is a more general database to generalize the concept of different types of sets to express membership degrees truth, indeterminacy, and a false degree in terms of intervals. Thus several articles are published in the field of fuzzy and neutrosophic sets. However, to the best of our insight, very few strategies dealing exclusively with NSSPP.

Broumi et al. [24,25] first introduced a technique of finding SP under SV-trapezoidal and triangular fuzzy neutrosophic environment. Recently, Kumar et al. [26] suggested a new method which overcomes the shortcoming of Broumi et al. [24,25], proposed method. Broumi et al. [27] developed a new algorithm to solve SPP using bipolar neutrosophic setting. Additionally, Broumi et al. [28] also discussed an algorithmic approach based on a score function defined in [29] for solving NSPP on a network with IVNN as the edges but in some cases obtained data may not be single valued triangular or single valued trapezoidal neutrosophic numbers. For this purpose we introduced a novel method which deals with Gaussian shaped neutrosophic environment problem for finding SP and Gaussian valued neutrosophic shortest path length. Also we noticed that all of the above authors did not consider GVNSSPP to solve shortest path. As per all the available informations, there is no such method available for solving GVNSSPPs. This article is sectioned as: In Section 2, some basic information is provided along with detailed description of the concepts on neutrosophic set theory, and an arithmetic operation on the Gaussian valued neutrosophic numbers. Section 3, includes the existing linear programming method under crisp SPPs and it also includes a novel method for solving GVNSSPP. In Section 4, some numerical precedents are given to uncover the adequacy of the proposed model. Finally, the last section deals with the conclusion for all the proposed methodologies

II. PRELIMINARIES

Definition 2.1: [22]: Let X be a space point or objects, with a genetic element in X denoted by *x.* A single-valued NS, V in X is characterised by three independent parts, namely truth-MF T_V, indeterm- inacy-MF I_V and falsity-MF F_V, such that $T_V : X \to [0,1], I_V : X \to [0,1],$ *and* $F_V : X \to [0,1].$

Now, V is denoted as

$V = \{< x, (T_V(x), I_V(x), F_V(x)) > \ | x \in X\},$ satisfying $0 \le T_V(x) + I_V(x) + F_V(x) \le 3.$

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Definition 2.2: [30]: $\hat{r}^N = \left\langle \left(\overline{\mu_{ij,l}}, \overline{\sigma_{ij,m}}\right), \left(\mu_{ij,l}, \sigma_{ij,m}\right), \left(\underline{\mu_{ij,l}}, \underline{\sigma_{ij,m}}\right) \right\rangle$ is a special NS on the real number set R, whose truth-MF $\Delta(x_t)$, indeterminacy-MF $\nabla(x_i)$, and falsity-MF $\nabla(x_f)$, are given as follows:

$$\Delta(x_t) = \exp\left(-\frac{1}{2}\left(\frac{x - \overline{\mu_{ij,l}}}{\overline{\sigma_{ij,l}}}\right)^2\right) \quad (1)$$

$$\nabla(x_i) = \exp\left(-\frac{1}{2}\left(\frac{x - \mu_{ij,l}}{\sigma_{ij,l}}\right)^2\right) \quad (2)$$

$$\nabla(x_f) = \exp\left(-\frac{1}{2}\left(\frac{x - \underline{\mu_{ij,l}}}{\underline{\sigma_{ij,l}}}\right)^2\right) \quad (3)$$

This definition is depicted in below figure I where truth function is shown by purple graph, falsity is shown by red graph and indeterminacy is shown by yellow color graph.

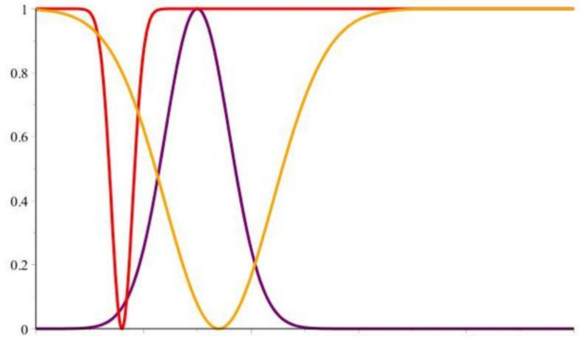

Figure 1. Graphical representation of GVNS number

Definition 2.3: [31,32]**:** Arithmetic operation).Let $\hat{r}^N = \left\langle \left(\overline{r_{ij,l}}, \overline{r_{ij,m}}\right), \left(r_{ij,l}, r_{ij,m}\right), \left(\underline{r_{ij,l}}, \underline{r_{ij,m}}\right) \right\rangle$ and $\hat{s}^N = \left\langle \left(\overline{s_{ij,l}}, \overline{s_{ij,m}}\right), \left(s_{ij,l}, s_{ij,m}\right), \left(\underline{s_{ij,l}}, \underline{s_{ij,m}}\right) \right\rangle$ be two arbitrary SVTNNs, and $\theta \geq 0$; then:

$$\hat{r}^N \oplus \hat{s}^N = \left\langle \left(\overline{r_{ij,l}} + \overline{s_{ij,l}}, \overline{r_{ij,m}} + \overline{s_{ij,m}}\right), \left(r_{ij,l} + s_{ij,l}, r_{ij,m} + s_{ij,m}\right), \left(\underline{r_{ij,l}} + \underline{s_{ij,l}}, \underline{r_{ij,m}} + \underline{s_{ij,m}}\right) \right\rangle$$

$$\hat{r}^N \otimes \hat{s}^N = \left\langle \left(\overline{r_{ij,l}} \cdot \overline{s_{ij,l}}, \overline{r_{ij,m}} \cdot \overline{s_{ij,m}}\right), \left(r_{ij,l} \cdot s_{ij,l}, r_{ij,m} \cdot s_{ij,m}\right), \left(\underline{r_{ij,l}} \cdot \underline{s_{ij,l}}, \underline{r_{ij,m}} \cdot \underline{s_{ij,m}}\right) \right\rangle$$

$if \ (\theta > 0)$

$$\theta \hat{r}^N = \left\langle \left(\theta\overline{r_{ij,l}}, \theta\overline{r_{ij,m}}\right), \left(\theta r_{ij,l}, \theta r_{ij,m}\right), \left(\theta\underline{r_{ij,l}}, \theta\underline{r_{ij,m}}\right) \right\rangle$$

Definition 2.4: [30] Let $\hat{r}^N = \left\langle \left(\overline{r_{ij,l}}, \overline{r_{ij,m}}\right), \left(r_{ij,l}, r_{ij,m}\right), \left(\underline{r_{ij,l}}, \underline{r_{ij,m}}\right) \right\rangle$ then the score function is defined as follows:

$$s(\tilde{r}) = \frac{1}{6}\left[4 - \left(\overline{r_{ij,l}} - r_{ij,l} - \underline{r_{ij,l}}\right) + \left(\cdot\overline{r_{ij,m}} - r_{ij,m} - \underline{r_{ij,m}}\right)\right]$$

Definition 2.5. [30]**:** Let $\hat{r}^N = \left\langle \left(\overline{r_{ij,l}}, \overline{r_{ij,m}}\right), \left(r_{ij,l}, r_{ij,m}\right), \left(\underline{r_{ij,l}}, \underline{r_{ij,m}}\right) \right\rangle$ and $\hat{s}^N = \left\langle \left(\overline{s_{ij,l}}, \overline{s_{ij,m}}\right), \left(s_{ij,l}, s_{ij,m}\right), \left(\underline{s_{ij,l}}, \underline{s_{ij,m}}\right) \right\rangle$ be two arbitrary SVTNNs, the ranking of $\tilde{r}$ and $\tilde{s}$ by score function is described as follows:

1. $if \ s(\tilde{r}) \succ s(\tilde{s}) \ then \ \tilde{r} \succ \tilde{s}$
2. $if \ s(\tilde{r}) \prec s(\tilde{s}) \ then \ \tilde{r} \prec \tilde{s}$

III. THE PROPOSED METHOD

Before we start the main algorithm, we introduce existing crisp shortest path model.

A. Existing crisp model in SPP

In this section, we have a tendency to study the notation and existing linear model in crisp and proposed neutrosophic SPPs

Notations

Ω **:** Starting node

$\mho$ **:** Final destination node

$\sum_{k=1}^{s} x_{mk}$: The total flow out of node *s.*

$\sum_{k=1}^{s} x_{mk}$: The total flow into node *s.*

RK_{mk} : The shortest distance from associate degree m^th node to k^th node.

The crisp SPP problem within the applied math model is as follows Kumar et al. [26]

$$Min = \sum_{m=1}^{s}\sum_{k=1}^{s} RK_{mk} \cdot x_{mk}$$

Subject to: (4)

$$\sum_{m=1}^{s} x_{mk} - \sum_{k=1}^{s} x_{km} = \xi_m$$

for all $x_{mk} \in \Re$ and non-negative where $m, k = 1, 2, \ldots\ldots, s$ and:

$$\xi_m = \begin{cases} 1 \ if & m = \Omega, \\ 0 \ if & m = \Omega+1, \Omega+2, \ldots\ldots\ldots\ldots, \mho - 1 \\ -1 \ if & m = \mho. \end{cases} \quad (5)$$

B. Transformation of crisp SPP model into neutrosophic SPP

If we tend to replace the parameter RK_{mk} into neutrosophic parameters, i.e.. RK_{mk}^{N}, then the applied math model of the neutrosophic surroundings is as follows: Kumar et al. [26]

$$Min = \sum_{m=1}^{s}\sum_{k=1}^{s} RK_{mk}^{N} \cdot x_{mk}$$

Subject to: (6)

$$\sum_{m=1}^{s} x_{mk} - \sum_{k=1}^{s} x_{km} = \tilde{\kappa}_m \qquad m,k = 1,2,.....,s.$$

$x_{mk} \in \Re$ And are non-negative.

C. Algorithm: A novel approach for finding the SPP under GVNS environment

In this section, we tend to provide a novel method for solving the NSP and the NSPL. For this purpose we consider GVNS numbers for the parameters.

Step 1: devlop a GVNS model for solving SPP.

$$Min\ GVC = \left\langle \begin{matrix} \left(\overline{NGV_{pq,s}}, \overline{NGV_{pq,t}}\right), \\ \left(NGV_{pq,s}, NGV_{pq,t}\right) \\ ,\left(\underline{NGV_{pq,s}}, \underline{NGV_{pq,t}}\right) \end{matrix} \right\rangle x_{pq} \tag{7}$$

Subject to:

$$\sum_{m=1}^{s} \overline{\pi}_{mk} - \sum_{k=1}^{s} \overline{\pi}_{mk} = \tilde{\kappa}_m$$

for all $\overline{\pi}_{mk} \in \Re$ and non-negative where $m,k = 1,2,.....,s$ and

$$\tilde{\kappa}_m = \begin{cases} 1 \ if & m = \Gamma, \\ 0 \ if & m = \Gamma+1, \Gamma+2, ..., \Lambda-1 \\ -1 \ if & m = \Lambda. \end{cases} \tag{8}$$

Step 2: use the arithmatic operation from the definition 2.3, then we get

$$GVC = \left\langle \begin{matrix} \left(\sum_{p=1}^{w}\sum_{q=1}^{w} \overline{NGV_{pq,s}} \cdot x_{pq}, \sum_{p=1}^{w}\sum_{q=1}^{w} \overline{NGV_{pq,t}} \cdot x_{pq}\right); \left(\sum_{p=1}^{w}\sum_{q=1}^{w} NGV_{pq,s} \cdot x_{pq}, \sum_{p=1}^{w}\sum_{q=1}^{w} NGV_{pq,t} \cdot x_{pq},\right); \\ \left(\sum_{p=1}^{w}\sum_{q=1}^{w} \underline{NGV_{pq,s}} \cdot x_{pq}, \sum_{p=1}^{w}\sum_{q=1}^{w} \underline{NGV_{pq,t}} \cdot x_{pq},\right) \end{matrix} \right\rangle \tag{9}$$

With subject to constraints (8)

Step 3: solve the following crisp SP problem using standard algorithm such as

$$\overline{NGV_r}^{*} = Min\ \overline{NGV_r} = \sum_{r=1}^{w}\sum_{m=1}^{w} \overline{NGV_{pq,s}} \cdot x_{pq} \tag{10}$$

With subject to constraints (8)

The optimum value of model (10), is $\overline{NGV_r}^{*}$

Step 4: solve the following crisp SP problem using standard algorithm such as

$$\overline{NGV_a}^{*} = Min\ \overline{NGV_a} = \sum_{r=1}^{w}\sum_{m=1}^{w} \overline{NGV_{pq,t}} \cdot x_{pq} \tag{11}$$

With subject to constraints

$$\sum_{p=1}^{w}\sum_{q=1}^{w} \overline{NGV_{pq,s}} \cdot x_{pq} = \overline{NGV_r}^{*}$$

Constraints of model (10)

The ideal value of equation (11) is $\overline{NGV_a}^{*}$

Step 5: solve the following crisp SP problem using standard algorithm such as

$$NGV_r^{*} = Min\ NGV_r = \sum_{p=1}^{w}\sum_{q=1}^{w} NGV_{pq,s} \cdot x_{pq} \tag{12}$$

With subject to constraints

$$\sum_{p=1}^{w}\sum_{q=1}^{w} \overline{NGV_{pq,t}} \cdot x_{pq} = \overline{NGV_a}^{*}$$

Constraints of model (11)

The ideal value of equation 12 is NGV_r^{*}

Step 6: Similarly, solve the following crisp SP problem using standard algorithm such as

$$NGV_a^{*} = Min\ NGV_a = \sum_{p=1}^{w}\sum_{q=1}^{w} NGV_{pq,t} \cdot x_{pq} \tag{13}$$

With subject to constraints

$$\sum_{p=1}^{w}\sum_{q=1}^{w} NGV_{pq,s} \cdot x_{pq} = NGV_r^{*}$$

Constraints of equation (12)

The ideal value of equation (13) is NGV_a^{*}

Step 7: Again solve the following crisp SP problem using standard algorithm such as

$$\underline{NGV_r}^{*} = Min\ \underline{NGV_r} = \sum_{p=1}^{w}\sum_{q=1}^{w} \underline{NGV_{pq,s}} \cdot x_{pq} \tag{14}$$

With subject to constraints

$$\sum_{p=1}^{w}\sum_{q=1}^{w} NGV_{pq,t} \cdot x_{pq} = NGV_a^{*}$$

Constraints of equation (13)

The ideal value of equation 14 is $\underline{NGV_r}^{*}$

Step 8: Again solve the following crisp SP problem using standard algorithm such as

$$\underline{NGV_a}^{*} = Min\ \underline{NGV_a} = \sum_{p=1}^{w}\sum_{q=1}^{w} \underline{NGV_{pq,t}} \cdot x_{pq} \tag{15}$$

With subject to constraints

$$\sum_{p=1}^{w}\sum_{q=1}^{w} \underline{NGV_{pq,s}} \cdot x_{pq} = \underline{NGV_r}^{*}$$

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Constraints of equation (14)

The ideal value of equation (15) is $\underline{NGV}_a^*$

Theorem 1: The ideal value of equation (15) provides the optimum value of IVNSSP problem (7).

Proof:let x^*_{pq} be the ideal arrangement of equation (18) and $\tilde{x}_{pq}$ be an arbitrary neutrosophic viable solution of IVNSSP (7). the solution system of the proposed technique confirms that the most excellent solution of problem (15) is the greatest answer of the problems (7)-(14). Owing the optimality of x^*_{pq} for problem (10) and feasibility of $\tilde{x}_{pq}$ for problem (10), we conclude that

$$\overline{NGV}_r^* = \sum_{r=1}^{w}\sum_{m=1}^{w}\overline{NGV}_{pq,s}\cdot x^*_{pq} \le \sum_{r=1}^{w}\sum_{m=1}^{w}\overline{NGV}_{pq,s}\cdot \tilde{x}_{pq}$$ moreover,

owing the optimality of x^*_{pq} for hassle (11) and we conclude that

$$\overline{NGV}_a^* = \sum_{r=1}^{w}\sum_{m=1}^{w}\overline{NGV}_{pq,t}\cdot x^*_{pq} \le \sum_{r=1}^{w}\sum_{m=1}^{w}\overline{NGV}_{pq,t}\cdot \tilde{x}_{pq}$$ similar

discussions make sure that

$$NGV_r^* = \sum_{p=1}^{w}\sum_{q=1}^{w}NGV_{pq,s}\cdot x_{pq} \le \sum_{r=1}^{w}\sum_{m=1}^{w}\overline{NGV}_{pq,s}\cdot \tilde{x}_{pq}\ ;$$

$$NGV_a^* = \sum_{p=1}^{w}\sum_{q=1}^{w}NGV_{pq,t}\cdot x_{pq} \le \sum_{r=1}^{w}\sum_{m=1}^{w}\overline{NGV}_{pq,t}\cdot \tilde{x}_{pq}\ ;$$

$$\underline{NGV}_r^* = \sum_{p=1}^{w}\sum_{q=1}^{w}\underline{NGV}_{pq,s}\cdot x_{pq} \le \sum_{p=1}^{w}\sum_{q=1}^{w}\underline{NGV}_{pq,s}\cdot \tilde{x}_{pq}\ ;$$

$$\underline{NGV}_a^* = \sum_{p=1}^{w}\sum_{q=1}^{w}\underline{NGV}_{pq,t}\cdot x_{pq} \le \sum_{p=1}^{w}\sum_{q=1}^{w}\underline{NGV}_{pq,t}\cdot \tilde{x}_{pq}\ ;$$

Therefore

$$GVC = \left\langle \begin{matrix} \left(\overline{NGV}_r^*, \overline{NGV}_a^*\right), \\ \left(NGV_r^*, NGV_a^*\right), \\ \left(\underline{NGV}_r^*, \underline{NGV}_a^*\right) \end{matrix} \right\rangle \preceq \left\langle \begin{matrix} \left(\sum_{p=1}^{w}\sum_{q=1}^{w}\overline{NGV}_{pq,s}\cdot x_{pq}, \sum_{p=1}^{w}\sum_{q=1}^{w}\overline{NGV}_{pq,t}\cdot x_{pq}\right); \\ \left(\sum_{p=1}^{w}\sum_{q=1}^{w}NGV_{pq,s}\cdot x_{pq}, \sum_{p=1}^{w}\sum_{q=1}^{w}NGV_{pq,t}\cdot x_{pq},\right); \\ \left(\sum_{p=1}^{w}\sum_{q=1}^{w}\underline{NGV}_{pq,s}\cdot x_{pq}, \sum_{p=1}^{w}\sum_{q=1}^{w}\underline{NGV}_{pq,t}\cdot x_{pq},\right) \end{matrix} \right\rangle$$

IV. EXAMPLE OF NETWORK

To justify our proposed algorithms, we consider a network shown in fig. 3 Kumar et al. [33]

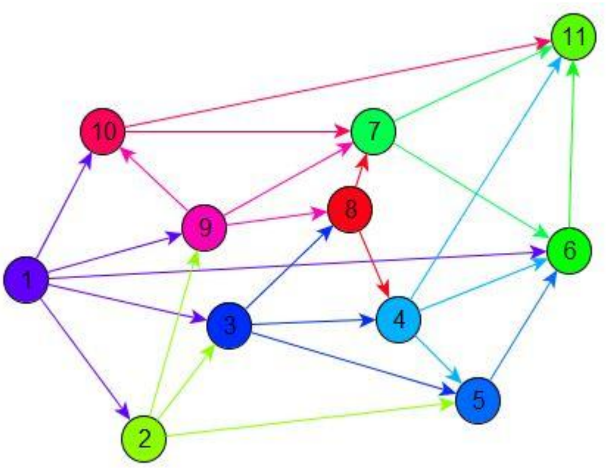

Figure 2. A network with eleven vertices and twenty-five edges Kumar et al. [33]

Example 4.1. Consider ***Figure 2*** with 11 nodes and 25 edges, where SV is 1 and DV is 11. The GVNS time is given in Table 1.

I. Table 2. The conditions of Example 4.1.

T	H	TrNS time	T	H	TrNS time
1	2	<(15,3);(17,5);(8,1)>	9	7	<(25,5);(20,6);(9,7)>
1	6	<(14,2);(5,1);(11,6)>	10	7	<(28,8);(6,1);(16,2)>
1	9	<(15,3);(4,1);(12,5)>	4	6	<(19,10);(8,3);(10,5)>
1	10	<(4,1); (5,1);(6,2)>	10	11	<(50,11);(10,6);(12,7)>
2	3	<(6,4);(5,3);(3,1)>	1	3	<(3,1);(2,1);(2,1)>
2	5	<(16,8);(11,7);(7,2)>	4	11	<(31,20);(9,7);(17,14)>
3	4	<(24,2);(8,1);(15,9)>	2	9	<(30,5);(15,5);(16,6)>
3	5	<(27,9);(9,6);(15,9)>	3	8	<(38,30);(20,10);(27,20)>
4	5	<(25,4);(13,2);(12,8)>	6	11	<(35,21);(9,7);(18,10)>
5	6	<(24,6);(13,2);(13,2)>	7	11	<(13,3);(3,1);(2,1)>
7	6	<(23,3);(11,4);(15,7)>	9	8	<(19,9);(8,7);(7,4)>
8	4	<(28,9);(15,7);(16,10)>	9	10	<(26,4);(5,3)(18,8)>
8	7	<(30,20);(8,6);(19,9)>			

Solution: Applying steps 1-8 in proposed Algorithm, the GVNSSP is $1 \to 10 \to 7 \to 11$ and the GVNSSPL is < (45, 12); (14, 3); (24, 5

>. The result is shown in below figure 3 and we can conclude that the GVNSSPL preserve the GVNS structure. Moreover, the suggested shortest route is depicted in figure 4.

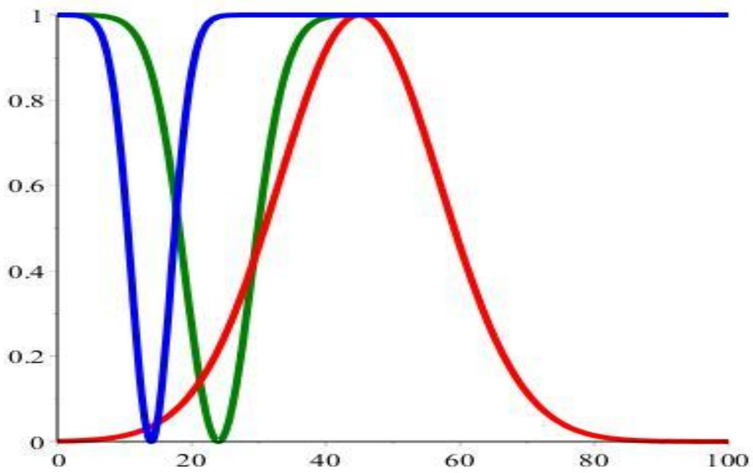

Figure 3. the optimum solution also preserve the weight of gaussian fuzzy structure.

Proposed algorithm is executed numerically as follows:

Step 1: The GVNSSP model is detailed as shown in equation 7:

$$
\begin{aligned}
Min\ GVC =\ & <(15,3);(17,5);(8,1)> \cdot x_{12} + <(14,2);(5,1);(11,6)> \cdot x_{16} + <(3,1);(2,1);(2,1)> \cdot x_{13} \\
& + <(15,3);(4,1);(12,5)> \cdot x_{19} + <(4,1);\ (5,1);(6,2)> \cdot x_{110} + <(6,4);(5,3);(3,1)> \cdot x_{23} + \\
& <(25,5);(20,6);(9,7)> \cdot x_{97} + <(28,8);(6,1);(16,9)> \cdot x_{107} + <(19,10);(8,3);(10,5)> \cdot x_{46} + \\
& <(50,11);(10,6);(12,7)> \cdot x_{1011} + <(16,8);(11,7);(7,2)> \cdot x_{25} + <(31,20);(9,7);(17,14)> \cdot x_{411} + \\
& <(24,2);(8,1);(15,9)> \cdot x_{34} + <(30,5);(15,5);(16,6)> \cdot x_{29} + <(27,9);(9,6);(15,9)> \cdot x_{35} + \\
& <(38,30);(20,10);(27,20)> \cdot x_{35} + <(25,4);(13,2);(12,8)> \cdot x_{45} + <(35,21);(9,7);(18,10)> \cdot x_{611} + \\
& <(24,6);(13,2);(13,2)> \cdot x_{56} + <(13,3);(3,1);(2,1)> \cdot x_{711} + <(23,3);(11,4);(15,7)> \cdot x_{76} + \\
& <(19,9);(8,7);(7,4)> \cdot x_{98} + <(28,9);(15,7);(16,10)> \cdot x_{84} + <(26,4);(5,3)(18,8)> \cdot x_{910} + \\
& <(30,20);(8,6);(19,9)> \cdot x_{87}
\end{aligned}
$$

Subject to constraints in line with equation (8)

$$
\begin{array}{lll}
x_{12}+x_{13}+x_{16}+x_{19}+x_{110}=1; & x_{23}+x_{25}+x_{29}=x_{12}; & x_{34}+x_{35}+x_{38}=x_{13}+x_{23} \\
x_{45}+x_{46}+x_{411}=x_{34}+x_{84} & x_{56}=x_{25}+x_{35}+x_{45}; & x_{611}=x_{56}+x_{46}+x_{16}+x_{76}; \\
x_{1011}=x_{110}+x_{910}; & x_{76}+x_{711}=x_{87}+x_{97}+x_{107}; & x_{84}+x_{87}=x_{38}+x_{98}; \\
x_{98}+x_{97}+x_{910}=x_{19}+x_{29}; & x_{1011}=x_{110}+x_{910}; & x_{411}+x_{611}+x_{711}+x_{1011}=1;
\end{array}
$$

Step 2: Execute the arithmatic operation on equation (7) then proceed to step 3

Step 3: Now we get the linear standard equation (10)

$$
\begin{aligned}
\overline{NGV_r}^{*} = Min\ \overline{NGV_r} =\ & 15 \bullet x_{12} + 14 \bullet x_{16} + 15 \bullet x_{19} + 15 \bullet x_{110} + 6 \bullet x_{23} + 16 \bullet x_{25} + 24 \bullet x_{34} + 27 \bullet x_{35} + 25 \bullet x_{45} + \\
& 24 \bullet x_{56} + 23 \bullet x_{76} + 28 \bullet x_{84} + 30 \bullet x_{87} + 25 \bullet x_{97} + 28 \bullet x_{107} + 19 \bullet x_{46} + 50 \bullet x_{1011} + 3 \bullet x_{13} + \\
& 31 \bullet x_{411} + 30 \bullet x_{29} + 38 \bullet x_{38} + 35 \bullet x_{611} + 13 \bullet x_{711} + 19 \bullet x_{98} + 26 \bullet x_{910}
\end{aligned}
$$

Subject to constraints in line with equation (8)

After excecuting the LPP then the optimal solution is 45.

Step 4: Now we get the linear standard equation (11)

$$
\begin{aligned}
\overline{NGV_a}^{*} = Min\ \overline{NGV_a} =\ & 3 \bullet x_{12} + 2 \bullet x_{16} + 3 \bullet x_{19} + 1 \bullet x_{110} + 4 \bullet x_{23} + 8 \bullet x_{25} + 2 \bullet x_{34} + 9 \bullet x_{35} + 4 \bullet x_{45} + \\
& 6 \bullet x_{56} + 3 \bullet x_{76} + 20 \bullet x_{84} + 9 \bullet x_{87} + 5 \bullet x_{97} + 8 \bullet x_{107} + 10 \bullet x_{46} + 11 \bullet x_{1011} + 1 \bullet x_{13} + \\
& 30 \bullet x_{411} + 5 \bullet x_{29} + 20 \bullet x_{38} + 21 \bullet x_{611} + 3 \bullet x_{711} + 9 \bullet x_{98} + 4 \bullet x_{910}
\end{aligned}
$$

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Subject to constraints in line with equation (10) and

$$15\bullet x_{12} + 14\bullet x_{16} + 15\bullet x_{19} + 15\bullet x_{110} + 6\bullet x_{23} + 16\bullet x_{25} + 24\bullet x_{34} + 27\bullet x_{35} + 25\bullet x_{45} + 24\bullet x_{56} + 23\bullet x_{76} + 28\bullet x_{84} + 30\bullet x_{87} + 25\bullet x_{97} + 28\bullet x_{107} + 19\bullet x_{46} + 50\bullet x_{1011} + 3\bullet x_{13} + 31\bullet x_{411} + 30\bullet x_{29} + 38\bullet x_{38} + 35\bullet x_{611} + 13\bullet x_{711} + 19\bullet x_{98} + 26\bullet x_{910} = 45;$$

After excecute the LPP then the optimal solution is 12

Similarly proceed from step 5 to step 8, we get the final optimum solution the NSSP is $1 \to 10 \to 7 \to 11$ and the NSSPL is <(45,12);(14,3);(24,5)>. Finally the shortest route is shown in figure 4:

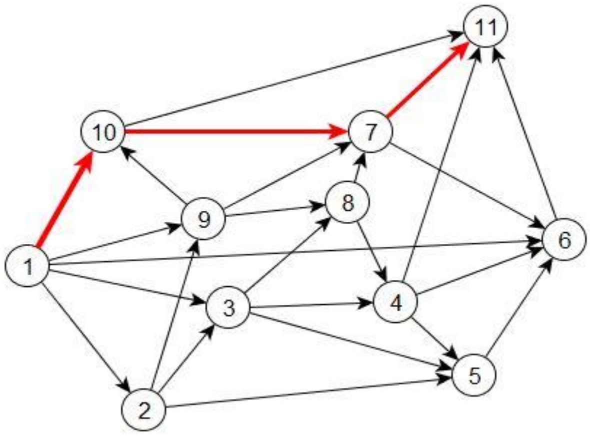

Figure 4: shown the suggested shortest route

V. CONCLUSION

Conventional SP issue expects exact qualities for the curve loads which aren't generally the situation in genuine circumstances. In this article, briefest issue for numbering esteemed neutrosophic circular segment loads has been explored. We initially figured the issue in the number esteemed neutrosophic condition. At that point, we proposed another arrangement approach for understanding whole number esteemed neutrosophic most limited issue. We have changed over the GVNSSPP issue under thought to multi-objective LP issues which can be illuminated utilizing the standard LP calculations. According to the proposed optimization manner, the Gaussian-valued neutrosophic source weight has preserved the shape of a Gaussian-valued neutrosophic quantity. The numerical results show that the new algorithms outperform the present day strategies. In future, we will extend the method to more complicated community issues involving Gaussian-valued neutrosophic costs.

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