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A Novel Complex Intuitionistic Fuzzy Linguistic Framework with Generalized Power-Geometric Aggregation Operators for Human–Machine Interface Analysis

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A human-machine interface (HMI) is a technique of technology that enables communication and interaction between machines, robots, and humans. The major goal is to create an intuitive and effective means for humans to interact with awkward machinery or computerized systems. In this manuscript, we propose complex intuitionistic fuzzy linguistic (CIFL) sets and derive their valuable laws. Furthermore, we introduce the CIFL power geometric (CIFLPG) operator, CIFL power weighted geometric (CIFLPWG) operator, CIFL generalized power geometric (CIFLGPG) operator, and CIFL generalized power weighted geometric (CIFLGPWG) operator. Several fundamental properties are likewise established associated with these four techniques. Moreover, each procedure contains many features, but identifying which feature significantly influences the application of the human-machine interface is very complicated; for this, we describe the process of the multi-attribute decision-making (MADM) method using the derived operators for identifying the optimal feature for the human-machine interface to improve the performance of the proposed operators. Subsequently, we discuss a comparison of the proposed methods against selected existing techniques through numerical examples to show the superiority as well as flexibility of the proposed method.

1. Introduction

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In real-world problems, we need a valuable and robust procedure for evaluating them because, in our observations, many people use decision-making techniques to determine the optimal decision among a finite set of available alternatives according to specific criteria or attributes.

Moreover, the human-machine interface [1, 2] is also a very dominant technique for evaluating or depicting imprecise and uncertain information in real-world problems. Many scholars have utilized it in the fields of engineering, computer science, and artificial intelligence based on crisp set theory. Furthermore, these applications have been utilized based on crisp set or classical set theory, and as a consequence, substantial information was lost. It was noticed that under crisp set theory, only two forms of information are possible: zero or one, with no intermediate values. For handling such kinds of problems, Zadeh [3] introduced the concept of fuzzy set (FS). The membership grade in FS theory is specified over the unit interval for elements of the universal set. Furthermore, Atanassov [4, 5] derived the intuitionistic FS (IFS) with two functions, referred to as supporting grade "$\Re_{\Xi_\tau}(\mathfrak{x})$" and supporting against grade "$\Im_{\Xi_\tau}(\mathfrak{x})$" with a characteristic that is $0 \leq \Re_{\Xi_\tau}(\mathfrak{x}) + \Im_{\Xi_\tau}(\mathfrak{x}) \leq 1$, because without support against the grade, many problems have occurred in genuine life dilemmas. Further, we noticed that the FS is the dominant idea of the IFS because to remove the grade of falsity "$\Im_{\Xi_\tau}(\mathfrak{x})$" from IFS, then we can easily derive the FS theory. Furthermore, we have the following applications based on FSs and IFSs, for instance, on a novel view of FS theory [6], fuzzy superior mandelbrot set [7], fuzzy set-configurational analysis concerning job characteristics [8], TOPSIS technique and Hamacher operators for IFSs [9], and power aggregation operators founded on Aczel-Alsina operational rules for interval-valued IFSs [10].

Ramot et al. [11] introduced the complex FS (CFS), which is a similar concept formulated differently, since FS theory employs a truth grade defined over the unit interval, but in the case of CFS, we have a truth grade represented by a complex number, in which both real and imaginary components lie within the unit interval, indicating that FS theory can be regarded as a special case of CFS. However, truth with a complex-valued representation is not enough because, in many situations, we are required to use an extended approach that will contain a complex-valued membership grade and a complex-valued non-membership grade. For this, Alkouri and Salleh [12] introduced the complex intuitionistic fuzzy set (CIFS), where the CIFS theory incorporates two distinct grades within the same framework, denoted as truth grade $\left(\Re^R_{\Xi_\tau}(\mathfrak{x}), \Re^I_{\Xi_\tau}(\mathfrak{x})\right)$and falsity grade "$\left(\Im^R_{\Xi_\tau}(\mathfrak{x}), \Im^I_{\Xi_\tau}(\mathfrak{x})\right)$", with two strong conditions: $0 \leq \Re^R_{\Xi_\tau}(\mathfrak{x}) + \Im^R_{\Xi_\tau}(\mathfrak{x}) \leq 1$ and $0 \leq \Re^I_{\Xi_\tau}(\mathfrak{x}) + \Im^I_{\Xi_\tau}(\mathfrak{x}) \leq 1$. Moreover, these concepts have numerous applications owing to their ability to represent two-dimensional information in real-world applications. Several important applications of CFSs and CIFSs have been developed including, for example, for instance, complex fuzzy distance and cross-entropy measures [13], complex fuzzy neighborhood operators [14], information measures associated with CIFSs [15], Aczel-Alsina power operators for CIFSs [16], robust correlation coefficient measures for CIFSs [17], competition graph for CIFSs [18], operation properties and (a, b)-equalities for CIFSs [19], together with a novel representation of IFSs and their applications in decision-making problems [20].

In numerous real-world problems, we have assigned information expressed through linguistic terms, where the linguistic set (LS) framework was initiated by Zadeh [21, 22], which provides an effective framework for representing imprecise information in various real-world situations. Further, Herrera et al. [23] evaluated the combination of FS and LS, called fuzzy LS (FLS). Moreover, Zhang [24] derived linguistic IFS (LIFS). Further, the novel complex linguistic fuzzy set (CLFS) theory was introduced by Mahmood et al. [25] through the integration of two distinct approaches, called CFSs and LSs. Additionally, Rodriguez et al. [26] derived the complex fuzzy preference relations. Anyhow,

many scholars have combined the idea of LSs and CFSs, for instance, Alkouri and Salleh [27]. Further, Yager [28] presented the generalized weighted geometric (GWG) operators. Yager [29] also introduced the power averaging (PA) operators. Furthermore, the above operators are defined based on fuzzy set and their extensions by many scholars, for example, Zhao et al. [30] introduced modified operators for IFSs, Bi et al. [31] presented averaging operators associated with IFSs, Hu et al. [32] proposed PA operators, Garg and Rani [33] developed modified operators for CIFSs, Liu et al. [34] examined power-modified operators for intuitionistic linguistic sets, Zhao et al. [35] proposed the modified power operators for IFSS, Jiang et al. [36] developed power operators for IFSs, Xu [37] examined aggregation operators for IFSs, and Rani and Garg [38] analyzed power operators for CIFSs. After our observations, we noticed that the existing techniques present several limitations and problems owing to their underlying structure; therefore, we are required to examine the CIFL sets and their operational laws. During decision-making processes, experts commonly encounter the following questions; for instance, how can new ideas be assessed? How can new operators be formulated? How can the optimal choice be determined according to the ranking values obtained? Therefore, we aim to investigate CIFLS and their operational laws, because this idea has many advantages. While retaining the benefits of CIFLS, the principal contributions of this study are given below:

i. To formulate CIFL sets and establish their fundamental laws.
ii. To introduce the CIFLPG operator, CIFLPWG operator, CIFLGPG operator, and CIFLGPWG operator.
iii. To establish several important properties associated with the four proposed techniques.
iv. Each procedure involves multiple features, but finding which feature has a significant role in applying the Human-machine interface is very complicated.
v. To formulate the MADM procedure using the proposed operators for identifying the optimal feature for the human-machine interface to improve the performance of the proposed operators.
vi. To discuss a comparison of the proposed methods against selected existing techniques through numerical examples to demonstrate the superiority and flexibility of the proposed approaches.

This manuscript is organized as follows: In Section 2, we presented the concept of the PA operator and the GWG operator within the crisp set framework. Further, we reviewed the IFLS and reformulated their operational laws with respect to the universal set $\mathfrak{X}$. In Section 3, we formulated the CIFL sets and established their fundamental laws. In Section 4, we introduced the CIFLPG operator, CIFLPWG operator, CIFLGPG operator, and CIFLGPWG operator. Several fundamental properties are also established for the above four techniques. Section 5 focuses on the fact that each procedure involves multiple features, but identifying the feature that is most influential in applying the Human-machine interface is considerably challenging; therefore, we formulated the procedure for the MADM framework using the proposed operators for identifying the optimal feature for the human-machine interface to improve the performance of the proposed operators. In Section 6, we presented a comparison among the proposed methods against selected existing techniques through numerical examples to demonstrate the superiority and flexibility of the proposed approaches. Section 7 presents the concluding remarks.

2. Preliminaries

This section briefly presents the concept of the PA operator, together with the GWG operator within the crisp set framework. Further, we reviewed the IFLS and reformulated their operational laws with respect to the universal set $\mathfrak{X}$.

Definition 1: [29] The PA operator concept based on the family of non-negative integers $\Xi_\tau^\varsigma, \varsigma = 1,2,\dots,\varrho$, is defined below:

$$PA\left(\Xi_\tau^1, \Xi_\tau^2, \dots, \Xi_\tau^\varrho\right) = \sum_{\varsigma=1}^{\varrho} \frac{\left(1+\overline{\overline{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\sum_{\varsigma=1}^{\varrho}\left(1+\overline{\overline{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)} \Xi_\tau^\varsigma \tag{1}$$

Additionally, the term $\overline{\overline{\Phi}}_Z\left(\Xi_\tau^\varsigma\right) = \sum_{\varsigma\neq\iota=1}^{\varrho} S\left(\Xi_\tau^\varsigma, \Xi_\tau^\iota\right)$, where $S\left(\Xi_\tau^\varsigma, \Xi_\tau^\iota\right) = 1 - D\left(\Xi_\tau^\varsigma, \Xi_\tau^\iota\right)$. Here, we have the following properties:

i. $S\left(\Xi_\tau^\varsigma, \Xi_\tau^\iota\right) \in [0,1]$.
ii. $S\left(\Xi_\tau^\varsigma, \Xi_\tau^\iota\right) = S\left(\Xi_\tau^\iota, \Xi_\tau^\varsigma\right)$.
iii. If $S\left(\Xi_\tau^\varsigma, \Xi_\tau^\iota\right) > S(\Xi_\tau^k, \Xi_\tau^l)$ then $S\left(\Xi_\tau^\varsigma, \Xi_\tau^\iota\right) < S(\Xi_\tau^k, \Xi_\tau^l)$.

Definition 2: [28] The idea of GWG operator based on the family of non-negative integers $\Xi_\tau^\varsigma, \varsigma = 1,2,\dots,\varrho$, is initiated below:

$$GWG\left(\Xi_\tau^1, \Xi_\tau^2, \dots, \Xi_\tau^\varrho\right) = \frac{1}{\mathbb{C}_s}\left(\sum_{\varsigma=1}^{\varrho} \mathbb{C}_s\left(\Xi_\tau^\varsigma\right)^{\overline{\overline{\mathfrak{H}w_\varsigma}}}\right) \tag{2}$$

The mathematical shape of the weight vector is denoted by: $\sum_{\varsigma=1}^{\varrho} \overline{\overline{\mathfrak{H}w_\varsigma}} = 1, \overline{\overline{\mathfrak{H}w_\varsigma}} \in [0,1]$, and $\mathbb{C}_s \geq 1$.

Definition 3: [34] An IFLS is exposed in the shape:

$$\Xi_\tau = \left\{\left(\mathfrak{Q}_{\Lambda(\mathfrak{x})}, \mathfrak{R}_{\Xi_\tau}(\mathfrak{x}), \mathfrak{S}_{\Xi_\tau}(\mathfrak{x})\right) : \mathfrak{x} \in \mathfrak{X}\right\} \tag{3}$$

Noticed that $\mathfrak{Q}_{\Lambda(\mathfrak{x})} \in \ddot{\mathcal{S}}_{[0,\Pi]} = \{\mathcal{s}_\ell : \ell \in R\}$ represents the linguistic set and the mathematical shape of truth and falsity functions are denoted by: $\mathfrak{R}_{\Xi_\tau}, \mathfrak{S}_{\Xi_\tau} : \mathfrak{X} \to [0,1]$ with $0 \leq \mathfrak{R}_{\Xi_\tau}(\mathfrak{x}) + \mathfrak{S}_{\Xi_\tau}(\mathfrak{x}) \leq 1$. Moreover, the refusal degree is obtained expressed as: $\mathcal{R}_{\Xi_\tau}((\mathfrak{x})) = 1 - \left(\mathfrak{R}_{\Xi_\tau}(\mathfrak{x}) + \mathfrak{S}_{\Xi_\tau}(\mathfrak{x})\right)$. Finally, the form $\Xi_\tau^\varsigma = \left(\mathfrak{Q}_{\Lambda_\varsigma}, \mathfrak{R}_{\Xi_\tau^\varsigma}, \mathfrak{S}_{\Xi_\tau^\varsigma}\right), \varsigma = 1,2,\dots,\varrho$, represents the IFL numbers (IFLNs).

Definition 4: [34] Let $\Xi_\tau^\varsigma = \left(\mathfrak{Q}_{\Lambda_\varsigma}, \mathfrak{R}_{\Xi_\tau^\varsigma}, \mathfrak{S}_{\Xi_\tau^\varsigma}\right), \varsigma = 1,2,\dots,\varrho$ be any IFLNs. Then

$$\Xi_\tau^1 \oplus \Xi_\tau^2 = \left(\mathfrak{Q}_{\Pi\left(\frac{\Lambda_1}{\Pi}+\frac{\Lambda_2}{\Pi}-\frac{\Lambda_1\Lambda_2}{\Pi\,\Pi}\right)}, \mathfrak{R}_{\Xi_\tau^1} + \mathfrak{R}_{\Xi_\tau^2} - \mathfrak{R}_{\Xi_\tau^1}\mathfrak{R}_{\Xi_\tau^2}, \mathfrak{S}_{\Xi_\tau^1}\mathfrak{S}_{\Xi_\tau^2}\right)$$

$$\Xi_\tau^1 \otimes \Xi_\tau^2 = \left(\mathfrak{Q}_{\Pi\left(\frac{\Lambda_1\Lambda_2}{\Pi\,\Pi}\right)}, \mathfrak{R}_{\Xi_\tau^1}\mathfrak{R}_{\Xi_\tau^2}, \mathfrak{S}_{\Xi_\tau^1} + \mathfrak{S}_{\Xi_\tau^2} - \mathfrak{S}_{\Xi_\tau^1}\mathfrak{S}_{\Xi_\tau^2}\right)$$

$$\mathbb{C}_s\Xi_\tau^1 = \left(\mathfrak{Q}_{\Pi\left(1-\left(1-\frac{\Lambda_1}{\Pi}\right)^{\mathbb{C}_s}\right)}, 1 - \left(1 - \mathfrak{R}_{\Xi_\tau^1}\right)^{\mathbb{C}_s}, \left(\mathfrak{S}_{\Xi_\tau^1}\right)^{\mathbb{C}_s}\right)$$

$$(\Xi_\tau^1)^{\mathbb{C}_s} = \left(\mathfrak{L}_{\Pi\left(\frac{\Lambda_1}{\Pi}\right)^{\mathbb{C}_s}}, \left(\Re_{\Xi_\tau^1}\right)^{\mathbb{C}_s}, 1 - \left(1 - \Im_{\Xi_\tau^1}\right)^{\mathbb{C}_s} \right)$$

Definition 5: [34] Let $\Xi_\tau^\varsigma = \left(\mathfrak{L}_{\Lambda_\varsigma}, \Re_{\Xi_\tau^\varsigma}, \Im_{\Xi_\tau^\varsigma}\right), \varsigma = 1,2, \dots, \varrho$ be any IFLNs. Then the score function and accuracy function are derived below:

$$\Im^{SF}\left(\Xi_\tau^\varsigma\right) = \mathfrak{L}_{\Lambda_\varsigma * \left(\Re_{\Xi_\tau^\varsigma} - \Im_{\Xi_\tau^\varsigma}\right)} \in \mathfrak{L}_{[-1,\Pi]}$$

$$\Im^{AF}\left(\Xi_\tau^\varsigma\right) = \mathfrak{L}_{\Lambda_\varsigma * \left(\Re_{\Xi_\tau^\varsigma} + \Im_{\Xi_\tau^\varsigma}\right)} \in \mathfrak{L}_{[0,\Pi]}$$

Some dominant conditions are derived below: If $\Im^{SF}(\Xi_\tau^1) > \Im^{SF}(\Xi_\tau^2)$, then $\Xi_\tau^1 > \Xi_\tau^2$; if $\Im^{SF}(\Xi_\tau^1) < \Im^{SF}(\Xi_\tau^2)$, then $\Xi_\tau^1 < \Xi_\tau^2$; if $\Im^{SF}(\Xi_\tau^1) = \Im^{SF}(\Xi_\tau^2)$, then, if $\Im^{AF}(\Xi_\tau^1) > \Im^{AF}(\Xi_\tau^2)$, then $\Xi_\tau^1 > \Xi_\tau^2$; if $\Im^{AF}(\Xi_\tau^1) < \Im^{AF}(\Xi_\tau^2)$, then $\Xi_\tau^1 < \Xi_\tau^2$.

3. CIFL Sets

This section introduces the novel idea of CIFLSs and their fundamental properties, like score value, accuracy value, and algebraic laws.

Definition 6: A CIFLS is expressed in the following form:

$$\Xi_\tau = \left\{ \left(\mathfrak{L}_{\Lambda(\mathfrak{x})}, \left(\Re_{\Xi_\tau}^R(\mathfrak{x}), \Re_{\Xi_\tau}^I(\mathfrak{x}) \right), \left(\Im_{\Xi_\tau}^R(\mathfrak{x}), \Im_{\Xi_\tau}^I(\mathfrak{x}) \right) \right) : \mathfrak{x} \in \mathfrak{X} \right\} \tag{4}$$

Noticed that $\mathfrak{L}_{\Lambda(\mathfrak{x})} \in \ddot{S}_{[0,\Pi]} = \{\mathcal{s}_\ell : \ell \in R\}$ represents the linguistic set, and the mathematical shape of truth and falsity grades is initiated in the shape: $\Re_{\Xi_\tau}^R, \Im_{\Xi_\tau}^R, \Re_{\Xi_\tau}^I, \Im_{\Xi_\tau}^I : \mathfrak{X} \to [0,1]$ with $0 \le \Re_{\Xi_\tau}^R(\mathfrak{x}) + \Im_{\Xi_\tau}^R(\mathfrak{x}) \le 1$ and $0 \le \Re_{\Xi_\tau}^I(\mathfrak{x}) + \Im_{\Xi_\tau}^I(\mathfrak{x}) \le 1$. Additionally, we derived the refusal grade in the shape: $\mathcal{R}_{\Xi_\tau}(\mathfrak{x}) = \left(\mathcal{R}_{\Xi_\tau}^R(\mathfrak{x}), \mathcal{R}_{\Xi_\tau}^I(\mathfrak{x})\right) = \left(1 - \left(\Re_{\Xi_\tau}^R(\mathfrak{x}) + \Im_{\Xi_\tau}^R(\mathfrak{x})\right), 1 - \left(\Re_{\Xi_\tau}^I(\mathfrak{x}) + \Im_{\Xi_\tau}^I(\mathfrak{x})\right)\right)$. Finally, $\Xi_\tau^\varsigma = \left(\mathfrak{L}_{\Lambda_\varsigma}, \left(\Re_{\Xi_\tau^\varsigma}^R, \Re_{\Xi_\tau^\varsigma}^I\right), \left(\Im_{\Xi_\tau^\varsigma}^R, \Im_{\Xi_\tau^\varsigma}^I\right)\right), \varsigma = 1,2, \dots, \varrho$ represents the CIFL numbers (CIFLNs).

Definition 7: Let $\Xi_\tau^\varsigma = \left(\mathfrak{L}_{\Lambda_\varsigma}, \left(\Re_{\Xi_\tau^\varsigma}^R, \Re_{\Xi_\tau^\varsigma}^I\right), \left(\Im_{\Xi_\tau^\varsigma}^R, \Im_{\Xi_\tau^\varsigma}^I\right)\right), \varsigma = 1,2$, be any CIFLN. Then

$$\Xi_\tau^1 \oplus \Xi_\tau^2 = \left(\mathfrak{L}_{\Pi\left(\frac{\Lambda_1}{\Pi} + \frac{\Lambda_2}{\Pi} - \frac{\Lambda_1 \Lambda_2}{\Pi\ \Pi}\right)}, \left(\Re_{\Xi_\tau^1}^R + \Re_{\Xi_\tau^2}^R - \Re_{\Xi_\tau^1}^R \Re_{\Xi_\tau^2}^R, \Re_{\Xi_\tau^1}^I + \Re_{\Xi_\tau^2}^I - \Re_{\Xi_\tau^1}^I \Re_{\Xi_\tau^2}^I \right), \left(\Im_{\Xi_\tau^1}^R \Im_{\Xi_\tau^2}^R, \Im_{\Xi_\tau^1}^I \Im_{\Xi_\tau^2}^I \right) \right)$$

$$\Xi_\tau^1 \otimes \Xi_\tau^2 = \left(\mathfrak{L}_{\Pi\left(\frac{\Lambda_1 \Lambda_2}{\Pi\ \Pi}\right)}, \left(\Re_{\Xi_\tau^1}^R \Re_{\Xi_\tau^2}^R, \Re_{\Xi_\tau^1}^I \Re_{\Xi_\tau^2}^I \right), \left(\Im_{\Xi_\tau^1}^R + \Im_{\Xi_\tau^2}^R - \Im_{\Xi_\tau^1}^R \Im_{\Xi_\tau^2}^R, \Im_{\Xi_\tau^1}^I + \Im_{\Xi_\tau^2}^I - \Im_{\Xi_\tau^1}^I \Im_{\Xi_\tau^2}^I \right) \right)$$

$$\mathbb{C}_s \Xi_\tau^1 = \left(\mathfrak{L}_{\Pi\left(1 - \left(1 - \frac{\Lambda_1}{\Pi}\right)^{\mathbb{C}_s}\right)}, \left(1 - \left(1 - \Re_{\Xi_\tau^1}^R\right)^{\mathbb{C}_s}, 1 - \left(1 - \Re_{\Xi_\tau^1}^I\right)^{\mathbb{C}_s} \right), \left(\left(\Im_{\Xi_\tau^1}^R\right)^{\mathbb{C}_s}, \left(\Im_{\Xi_\tau^1}^I\right)^{\mathbb{C}_s} \right) \right)$$

$$(\Xi_\tau^1)^{\mathbb{C}_s} = \left(\mathfrak{L}_{\Pi\left(\frac{\Lambda_1}{\Pi}\right)^{\mathbb{C}_s}}, \left(\left(\Re_{\Xi_\tau^1}^R\right)^{\mathbb{C}_s}, \left(\Re_{\Xi_\tau^1}^I\right)^{\mathbb{C}_s} \right), \left(1-\left(1-\Im_{\Xi_\tau^1}^R\right)^{\mathbb{C}_s}, 1-\left(1-\Im_{\Xi_\tau^1}^I\right)^{\mathbb{C}_s} \right) \right)$$

Definition 8: Let $\Xi_\tau^\varsigma = \left(\mathfrak{L}_{\Lambda_\varsigma}, \left(\Re_{\Xi_\tau^\varsigma}^R, \Re_{\Xi_\tau^\varsigma}^I \right), \left(\Im_{\Xi_\tau^\varsigma}^R, \Im_{\Xi_\tau^\varsigma}^I \right) \right), \varsigma = 1,2$, be any CIFLN. Then we derived the score and accuracy function, such as

$$\Im^{SF}\left(\Xi_\tau^\varsigma\right) = \mathfrak{L}_{\Lambda_\varsigma * \frac{\left(\Re_{\Xi_\tau^\varsigma}^R - \Im_{\Xi_\tau^\varsigma}^R + \Re_{\Xi_\tau^\varsigma}^I - \Im_{\Xi_\tau^\varsigma}^I\right)}{2}} \in \mathfrak{L}_{[-1,\Pi]}$$

$$\Im^{AF}\left(\Xi_\tau^\varsigma\right) = \mathfrak{L}_{\Lambda_\varsigma * \frac{\left(\Re_{\Xi_\tau^\varsigma}^R + \Im_{\Xi_\tau^\varsigma}^R + \Re_{\Xi_\tau^\varsigma}^I + \Im_{\Xi_\tau^\varsigma}^I\right)}{2}} \in \mathfrak{L}_{[0,\Pi]}$$

Some dominant conditions are stated in the shape: If $\Im^{SF}(\Xi_\tau^1) > \Im^{SF}(\Xi_\tau^2)$, then $\Xi_\tau^1 > \Xi_\tau^2$; if $\Im^{SF}(\Xi_\tau^1) < \Im^{SF}(\Xi_\tau^2)$, then $\Xi_\tau^1 < \Xi_\tau^2$; if $\Im^{SF}(\Xi_\tau^1) = \Im^{SF}(\Xi_\tau^2)$, then if $\Im^{AF}(\Xi_\tau^1) > \Im^{AF}(\Xi_\tau^2)$, then $\Xi_\tau^1 > \Xi_\tau^2$; if $\Im^{AF}(\Xi_\tau^1) < \Im^{AF}(\Xi_\tau^2)$, then $\Xi_\tau^1 < \Xi_\tau^2$.

Theorem 1: Let $\Xi_\tau^\varsigma = \left(\mathfrak{L}_{\Lambda_\varsigma}, \left(\Re_{\Xi_\tau^\varsigma}^R, \Re_{\Xi_\tau^\varsigma}^I \right), \left(\Im_{\Xi_\tau^\varsigma}^R, \Im_{\Xi_\tau^\varsigma}^I \right) \right), \varsigma = 1,2, \dots, \varrho$, be any collection of CIFLNs. Thus

1) $\Xi_\tau^1 \oplus \Xi_\tau^2 = \Xi_\tau^2 \oplus \Xi_\tau^1$.
2) $\Xi_\tau^1 \otimes \Xi_\tau^2 = \Xi_\tau^2 \otimes \Xi_\tau^1$.
3) $\mathbb{C}_s \Xi_\tau^1 \oplus \mathbb{C}_s \Xi_\tau^2 = \mathbb{C}_s(\Xi_\tau^1 \oplus \Xi_\tau^2)$.
4) $(\Xi_\tau^1)^{\mathbb{C}_s} \otimes (\Xi_\tau^2)^{\mathbb{C}_s} = (\Xi_\tau^1 \oplus \Xi_\tau^2)^{\mathbb{C}_s}$.
5) $(\mathbb{C}_s^1 + \mathbb{C}_s^2)\Xi_\tau^1 = \mathbb{C}_s^1 \Xi_\tau^1 \oplus \mathbb{C}_s^2 \Xi_\tau^1$.
6) $(\Xi_\tau^1)^{(\mathbb{C}_s^1 + \mathbb{C}_s^2)} = (\Xi_\tau^1)^{\mathbb{C}_s^1} \otimes (\Xi_\tau^1)^{\mathbb{C}_s^2}$.

Proof:

1) Let

$$\Xi_\tau^1 \oplus \Xi_\tau^2 = \left(\mathfrak{L}_{\Pi\left(\frac{\Lambda_1}{\Pi} + \frac{\Lambda_2}{\Pi} - \frac{\Lambda_1 \Lambda_2}{\Pi\,\Pi}\right)}, \left(\Re_{\Xi_\tau^1}^R + \Re_{\Xi_\tau^2}^R - \Re_{\Xi_\tau^1}^R \Re_{\Xi_\tau^2}^R, \Re_{\Xi_\tau^1}^I + \Re_{\Xi_\tau^2}^I - \Re_{\Xi_\tau^1}^I \Re_{\Xi_\tau^2}^I \right), \left(\Im_{\Xi_\tau^1}^R \Im_{\Xi_\tau^2}^R, \Im_{\Xi_\tau^1}^I \Im_{\Xi_\tau^2}^I \right) \right)$$

$$= \left(\mathfrak{L}_{\Pi\left(\frac{\Lambda_2}{\Pi} + \frac{\Lambda_1}{\Pi} - \frac{\Lambda_2 \Lambda_1}{\Pi\,\Pi}\right)}, \left(\Re_{\Xi_\tau^2}^R + \Re_{\Xi_\tau^1}^R - \Re_{\Xi_\tau^2}^R \Re_{\Xi_\tau^1}^R, \Re_{\Xi_\tau^2}^I + \Re_{\Xi_\tau^1}^I - \Re_{\Xi_\tau^2}^I \Re_{\Xi_\tau^1}^I \right), \left(\Im_{\Xi_\tau^2}^R \Im_{\Xi_\tau^1}^R, \Im_{\Xi_\tau^2}^I \Im_{\Xi_\tau^1}^I \right) \right)$$

$$= \Xi_\tau^2 \oplus \Xi_\tau^1.$$

2) Omitted.
3) Let

$$\mathbb{C}_s \Xi_\tau^1 \oplus \mathbb{C}_s \Xi_\tau^2$$

$$= \left(\mathfrak{L}_{\Pi\left(1-\left(1-\frac{\Lambda_1}{\Pi}\right)^{\mathbb{C}_s}\right)}, \left(1-\left(1-\Re^R_{\Xi^1_\tau}\right)^{\mathbb{C}_s}, 1-\left(1-\Re^I_{\Xi^1_\tau}\right)^{\mathbb{C}_s}\right), \left(\left(\Im^R_{\Xi^1_\tau}\right)^{\mathbb{C}_s}, \left(\Im^I_{\Xi^1_\tau}\right)^{\mathbb{C}_s}\right)\right)$$

$$\oplus \left(\mathfrak{L}_{\Pi\left(1-\left(1-\frac{\Lambda_2}{\Pi}\right)^{\mathbb{C}_s}\right)}, \left(1-\left(1-\Re^R_{\Xi^2_\tau}\right)^{\mathbb{C}_s}, 1-\left(1-\Re^I_{\Xi^2_\tau}\right)^{\mathbb{C}_s}\right), \left(\left(\Im^R_{\Xi^2_\tau}\right)^{\mathbb{C}_s}, \left(\Im^I_{\Xi^2_\tau}\right)^{\mathbb{C}_s}\right)\right)$$

$$= \left(\mathfrak{L}_{\Pi\left(1-\left(1-\frac{\Lambda_1}{\Pi}\right)^{\mathbb{C}_s}\left(1-\frac{\Lambda_2}{\Pi}\right)^{\mathbb{C}_s}\right)}, \left(1-\left(1-\Re^R_{\Xi^1_\tau}\right)^{\mathbb{C}_s}\left(1-\Re^R_{\Xi^2_\tau}\right)^{\mathbb{C}_s}, 1 \right.\right.$$

$$\left.\left. -\left(1-\Re^I_{\Xi^1_\tau}\right)^{\mathbb{C}_s}\left(1-\Re^I_{\Xi^2_\tau}\right)^{\mathbb{C}_s}\right), \left(\left(\Im^R_{\Xi^1_\tau}\right)^{\mathbb{C}_s}\left(\Im^R_{\Xi^2_\tau}\right)^{\mathbb{C}_s}, \left(\Im^I_{\Xi^1_\tau}\right)^{\mathbb{C}_s}\left(\Im^I_{\Xi^2_\tau}\right)^{\mathbb{C}_s}\right)\right)$$

$$= \mathbb{C}_s \left(\mathfrak{L}_{\Pi\left(\frac{\Lambda_1}{\Pi}+\frac{\Lambda_2}{\Pi}-\frac{\Lambda_1\Lambda_2}{\Pi\,\Pi}\right)}, \left(\Re^R_{\Xi^1_\tau}+\Re^R_{\Xi^2_\tau}-\Re^R_{\Xi^1_\tau}\Re^R_{\Xi^2_\tau}, \Re^I_{\Xi^1_\tau}+\Re^I_{\Xi^2_\tau}-\Re^I_{\Xi^1_\tau}\Re^I_{\Xi^2_\tau}\right), \left(\Im^R_{\Xi^1_\tau}\Im^R_{\Xi^2_\tau}, \Im^I_{\Xi^1_\tau}\Im^I_{\Xi^2_\tau}\right)\right)$$

$$= \mathbb{C}_s(\Xi^1_\tau \oplus \Xi^2_\tau).$$

4) Omitted.
5) Let

$$(\mathbb{C}^1_s + \mathbb{C}^2_s)\Xi^1_\tau$$

$$= \left(\mathfrak{L}_{\Pi\left(1-\left(1-\frac{\Lambda_1}{\Pi}\right)^{\mathbb{C}^1_s+\mathbb{C}^2_s}\right)}, \left(1-\left(1-\Re^R_{\Xi^1_\tau}\right)^{\mathbb{C}^1_s+\mathbb{C}^2_s}, 1 \right.\right.$$

$$\left.\left. -\left(1-\Re^I_{\Xi^1_\tau}\right)^{\mathbb{C}^1_s+\mathbb{C}^2_s}\right), \left(\left(\Im^R_{\Xi^1_\tau}\right)^{\mathbb{C}^1_s+\mathbb{C}^2_s}, \left(\Im^I_{\Xi^1_\tau}\right)^{\mathbb{C}^1_s+\mathbb{C}^2_s}\right)\right)$$

$$= \left(\mathfrak{L}_{\Pi\left(1-\left(1-\frac{\Lambda_1}{\Pi}\right)^{\mathbb{C}^1_s}\right)}, \left(1-\left(1-\Re^R_{\Xi^1_\tau}\right)^{\mathbb{C}^1_s}, 1-\left(1-\Re^I_{\Xi^1_\tau}\right)^{\mathbb{C}^1_s}\right), \left(\left(\Im^R_{\Xi^1_\tau}\right)^{\mathbb{C}^1_s}, \left(\Im^I_{\Xi^1_\tau}\right)^{\mathbb{C}^1_s}\right)\right)$$

$$\oplus \left(\mathfrak{L}_{\Pi\left(1-\left(1-\frac{\Lambda_1}{\Pi}\right)^{\mathbb{C}^2_s}\right)}, \left(1-\left(1-\Re^R_{\Xi^1_\tau}\right)^{\mathbb{C}^2_s}, 1-\left(1-\Re^I_{\Xi^1_\tau}\right)^{\mathbb{C}^2_s}\right), \left(\left(\Im^R_{\Xi^1_\tau}\right)^{\mathbb{C}^2_s}, \left(\Im^I_{\Xi^1_\tau}\right)^{\mathbb{C}^2_s}\right)\right)$$

$$= \mathfrak{C}_S^1 \Xi_\tau^1 \oplus \mathfrak{C}_S^2 \Xi_\tau^1.$$

6) Omitted.

3.1 CIFL Generalized Power Geometric Operators

This section derives the idea of CIFLPWG, CIFLGPG, and CIFLGPWG operators, and also initiates their basic properties like idempotency, monotonicity, and boundedness.

Definition 9: Let $\Xi_\tau^\varsigma = \left(\mathfrak{L}_{\Lambda_\varsigma}, \left(\Re_{\Xi_\tau^\varsigma}^R, \Re_{\Xi_\tau^\varsigma}^I\right), \left(\Im_{\Xi_\tau^\varsigma}^R, \Im_{\Xi_\tau^\varsigma}^I\right)\right), \varsigma = 1,2,\dots,\varrho$, be any collection of CIFLNs. Then, we initiated the CIFLPG operator, such as

$$CIFLPG\left(\Xi_\tau^1, \Xi_\tau^2, \dots, \Xi_\tau^\varrho\right) = \otimes_{\varsigma=1}^{\varrho} \left(\Xi_\tau^\varsigma\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}$$

Further, we stated the distance measure for any two CIFLNs, such as

$$D\left(\Xi_\tau^\varsigma, \Xi_\tau^\iota\right) = \left(\frac{\left|\Lambda_\varsigma - \Lambda_\iota\right|}{\Pi}\right) * \frac{1}{4}\left(\left|\Re_{\Xi_\tau^\varsigma}^R - \Re_{\Xi_\tau^\iota}^R\right| + \left|\Re_{\Xi_\tau^\varsigma}^I - \Re_{\Xi_\tau^\iota}^I\right| + \left|\Im_{\Xi_\tau^\varsigma}^R - \Im_{\Xi_\tau^\iota}^R\right| + \left|\Im_{\Xi_\tau^\varsigma}^I - \Im_{\Xi_\tau^\iota}^I\right|\right) \quad (5)$$

Theorem 2: Given a collation of CIFLNs, it follows that the resulting aggregation under the CIFLPG operator remains a CIFLN, as follows

$$CIFLPG\left(\Xi_\tau^1, \Xi_\tau^2, \dots, \Xi_\tau^\varrho\right)$$
$$= \left(\begin{array}{c} \mathfrak{L}_{\Pi\left(\prod_{\varsigma=1}^{\varrho}\left(\frac{\Lambda_\varsigma}{\Pi}\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}\right)}, \left(\prod_{\varsigma=1}^{\varrho}\left(\Re_{\Xi_\tau^\varsigma}^R\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}, \prod_{\varsigma=1}^{\varrho}\left(\Re_{\Xi_\tau^\varsigma}^I\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}\right), \\ \left(1-\prod_{\varsigma=1}^{\varrho}\left(1-\Im_{\Xi_\tau^\varsigma}^R\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}, 1-\prod_{\varsigma=1}^{\varrho}\left(1-\Im_{\Xi_\tau^\varsigma}^I\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}\right) \end{array} \right)$$

Proof: By mathematical induction, we verify the above result, when $\varrho = 2$, we have

$$\left(\Xi_\tau^1\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^1\right)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}} = \left(\begin{array}{c} \mathfrak{L}_{\Pi\left(\left(\frac{\Lambda_1}{\Pi}\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^1\right)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}\right)}, \\ \left(\left(\Re_{\Xi_\tau^1}^R\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^1\right)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}, \left(\Re_{\Xi_\tau^1}^I\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^1\right)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}\right), \\ \left(1-\left(1-\Im_{\Xi_\tau^1}^R\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^1\right)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}, 1-\left(1-\Im_{\Xi_\tau^1}^I\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^1\right)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}\right) \end{array} \right)$$

$$(\Xi_\tau^2)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^2)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}}=\left(\begin{array}{c}\mathfrak{L}\\ \Pi\left(\left(\frac{\Lambda_2}{\Pi}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^2)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}}\right),\\ \left(\left(\Re_{\Xi_\tau^2}^{R}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^2)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}},\left(\Re_{\Xi_\tau^2}^{I}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^2)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}}\right),\\ \left(1-\left(1-\Im_{\Xi_\tau^2}^{R}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^2)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}},1-\left(1-\Im_{\Xi_\tau^2}^{I}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^2)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}}\right)\end{array}\right)$$

Then

$$CIFLPG(\Xi_\tau^1,\Xi_\tau^2)=(\Xi_\tau^1)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^1)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}}\otimes(\Xi_\tau^2)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^2)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}}$$

$$=\left(\begin{array}{c}\mathfrak{L}\\ \Pi\left(\left(\frac{\Lambda_1}{\Pi}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^1)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}}\right),\\ \left(\left(\Re_{\Xi_\tau^1}^{R}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^1)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}},\left(\Re_{\Xi_\tau^1}^{I}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^1)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}}\right),\\ \left(1-\left(1-\Im_{\Xi_\tau^1}^{R}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^1)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}},1-\left(1-\Im_{\Xi_\tau^1}^{I}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^1)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}}\right)\end{array}\right)\otimes$$

$$\left(\begin{array}{c}\mathfrak{L}\\ \Pi\left(\left(\frac{\Lambda_2}{\Pi}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^2)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}}\right),\\ \left(\left(\Re_{\Xi_\tau^2}^{R}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^2)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}},\left(\Re_{\Xi_\tau^2}^{I}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^2)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}}\right),\\ \left(1-\left(1-\Im_{\Xi_\tau^2}^{R}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^2)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}},1-\left(1-\Im_{\Xi_\tau^2}^{I}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^2)\right)}{\oplus_{\varsigma=1}^{2}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}}\right)\end{array}\right)$$

$$= \left(\begin{array}{c} \mathfrak{L}_{\Pi\left(\prod_{\varsigma=1}^{2}\left(\frac{\Lambda_\varsigma}{\Pi}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}{\oplus_{\varsigma=1}^{\varrho}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}}\right)}, \left(\prod_{\varsigma=1}^{2}\left(\Re_{\Xi_\tau^\varsigma}^{R}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}{\oplus_{\varsigma=1}^{\varrho}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}}, \prod_{\varsigma=1}^{2}\left(\Re_{\Xi_\tau^\varsigma}^{I}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}{\oplus_{\varsigma=1}^{\varrho}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}} \right), \\ \left(1-\prod_{\varsigma=1}^{2}\left(1-\Im_{\Xi_\tau^\varsigma}^{R}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}{\oplus_{\varsigma=1}^{\varrho}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}}, 1-\prod_{\varsigma=1}^{2}\left(1-\Im_{\Xi_\tau^\varsigma}^{I}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}{\oplus_{\varsigma=1}^{\varrho}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}} \right) \end{array} \right)$$

We have obtained our result for $\varrho = 2$, further, for $\varrho = y$, we have

$$CIFLPG\left(\Xi_\tau^1, \Xi_\tau^2, \ldots, \Xi_\tau^y\right)$$

$$= \left(\begin{array}{c} \mathfrak{L}_{\Pi\left(\prod_{\varsigma=1}^{y}\left(\frac{\Lambda_\varsigma}{\Pi}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}{\oplus_{\varsigma=1}^{y}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}}\right)}, \left(\prod_{\varsigma=1}^{y}\left(\Re_{\Xi_\tau^\varsigma}^{R}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}{\oplus_{\varsigma=1}^{y}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}}, \prod_{\varsigma=1}^{y}\left(\Re_{\Xi_\tau^\varsigma}^{I}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}{\oplus_{\varsigma=1}^{y}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}} \right), \\ \left(1-\prod_{\varsigma=1}^{y}\left(1-\Im_{\Xi_\tau^\varsigma}^{R}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}{\oplus_{\varsigma=1}^{y}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}}, 1-\prod_{\varsigma=1}^{y}\left(1-\Im_{\Xi_\tau^\varsigma}^{I}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}{\oplus_{\varsigma=1}^{y}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}} \right) \end{array} \right)$$

For $\varrho = y+1$, we prove our required result, such as

$$CIFLPG\left(\Xi_\tau^1, \Xi_\tau^2, \ldots, \Xi_\tau^{y+1}\right) = \otimes_{\varsigma=1}^{y}\left(\Xi_\tau^\varsigma\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}{\oplus_{\varsigma=1}^{y+1}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}} \otimes \left(\Xi_\tau^{y+1}\right)^{\frac{\left(1+\overline{\Phi}_Z\left(\Xi_\tau^{y+1}\right)\right)}{\oplus_{\varsigma=1}^{y+1}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}}$$

$$= \left(\begin{array}{c} \mathfrak{L}_{\Pi\left(\prod_{\varsigma=1}^{y}\left(\frac{\Lambda_\varsigma}{\Pi}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}{\oplus_{\varsigma=1}^{y+1}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}}\right)}, \left(\prod_{\varsigma=1}^{y}\left(\Re_{\Xi_\tau^\varsigma}^{R}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}{\oplus_{\varsigma=1}^{y+1}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}}, \prod_{\varsigma=1}^{y}\left(\Re_{\Xi_\tau^\varsigma}^{I}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}{\oplus_{\varsigma=1}^{y+1}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}} \right), \\ \left(1-\prod_{\varsigma=1}^{y}\left(1-\Im_{\Xi_\tau^\varsigma}^{R}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}{\oplus_{\varsigma=1}^{y+1}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}}, 1-\prod_{\varsigma=1}^{y}\left(1-\Im_{\Xi_\tau^\varsigma}^{I}\right)^{\frac{\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}{\oplus_{\varsigma=1}^{y+1}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}} \right) \end{array} \right) \otimes \left(\Xi_\tau^{y+1}\right)^{\frac{\left(1+\overline{\Phi}_Z\left(\Xi_\tau^{y+1}\right)\right)}{\oplus_{\varsigma=1}^{y+1}\left(1+\overline{\Phi}_Z(\Xi_\tau^\varsigma)\right)}}$$

$$= \left(\begin{array}{c} \mathfrak{L}_{\Pi\left(\prod_{\varsigma=1}^{y} \left(\frac{\Lambda_\varsigma}{\Pi}\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{y+1}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}} \right)}, \left(\prod_{\varsigma=1}^{y} \left(\mathfrak{R}_{\Xi_\tau^\varsigma}^R\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{y+1}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}, \prod_{\varsigma=1}^{y} \left(\mathfrak{R}_{\Xi_\tau^\varsigma}^I\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{y+1}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}} \right), \\ \left(1-\prod_{\varsigma=1}^{y} \left(1-\mathfrak{S}_{\Xi_\tau^\varsigma}^R\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{y+1}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}, 1-\prod_{\varsigma=1}^{y} \left(1-\mathfrak{S}_{\Xi_\tau^\varsigma}^I\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{y+1}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}} \right) \end{array} \right)$$

$$\oplus \left(\begin{array}{c} \mathfrak{L}_{\Pi\left(\left(\frac{\Lambda_{y+1}}{\Pi}\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^{y+1}\right)\right)}{\oplus_{\varsigma=1}^{y+1}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}} \right)}, \\ \left(\left(\mathfrak{R}_{\Xi_\tau^{y+1}}^R\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^{y+1}\right)\right)}{\oplus_{\varsigma=1}^{y+1}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}, \left(\mathfrak{R}_{\Xi_\tau^{y+1}}^I\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^{y+1}\right)\right)}{\oplus_{\varsigma=1}^{y+1}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}} \right), \\ \left(1-\left(1-\mathfrak{S}_{\Xi_\tau^{y+1}}^R\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^{y+1}\right)\right)}{\oplus_{\varsigma=1}^{y+1}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}, 1-\left(1-\mathfrak{S}_{\Xi_\tau^{y+1}}^I\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^{y+1}\right)\right)}{\oplus_{\varsigma=1}^{y+1}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}} \right) \end{array} \right)$$

$$= \left(\begin{array}{c} \mathfrak{L}_{\Pi\left(\prod_{\varsigma=1}^{y+1} \left(\frac{\Lambda_\varsigma}{\Pi}\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{y+1}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}} \right)}, \left(\prod_{\varsigma=1}^{y+1} \left(\mathfrak{R}_{\Xi_\tau^\varsigma}^R\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{y+1}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}, \prod_{\varsigma=1}^{y+1} \left(\mathfrak{R}_{\Xi_\tau^\varsigma}^I\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{y+1}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}} \right), \\ \left(1-\prod_{\varsigma=1}^{y+1} \left(1-\mathfrak{S}_{\Xi_\tau^\varsigma}^R\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{y+1}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}, 1-\prod_{\varsigma=1}^{y+1} \left(1-\mathfrak{S}_{\Xi_\tau^\varsigma}^I\right)^{\frac{\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{y+1}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}} \right) \end{array} \right)$$

Hence, we have done the needful.

Property 1: If $\Xi_\tau^\varsigma = \Xi_\tau = \left(\mathfrak{L}_\Lambda, \left(\mathfrak{R}_{\Xi_\tau}^R, \mathfrak{R}_{\Xi_\tau}^I\right), \left(\mathfrak{S}_{\Xi_\tau}^R, \mathfrak{S}_{\Xi_\tau}^I\right)\right), \varsigma = 1,2, \dots, \varrho$, then

$$CIFLPG\left(\Xi_\tau^1, \Xi_\tau^2, \dots, \Xi_\tau^\varrho\right) = \Xi_\tau.$$

Property 2: If $\Xi_\tau^\varsigma \leq \Xi^{\#\varsigma}{}_\tau, \varsigma = 1,2, \dots, \varrho$, i.e., $\mathfrak{L}_{\Lambda_\varsigma} \leq \mathfrak{L}_{\Lambda_\varsigma}^\#, \mathfrak{R}_{\Xi_\tau^\varsigma}^R \leq \mathfrak{R}^{\#R}{}_{\Xi_\tau^\varsigma}, \mathfrak{R}_{\Xi_\tau^\varsigma}^I \leq \mathfrak{R}^{\#I}{}_{\Xi_\tau^\varsigma}$ and $\mathfrak{S}_{\Xi_\tau^\varsigma}^R \geq \mathfrak{S}^{\#R}{}_{\Xi_\tau^\varsigma}, \mathfrak{S}_{\Xi_\tau^\varsigma}^I \geq \mathfrak{S}^{\#I}{}_{\Xi_\tau^\varsigma}$, then

$$CIFLPG\left(\Xi_\tau^1, \Xi_\tau^2, \dots, \Xi_\tau^\varrho\right) \leq CIFLPG\left(\Xi^{\#1}{}_\tau, \Xi^{\#2}{}_\tau, \dots, \Xi^{\#\varrho}{}_\tau\right).$$

Property 3: If $\Xi_\tau^- = \left(\mathfrak{L}_{\min(\Lambda_\varsigma)}, \left(\min\left(\Re_{\Xi_\tau^\varsigma}^R\right), \min\left(\Re_{\Xi_\tau^\varsigma}^I\right)\right), \left(\max\left(\Im_{\Xi_\tau^\varsigma}^R\right), \max\left(\Im_{\Xi_\tau^\varsigma}^I\right)\right)\right)$ and $\Xi_\tau^+ = \left(\mathfrak{L}_{\max(\Lambda_\varsigma)}, \left(\max\left(\Re_{\Xi_\tau^\varsigma}^R\right), \max\left(\Re_{\Xi_\tau^\varsigma}^I\right)\right), \left(\min\left(\Im_{\Xi_\tau^\varsigma}^R\right), \min\left(\Im_{\Xi_\tau^\varsigma}^I\right)\right)\right), \varsigma = 1,2,\dots,\varrho$, then

$$\Xi_\tau^- \le CIFLPG\left(\Xi_\tau^1, \Xi_\tau^2, \dots, \Xi_\tau^\varrho\right) \le \Xi_\tau^+.$$

Definition 10: Let $\Xi_\tau^\varsigma = \left(\mathfrak{L}_{\Lambda_\varsigma}, \left(\Re_{\Xi_\tau^\varsigma}^R, \Re_{\Xi_\tau^\varsigma}^I\right), \left(\Im_{\Xi_\tau^\varsigma}^R, \Im_{\Xi_\tau^\varsigma}^I\right)\right), \varsigma = 1,2,\dots,\varrho$, be any CIFLNs. Then, we initiated the CIFLPWG operator, such as

$$CIFLPWG\left(\Xi_\tau^1, \Xi_\tau^2, \dots, \Xi_\tau^\varrho\right) = \bigotimes_{\varsigma=1}^{\varrho} \left(\Xi_\tau^\varsigma\right)^{\frac{\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}$$

Noticed that $\overline{\overline{\mathfrak{H}_\varsigma}} \in [0,1], \sum_{\varsigma=1}^{\varrho} \overline{\overline{\mathfrak{H}_\varsigma}} = 1$, represents the weight vectors. Further, we stated the distance measure for any two CIFLNs, such as

$$D\left(\Xi_\tau^\varsigma, \Xi_\tau^\iota\right) = \left(\frac{\left|\Lambda_\varsigma - \Lambda_\iota\right|}{\Pi}\right) * \frac{1}{4}\left(\left|\Re_{\Xi_\tau^\varsigma}^R - \Re_{\Xi_\tau^\iota}^R\right| + \left|\Re_{\Xi_\tau^\varsigma}^I - \Re_{\Xi_\tau^\iota}^I\right| + \left|\Im_{\Xi_\tau^\varsigma}^R - \Im_{\Xi_\tau^\iota}^R\right| + \left|\Im_{\Xi_\tau^\varsigma}^I - \Im_{\Xi_\tau^\iota}^I\right|\right)$$

Theorem 3: Given a collection of CIFLNs, it follows that the resulting value under the CIFLPWG operator remains a CIFLN, as follows

$$CIFLPWG\left(\Xi_\tau^1, \Xi_\tau^2, \dots, \Xi_\tau^\varrho\right)$$
$$= \left(\begin{array}{c} \mathfrak{L}_{\Pi\left(\prod_{\varsigma=1}^{\varrho}\left(\frac{\Lambda_\varsigma}{\Pi}\right)^{\frac{\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}\right)}, \left(\prod_{\varsigma=1}^{\varrho}\left(\Re_{\Xi_\tau^\varsigma}^R\right)^{\frac{\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}, \prod_{\varsigma=1}^{\varrho}\left(\Re_{\Xi_\tau^\varsigma}^I\right)^{\frac{\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}\right), \\ \left(1 - \prod_{\varsigma=1}^{\varrho}\left(1 - \Im_{\Xi_\tau^\varsigma}^R\right)^{\frac{\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}, 1 - \prod_{\varsigma=1}^{\varrho}\left(1 - \Im_{\Xi_\tau^\varsigma}^I\right)^{\frac{\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}\right) \end{array}\right)$$

Proof: Straightforward.

Property 4: If $\Xi_\tau^\varsigma = \Xi_\tau = \left(\mathfrak{L}_\Lambda, \left(\Re_{\Xi_\tau}^R, \Re_{\Xi_\tau}^I\right), \left(\Im_{\Xi_\tau}^R, \Im_{\Xi_\tau}^I\right)\right), \varsigma = 1,2,\dots,\varrho$, then

$$CIFLPWG\left(\Xi_\tau^1, \Xi_\tau^2, \dots, \Xi_\tau^\varrho\right) = \Xi_\tau.$$

Property 5: If $\Xi_\tau^\varsigma \le \Xi^{\#\varsigma}{}_\tau, \varsigma = 1,2,\dots,\varrho$, i.e., $\mathfrak{L}_{\Lambda_\varsigma} \le \mathfrak{L}_{\Lambda_\varsigma}^{\#}, \Re_{\Xi_\tau^\varsigma}^R \le \Re^{\#R}{}_{\Xi_\tau^\varsigma}, \Re_{\Xi_\tau^\varsigma}^I \le \Re^{\#I}{}_{\Xi_\tau^\varsigma}$ and $\Im_{\Xi_\tau^\varsigma}^R \ge \Im^{\#R}{}_{\Xi_\tau^\varsigma}, \Im_{\Xi_\tau^\varsigma}^I \ge \Im^{\#I}{}_{\Xi_\tau^\varsigma}$, then

$$CIFLPWG\left(\Xi_\tau^1, \Xi_\tau^2, \dots, \Xi_\tau^\varrho\right) \le CIFLPWG\left(\Xi^{\#1}{}_\tau, \Xi^{\#2}{}_\tau, \dots, \Xi^{\#\varrho}{}_\tau\right).$$

Property 6: If $\Xi_\tau^- = \left(\mathfrak{L}_{\min(\Lambda_\varsigma)}, \left(\min\left(\Re_{\Xi_\tau^\varsigma}^R\right), \min\left(\Re_{\Xi_\tau^\varsigma}^I\right)\right), \left(\max\left(\Im_{\Xi_\tau^\varsigma}^R\right), \max\left(\Im_{\Xi_\tau^\varsigma}^I\right)\right)\right)$ and $\Xi_\tau^+ = \left(\mathfrak{L}_{\max(\Lambda_\varsigma)}, \left(\max\left(\Re_{\Xi_\tau^\varsigma}^R\right), \max\left(\Re_{\Xi_\tau^\varsigma}^I\right)\right), \left(\min\left(\Im_{\Xi_\tau^\varsigma}^R\right), \min\left(\Im_{\Xi_\tau^\varsigma}^I\right)\right)\right), \varsigma = 1,2,\dots,\varrho$, then

$$\Xi_\tau^- \le CIFLPWG\left(\Xi_\tau^1, \Xi_\tau^2, \dots, \Xi_\tau^\varrho\right) \le \Xi_\tau^+.$$

Definition 11: Let $\Xi_\tau^\varsigma = \left(\mathfrak{L}_{\Lambda_\varsigma}, \left(\Re_{\Xi_\tau^\varsigma}^R, \Re_{\Xi_\tau^\varsigma}^I\right), \left(\Im_{\Xi_\tau^\varsigma}^R, \Im_{\Xi_\tau^\varsigma}^I\right)\right), \varsigma = 1,2,\dots,\varrho$, be any collection of CIFLNs. Then, we initiated the CIFLGPG operator, such as

$$CIFLGPG\left(\Xi_\tau^1, \Xi_\tau^2, \dots, \Xi_\tau^\varrho\right) = \frac{1}{\mathbb{C}_s}\left(\bigotimes_{\varsigma=1}^{\varrho} \mathbb{C}_s\left(\Xi_\tau^\varsigma\right)^{\frac{\left(1+\overline{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\left(1+\overline{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}\right)$$

Further, we stated the distance measure for any two CIFLNs, such as

$$D\left(\Xi_\tau^\varsigma, \Xi_\tau^\iota\right) = \left(\frac{\left|\Lambda_\varsigma - \Lambda_\iota\right|}{\Pi}\right) * \frac{1}{4}\left(\left|\Re_{\Xi_\tau^\varsigma}^R - \Re_{\Xi_\tau^\iota}^R\right| + \left|\Re_{\Xi_\tau^\varsigma}^I - \Re_{\Xi_\tau^\iota}^I\right| + \left|\Im_{\Xi_\tau^\varsigma}^R - \Im_{\Xi_\tau^\iota}^R\right| + \left|\Im_{\Xi_\tau^\varsigma}^I - \Im_{\Xi_\tau^\iota}^I\right|\right)$$

Theorem 4: Given a collection of CIFLNs, it follows that the resulting value under the CIFLGPG operator remains a CIFLN, as follows

$$CIFLGPG\left(\Xi_\tau^1, \Xi_\tau^2, \dots, \Xi_\tau^\varrho\right)$$
$$= \left(\begin{array}{c} \mathfrak{L}\left(\Pi\left(\prod_{\varsigma=1}^{\varrho}\left(\left(\frac{\Lambda_\varsigma}{\Pi}\right)^{\mathbb{C}_s}\right)^{\frac{\left(1+\overline{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\left(1+\overline{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}\right)\right)^{\frac{1}{\mathbb{C}_s}}, \\ \left(1-\left(1-\prod_{\varsigma=1}^{\varrho}\left(1-\left(1-\Re_{\Xi_\tau^\varsigma}^R\right)^{\mathbb{C}_s}\right)^{\frac{\left(1+\overline{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\left(1+\overline{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}\right)^{\frac{1}{\mathbb{C}_s}}, 1-\left(1-\prod_{\varsigma=1}^{\varrho}\left(1-\left(1-\Re_{\Xi_\tau^\varsigma}^I\right)^{\mathbb{C}_s}\right)^{\frac{\left(1+\overline{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\left(1+\overline{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}\right)^{\frac{1}{\mathbb{C}_s}}\right), \\ \left(\left(1-\prod_{\varsigma=1}^{\varrho}\left(1-\left(\Im_{\Xi_\tau^\varsigma}^R\right)^{\mathbb{C}_s}\right)^{\frac{\left(1+\overline{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\left(1+\overline{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}\right)^{\frac{1}{\mathbb{C}_s}}, \left(1-\prod_{\varsigma=1}^{\varrho}\left(1-\left(\Im_{\Xi_\tau^\varsigma}^I\right)^{\mathbb{C}_s}\right)^{\frac{\left(1+\overline{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\left(1+\overline{\Phi}_Z\left(\Xi_\tau^\varsigma\right)\right)}}\right)^{\frac{1}{\mathbb{C}_s}}\right) \end{array}\right)$$

Proof: Straightforward.

Property 7: If $\Xi_\tau^\varsigma = \Xi_\tau = \left(\mathfrak{L}_\Lambda, \left(\Re_{\Xi_\tau}^R, \Re_{\Xi_\tau}^I\right), \left(\Im_{\Xi_\tau}^R, \Im_{\Xi_\tau}^I\right)\right), \varsigma = 1,2,\dots,\varrho$, then

$$CIFLGPG\left(\Xi_\tau^1, \Xi_\tau^2, \dots, \Xi_\tau^\varrho\right) = \Xi_\tau.$$

Property 8: If $\Xi_\tau^\varsigma \le \Xi^{\#\varsigma}{}_\tau, \varsigma = 1,2,\dots,\varrho$, i.e., $\mathfrak{L}_{\Lambda_\varsigma} \le \mathfrak{L}_{\Lambda_\varsigma}^{\#}, \Re_{\Xi_\tau^\varsigma}^R \le \Re^{\#R}{}_{\Xi_\tau^\varsigma}, \Re_{\Xi_\tau^\varsigma}^I \le \Re^{\#I}{}_{\Xi_\tau^\varsigma}$ and $\Im_{\Xi_\tau^\varsigma}^R \ge \Im^{\#R}{}_{\Xi_\tau^\varsigma}, \Im_{\Xi_\tau^\varsigma}^I \ge \Im^{\#I}{}_{\Xi_\tau^\varsigma}$, then

$$CIFLGPG\left(\Xi_\tau^1, \Xi_\tau^2, \dots, \Xi_\tau^\varrho\right) \le CIFLGPG\left(\Xi^{\#1}{}_\tau, \Xi^{\#2}{}_\tau, \dots, \Xi^{\#\varrho}{}_\tau\right).$$

Property 9: If $\Xi_\tau^- = \left(\mathfrak{L}_{\min(\Lambda_\varsigma)}, \left(\min\left(\Re_{\Xi_\tau^\varsigma}^R\right), \min\left(\Re_{\Xi_\tau^\varsigma}^I\right)\right), \left(\max\left(\Im_{\Xi_\tau^\varsigma}^R\right), \max\left(\Im_{\Xi_\tau^\varsigma}^I\right)\right)\right)$ and $\Xi_\tau^+ = \left(\mathfrak{L}_{\max(\Lambda_\varsigma)}, \left(\max\left(\Re_{\Xi_\tau^\varsigma}^R\right), \max\left(\Re_{\Xi_\tau^\varsigma}^I\right)\right), \left(\min\left(\Im_{\Xi_\tau^\varsigma}^R\right), \min\left(\Im_{\Xi_\tau^\varsigma}^I\right)\right)\right), \varsigma = 1,2,\dots,\varrho$, then

$$\Xi_\tau^- \leq CIFLGPG\left(\Xi_\tau^1, \Xi_\tau^2, \dots, \Xi_\tau^\varrho\right) \leq \Xi_\tau^+.$$

Definition 12: Let $\Xi_\tau^\varsigma = \left(\mathfrak{L}_{\Lambda_\varsigma}, \left(\Re_{\Xi_\tau^\varsigma}^R, \Re_{\Xi_\tau^\varsigma}^I\right), \left(\Im_{\Xi_\tau^\varsigma}^R, \Im_{\Xi_\tau^\varsigma}^I\right)\right), \varsigma = 1,2,\dots,\varrho$, be any collection of CIFLNs. Then, we initiated the CIFLGPWG operator, such as

$$CIFLGPWG\left(\Xi_\tau^1, \Xi_\tau^2, \dots, \Xi_\tau^\varrho\right) = \frac{1}{\mathbb{C}_s}\left(\otimes_{\varsigma=1}^{\varrho}\, \mathbb{C}_s\left(\Xi_\tau^\varsigma\right)^{\frac{\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\bar{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\bar{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}}\right)$$

Noticed that $\overline{\overline{\mathfrak{H}_\varsigma}} \in [0,1], \sum_{\varsigma=1}^{\varrho}\overline{\overline{\mathfrak{H}_\varsigma}} = 1$, represents the weight vectors. Further, we stated the distance measure for any two CIFLNs, such as

$$D\left(\Xi_\tau^\varsigma, \Xi_\tau^\iota\right) = \left(\frac{\left|\Lambda_\varsigma - \Lambda_\iota\right|}{\Pi}\right) * \frac{1}{4}\left(\left|\Re_{\Xi_\tau^\varsigma}^R - \Re_{\Xi_\tau^\iota}^R\right| + \left|\Re_{\Xi_\tau^\varsigma}^I - \Re_{\Xi_\tau^\iota}^I\right| + \left|\Im_{\Xi_\tau^\varsigma}^R - \Im_{\Xi_\tau^\iota}^R\right| + \left|\Im_{\Xi_\tau^\varsigma}^I - \Im_{\Xi_\tau^\iota}^I\right|\right)$$

Theorem 5: Given a collection of CIFLNs, it follows that the resulting value under the CIFLGPWG operator remains a CIFLN, as follows

$$CIFLGPWG\left(\Xi_\tau^1, \Xi_\tau^2, \dots, \Xi_\tau^\varrho\right)$$
$$= \left(\begin{array}{c} \mathfrak{L}\left(\Pi\left(\prod_{\varsigma=1}^{\varrho}\left(\left(\frac{\Lambda_\varsigma}{\Pi}\right)^{\mathbb{C}_s}\right)^{\frac{\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\bar{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\bar{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}}\right)\right)^{\frac{1}{\mathbb{C}_s}}, \\ \left(1-\left(1-\prod_{\varsigma=1}^{\varrho}\left(1-\left(1-\Re_{\Xi_\tau^\varsigma}^R\right)^{\mathbb{C}_s}\right)^{\frac{\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\bar{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\bar{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}}\right)^{\frac{1}{\mathbb{C}_s}}, 1-\left(1-\prod_{\varsigma=1}^{\varrho}\left(1-\left(1-\Re_{\Xi_\tau^\varsigma}^I\right)^{\mathbb{C}_s}\right)^{\frac{\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\bar{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\bar{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}}\right)^{\frac{1}{\mathbb{C}_s}}\right), \\ \left(\left(1-\prod_{\varsigma=1}^{\varrho}\left(1-\left(\Im_{\Xi_\tau^\varsigma}^R\right)^{\mathbb{C}_s}\right)^{\frac{\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\bar{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\bar{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}}\right)^{\frac{1}{\mathbb{C}_s}}, \left(1-\prod_{\varsigma=1}^{\varrho}\left(1-\left(\Im_{\Xi_\tau^\varsigma}^I\right)^{\mathbb{C}_s}\right)^{\frac{\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\bar{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\bar{\bar{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}}\right)^{\frac{1}{\mathbb{C}_s}}\right) \end{array}\right)$$

Proof: Straightforward.

Property 10: If $\Xi_\tau^\varsigma = \Xi_\tau = \left(\mathfrak{L}_\Lambda, \left(\Re_{\Xi_\tau}^R, \Re_{\Xi_\tau}^I\right), \left(\Im_{\Xi_\tau}^R, \Im_{\Xi_\tau}^I\right)\right), \varsigma = 1,2,\dots,\varrho$, then

$$CIFLGPWG\left(\Xi_\tau^1, \Xi_\tau^2, \dots, \Xi_\tau^\varrho\right) = \Xi_\tau.$$

Property 11: If $\Xi_\tau^\varsigma \leq \Xi^{\#\varsigma}{}_\tau, \varsigma = 1,2,\dots,\varrho$, i.e., $\mathfrak{L}_{\Lambda_\varsigma} \leq \mathfrak{L}_{\Lambda_\varsigma}^{\#}, \Re_{\Xi_\tau^\varsigma}^R \leq \Re^{\#R}{}_{\Xi_\tau^\varsigma}, \Re_{\Xi_\tau^\varsigma}^I \leq \Re^{\#I}{}_{\Xi_\tau^\varsigma}$ and $\Im_{\Xi_\tau^\varsigma}^R \geq \Im^{\#R}{}_{\Xi_\tau^\varsigma}, \Im_{\Xi_\tau^\varsigma}^I \geq \Im^{\#I}{}_{\Xi_\tau^\varsigma}$, then

$$CIFLGPWG\left(\Xi_\tau^1, \Xi_\tau^2, \ldots, \Xi_\tau^\varrho\right) \leq CIFLGPWG\left(\Xi^{\#^1}{}_\tau, \Xi^{\#^2}{}_\tau, \ldots, \Xi^{\#^\varrho}{}_\tau\right).$$

Property 12: If $\Xi_\tau^- = \left(\mathfrak{L}_{\min(\Lambda_\varsigma)}, \left(\min\left(\Re_{\Xi_\tau^\varsigma}^R\right), \min\left(\Re_{\Xi_\tau^\varsigma}^I\right)\right), \left(\max\left(\Im_{\Xi_\tau^\varsigma}^R\right), \max\left(\Im_{\Xi_\tau^\varsigma}^I\right)\right)\right)$ and $\Xi_\tau^+ = \left(\mathfrak{L}_{\max(\Lambda_\varsigma)}, \left(\max\left(\Re_{\Xi_\tau^\varsigma}^R\right), \max\left(\Re_{\Xi_\tau^\varsigma}^I\right)\right), \left(\min\left(\Im_{\Xi_\tau^\varsigma}^R\right), \min\left(\Im_{\Xi_\tau^\varsigma}^I\right)\right)\right), \varsigma = 1,2, \ldots, \varrho$, then

$$\Xi_\tau^- \leq CIFLGPWG\left(\Xi_\tau^1, \Xi_\tau^2, \ldots, \Xi_\tau^\varrho\right) \leq \Xi_\tau^+.$$

These proposed techniques are very dominant and reliable because of their underlying formulation, where the geometric operator, averaging operator, power operator, and generalized operators formulated using fuzzy set together with their extensions constitute special cases of the derived techniques.

4. MADM Approach Using the Proposed Techniques

In this section, we present the MADM approach using the proposed techniques, the CIFLPWG operator and the CIFLGPWG operator, to improve the utility of the proposed operators.

For this, we select some alternatives $\Xi_\tau^1, \Xi_\tau^2, \ldots, \Xi_\tau^\varrho$, where for each alternative we have a collection of attributes, such as $\Xi_{AT}^1, \Xi_{AT}^2, \ldots, \Xi_{AT}^m$. Further, we consider some weight vectors $\overline{\overline{\mathfrak{H}_\varsigma}} \in [0,1], \sum_{\varsigma=1}^\varrho \overline{\overline{\mathfrak{H}_\varsigma}} = 1$, where the order of the weight vectors could be equal to the order of the attributes. Then, we computed the matrix by including the values of the CIFL information and noticed that $\mathfrak{L}_{\Lambda(\mathfrak{x})} \in \ddot{\mathcal{S}}_{[0,\Pi]} = \{\mathcal{s}_\ell : \ell \in R\}$ represents the linguistic set, and the mathematical shape of truth and falsity grades are initiated in the shape: $\Re_{\Xi_\tau}^R, \Im_{\Xi_\tau}^R, \Re_{\Xi_\tau}^I, \Im_{\Xi_\tau}^I : \mathfrak{X} \to [0,1]$ with $0 \leq \Re_{\Xi_\tau}^R(\mathfrak{x}) + \Im_{\Xi_\tau}^R(\mathfrak{x}) \leq 1$ and $0 \leq \Re_{\Xi_\tau}^I(\mathfrak{x}) + \Im_{\Xi_\tau}^I(\mathfrak{x}) \leq 1$. Additionally, we derived the refusal grade in the shape: $\mathcal{R}_{\Xi_\tau}(\mathfrak{x}) = \left(\mathcal{R}_{\Xi_\tau}^R(\mathfrak{x}), \mathcal{R}_{\Xi_\tau}^I(\mathfrak{x})\right) = \left(1 - \left(\Re_{\Xi_\tau}^R(\mathfrak{x}) + \Im_{\Xi_\tau}^R(\mathfrak{x})\right), 1 - \left(\Re_{\Xi_\tau}^I(\mathfrak{x}) + \Im_{\Xi_\tau}^I(\mathfrak{x})\right)\right)$. Finally, $\Xi_\tau^\varsigma = \left(\mathfrak{L}_{\Lambda_\varsigma}, \left(\Re_{\Xi_\tau^\varsigma}^R, \Re_{\Xi_\tau^\varsigma}^I\right), \left(\Im_{\Xi_\tau^\varsigma}^R, \Im_{\Xi_\tau^\varsigma}^I\right)\right), \varsigma = 1,2, \ldots, \varrho$ represents the CIFLNs. Thus, for assessing certain real-world problems, we employ the following approach to assess the given information, as follows

Step 1: Construct the matrix by incorporating the values of CIFLNs. When cost-type data are present within the matrix, then the matrix is normalized, such as

$$N = \begin{cases} \left(\mathfrak{L}_{\Lambda_\varsigma}, \left(\Re_{\Xi_\tau^\varsigma}^R, \Re_{\Xi_\tau^\varsigma}^I\right), \left(\Im_{\Xi_\tau^\varsigma}^R, \Im_{\Xi_\tau^\varsigma}^I\right)\right) & beϱefıts \\ \left(\mathfrak{L}_{\Lambda_\varsigma}, \left(\Im_{\Xi_\tau^\varsigma}^R, \Im_{\Xi_\tau^\varsigma}^I\right), \left(\Re_{\Xi_\tau^\varsigma}^R, \Re_{\Xi_\tau^\varsigma}^I\right)\right) & cost \end{cases}$$

If we have a benefit kind of data in the matrix, then we will not require it to undergo normalization.

Step 2: Construct the aggregated matrix, employing the CIFLPWG operator together with the CIFLGPWG operator, as follows

$$CIFLPWG\left(\Xi_\tau^1, \Xi_\tau^2, \dots, \Xi_\tau^\varrho\right)$$

$$= \left(\begin{array}{c} \mathfrak{Q}\left(\Pi\left(\prod_{\varsigma=1}^{\varrho} \left(\frac{\Lambda_\varsigma}{\Pi}\right)^{\frac{\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\overline{\overline{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\overline{\overline{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}} \right) \right), \left(\prod_{\varsigma=1}^{\varrho} \left(\mathfrak{R}_{\Xi_\tau^\varsigma}^R\right)^{\frac{\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\overline{\overline{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\overline{\overline{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}}, \prod_{\varsigma=1}^{\varrho} \left(\mathfrak{R}_{\Xi_\tau^\varsigma}^I\right)^{\frac{\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\overline{\overline{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\overline{\overline{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}} \right), \\ \left(1 - \prod_{\varsigma=1}^{\varrho} \left(1 - \mathfrak{S}_{\Xi_\tau^\varsigma}^R\right)^{\frac{\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\overline{\overline{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\overline{\overline{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}}, 1 - \prod_{\varsigma=1}^{\varrho} \left(1 - \mathfrak{S}_{\Xi_\tau^\varsigma}^I\right)^{\frac{\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\overline{\overline{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\overline{\overline{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}} \right) \end{array} \right)$$

$$CIFLGPWG\left(\Xi_\tau^1, \Xi_\tau^2, \dots, \Xi_\tau^\varrho\right)$$

$$= \left(\begin{array}{c} \mathfrak{Q}\left(\Pi\left(\prod_{\varsigma=1}^{\varrho} \left(\left(\frac{\Lambda_\varsigma}{\Pi}\right)^{\mathfrak{C}_s}\right)^{\frac{\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\overline{\overline{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\overline{\overline{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}} \right) \right)^{\frac{1}{\mathfrak{C}_s}}, \\ \left(1 - \left(1 - \prod_{\varsigma=1}^{\varrho} \left(1 - \left(1 - \mathfrak{R}_{\Xi_\tau^\varsigma}^R\right)^{\mathfrak{C}_s}\right)^{\frac{\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\overline{\overline{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\overline{\overline{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}} \right)^{\frac{1}{\mathfrak{C}_s}}, 1 - \left(1 - \prod_{\varsigma=1}^{\varrho} \left(1 - \left(1 - \mathfrak{R}_{\Xi_\tau^\varsigma}^I\right)^{\mathfrak{C}_s}\right)^{\frac{\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\overline{\overline{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\overline{\overline{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}} \right)^{\frac{1}{\mathfrak{C}_s}} \right), \\ \left(\left(1 - \prod_{\varsigma=1}^{\varrho} \left(1 - \left(\mathfrak{S}_{\Xi_\tau^\varsigma}^R\right)^{\mathfrak{C}_s}\right)^{\frac{\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\overline{\overline{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\overline{\overline{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}} \right)^{\frac{1}{\mathfrak{C}_s}}, \left(1 - \prod_{\varsigma=1}^{\varrho} \left(1 - \left(\mathfrak{S}_{\Xi_\tau^\varsigma}^I\right)^{\mathfrak{C}_s}\right)^{\frac{\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\overline{\overline{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}{\oplus_{\varsigma=1}^{\varrho}\overline{\overline{\mathfrak{H}_\varsigma}}\left(1+\overline{\overline{\Phi}}_Z\left(\Xi_\tau^\varsigma\right)\right)}} \right)^{\frac{1}{\mathfrak{C}_s}} \right) \end{array} \right)$$

Step 3: Calculate the score values for the aggregated information, as follows

$$\mathfrak{S}^{SF}\left(\Xi_\tau^\varsigma\right) = \mathfrak{Q}_{\Lambda_\varsigma * \frac{\left(\mathfrak{R}_{\Xi_\tau^\varsigma}^R - \mathfrak{S}_{\Xi_\tau^\varsigma}^R + \mathfrak{R}_{\Xi_\tau^\varsigma}^I - \mathfrak{S}_{\Xi_\tau^\varsigma}^I\right)}{2}} \in \mathfrak{Q}_{[-1,\Pi]}$$

Step 4: Determine the optimal decision, based on score values for ranking the set of alternatives.

Finally, we established that the proposed techniques demonstrate superior performance; therefore, we examine several numerical examples using the proposed operators to demonstrate the effectiveness of the proposed framework.

4.1 Analysis of Human-Machine Interface Based on Initiated Operators

Human-machine interface is a technique or method that enables communication and interaction between humans and machines. The primary objective of this application is to identify an effective means for humans to interact with awkward machinery or computerized systems. Every technique or procedure contains many features, but finding which features significantly influence the application of the Human-machine interface is very complicated. To address this, we formulated the MADM framework using the proposed operators to identify the optimal features for the Human-machine interface and improve the operators' performance. For this, we consider the following five alternatives, as follows

1) Communication Protocols "Ξ_τ^1".
2) Sensors and Actuators "Ξ_τ^2".
3) Software Applications "Ξ_τ^3".
4) Control Systems "Ξ_τ^4".
5) User Interface "Ξ_τ^5".

To determine the optimal choice, we consider the following features, such as growth assessment, social influence, political influence, environmental effects, and internet execution, using the following weight vectors, such as $(0.2,0.2,0.2,0.2,0.2)^T$. Thus, to assess certain real-world problems, we employ the following approach for assessing the above information, such as

Step 1: Construct the matrix by incorporating the values of CIFLNs, as shown in Table 1. When cost-type data are present within the matrix, the matrix is normalized, such as

$$N = \begin{cases} \left(\mathfrak{L}_{\Lambda_\varsigma}, \left(\Re_{\Xi_\tau^\varsigma}^R, \Re_{\Xi_\tau^\varsigma}^I\right), \left(\Im_{\Xi_\tau^\varsigma}^R, \Im_{\Xi_\tau^\varsigma}^I\right)\right) & beǫefıts \\ \left(\mathfrak{L}_{\Lambda_\varsigma}, \left(\Im_{\Xi_\tau^\varsigma}^R, \Im_{\Xi_\tau^\varsigma}^I\right), \left(\Re_{\Xi_\tau^\varsigma}^R, \Re_{\Xi_\tau^\varsigma}^I\right)\right) & cost \end{cases}$$

When benefit-type data are present in the matrix, normalization is not required, whereas the data presented in Table 1 require no normalization.

Table 1
CIFL decision matrix

	Ξ_{AT}^1	Ξ_{AT}^2	Ξ_{AT}^3
Ξ_τ^1	$(\mathfrak{L}_2, (0.6,0.5), (0.2,0.3))$	$(\mathfrak{L}_{2.1}, (0.61,0.51), (0.21,0.31))$	$(\mathfrak{L}_{2.2}, (0.62,0.52), (0.22,0.32))$
Ξ_τ^2	$(\mathfrak{L}_2, (0.8,0.6), (0.1,0.2))$	$(\mathfrak{L}_{2.1}, (0.81,0.61), (0.11,0.21))$	$(\mathfrak{L}_{2.2}, (0.82,0.62), (0.12,0.22))$
Ξ_τ^3	$(\mathfrak{L}_2, (0.4,0.3), (0.1,0.1))$	$(\mathfrak{L}_{2.1}, (0.41,0.31), (0.11,0.11))$	$(\mathfrak{L}_{2.2}, (0.42,0.32), (0.12,0.12))$
Ξ_τ^4	$(\mathfrak{L}_2, (0.9,0.9), (0.0,0.0))$	$(\mathfrak{L}_{2.1}, (0.91,0.91), (0.01,0.01))$	$(\mathfrak{L}_{2.2}, (0.92,0.92), (0.02,0.02))$
Ξ_τ^5	$(\mathfrak{L}_2, (0.4,0.3), (0.4,0.3))$	$(\mathfrak{L}_{2.1}, (0.41,0.31), (0.41,0.31))$	$(\mathfrak{L}_{2.2}, (0.42,0.32), (0.42,0.32))$
	Ξ_{AT}^4	Ξ_{AT}^5	
Ξ_τ^1	$(\mathfrak{L}_{2.3}, (0.63,0.53), (0.23,0.33))$	$(\mathfrak{L}_{2.4}, (0.64,0.54), (0.24,0.34))$	
Ξ_τ^2	$(\mathfrak{L}_{2.3}, (0.83,0.63), (0.13,0.23))$	$(\mathfrak{L}_{2.4}, (0.84,0.64), (0.14,0.24))$	
Ξ_τ^3	$(\mathfrak{L}_{2.3}, (0.43,0.33), (0.13,0.13))$	$(\mathfrak{L}_{2.4}, (0.44,0.34), (0.14,0.14))$	
Ξ_τ^4	$(\mathfrak{L}_{2.3}, (0.93,0.93), (0.03,0.03))$	$(\mathfrak{L}_{2.4}, (0.94,0.94), (0.04,0.04))$	
Ξ_τ^5	$(\mathfrak{L}_{2.3}, (0.43,0.33), (0.43,0.33))$	$(\mathfrak{L}_{2.4}, (0.44,0.34), (0.44,0.34))$	

Step 2: Construct the aggregated matrix, employing the technique of the CIFLPWG operator together with the CIFLGPWG operator; see Table 2.

Table 2
CIFL aggregated matrix

	CIFLPWG Operator	***CIFLGPWG Operator***
Ξ_τ^1	$(\mathfrak{L}_{2.1954}, (0.6198,0.5198), (0.3806,0.4045))$	$(\mathfrak{L}_{1.2247}, (0.000056,0.000015), (0.2209,0.3206))$
Ξ_τ^2	$(\mathfrak{L}_{2.1954}, (0.8198,0.6198), (0.3878,0.3806))$	$(\mathfrak{L}_{1.2247}, (0.00069,0.000056), (0.1216,0.2209))$
Ξ_τ^3	$(\mathfrak{L}_{2.1954}, (0.4197,0.3196), (0.3878,0.3878))$	$(\mathfrak{L}_{1.2247}, (0.0000039,0.00000075), (0.1216,0.1216))$
Ξ_τ^4	$(\mathfrak{L}_{2.1954}, (0.9198,0.9198), (0.4808,0.4808))$	$(\mathfrak{L}_{1.2247}, (0.0033,0.0033), (0.0271,0.0271))$
Ξ_τ^5	$(\mathfrak{L}_{2.1954}, (0.4197,0.3196), (0.4474,0.4045))$	$(\mathfrak{L}_{1.2247}, (0.0000039,0.00000075), (0.4205,0.3206))$

Step 4: Calculate the score values for the aggregated information; see Table 3.

Table 3
Score values of the aggregated data

	$\boldsymbol{CIFLPWG\ Operator}$	$\boldsymbol{CIFLGPWG\ Operator}$
Ξ_τ^1	$\mathfrak{Q}_{.3891}$	$\mathfrak{Q}_{-0.3316}$
Ξ_τ^2	$\mathfrak{Q}_{.7368}$	$\mathfrak{Q}_{-0.2093}$
Ξ_τ^3	$\mathfrak{Q}_{-.0398}$	$\mathfrak{Q}_{-0.1489}$
Ξ_τ^4	$\mathfrak{Q}_{.9638}$	$\mathfrak{Q}_{-0.0291}$
Ξ_τ^5	$\mathfrak{Q}_{-.1235}$	$\mathfrak{Q}_{-0.4538}$

Step 5: Derive the best decision using the score values to aggregate the collection of alternatives; see Table 4.

Table 1

Ranking information.

Methods	Ranking values	Best optimal
$\boldsymbol{CIFLPWG\ Operator}$	$\Xi_\tau^4 > \Xi_\tau^2 > \Xi_\tau^1 > \Xi_\tau^3 > \Xi_\tau^5$	Ξ_τ^4
$\boldsymbol{CIFLGPWG\ Operator}$	$\Xi_\tau^4 > \Xi_\tau^3 > \Xi_\tau^2 > \Xi_\tau^1 > \Xi_\tau^5$	Ξ_τ^4

The most suitable and dominant alternative is Ξ_τ^4 according to the information obtained from the CIFLPWG operator as well as the CIFLGPWG operator. Furthermore, we assess the proposed techniques in comparison with selected existing methods to demonstrate the effectiveness and validity of the proposed framework.

5. Comparison with Existing Methods

In this section, we present a comparison of the proposed operators against selected existing methods using the data in Table 1. Comparative analysis provides an effective means for assessing the effectiveness and validity of the proposed techniques, for this comparison, it is necessary several established operators, therefore, the following existing methods are considered, for example, for example, Zhao et al. [30] introduced modified operators for IFSs, Bi et al. [31] proposed averaging operators for IFSs, Hu et al. [32] proposed the PA operators, Garg and Rani [33] developed modified operators for CIFSs, Liu et al. [34] examined power modified operators for intuitionistic linguistic sets, Zhao et al. [35] proposed modified power operators for IFSS, Jiang et al. [36] developed power operators for IFSs, Xu [37] examined aggregation operators for IFSs, and Rani and Garg [38] analyzed power operators for CIFSs. Therefore, the comparison is presented in Table 5 using the data in Table 1.

Table 2.

Comparison of Methods.

Methods	Ranking values	Best optimal
Zhao et al. [30]	Not succeed (Limited features)	Not succeed (Limited features)
Bi et al. [31]	Not succeed (Limited features)	Not succeed (Limited features)
Hu et al. [32]	Not succeed (Limited features)	Not succeed (Limited features)
Garg and Rani [33]	Not succeed (Limited features)	Not succeed (Limited features)
Liu et al. [34]	Not succeed (Limited features)	Not succeed (Limited features)
Zhao et al. [35]	Not succeed (Limited features)	Not succeed (Limited features)
Jiang et al. [36]	Not succeed (Limited features)	Not succeed (Limited features)
Xu [37]	Not succeed (Limited features)	Not succeed (Limited features)
Rani and Garg [38]	Not succeed (Limited features)	Not succeed (Limited features)
CIFLPWG Operator	$\Xi_\tau^4 > \Xi_\tau^2 > \Xi_\tau^1 > \Xi_\tau^3 > \Xi_\tau^5$	Ξ_τ^4
CIFLGPWG Operator	$\Xi_\tau^4 > \Xi_\tau^3 > \Xi_\tau^2 > \Xi_\tau^1 > \Xi_\tau^5$	Ξ_τ^4

The most preferable and the most dominant optimal is Ξ_τ^4 according to the information provided by the CIFLPWG operator and the CIFLGPWG operator. The previously developed techniques did not succeed owing to their inherent limitations. Furthermore, the existing approach represents special cases of the demonstrated techniques and therefore shows improved performance compared with the existing techniques. Hence, the proposed techniques demonstrate greater reliability and effectiveness compared with the established methods [30-38].

6. Conclusion

The main contributions of this study are summarized below:

1) We formulated CIFL sets and established their fundamental laws.
2) We introduced the CIFLPG operator, CIFLPWG operator, CIFLGPG operator, and CIFLGPWG operator.
3) We examined several important properties associated with the four proposed techniques.
4) Each procedure involves multiple features, but finding which feature significantly influences the application of the Human-machine interface is very complicated.
5) We formulated the MADM framework using the proposed operators for identifying the optimal feature for the Human-machine interface to improve the performance of the proposed operators.
6) We presented a comparison of the proposed methods against selected existing techniques through numerical examples to demonstrate the superiority and flexibility of the proposed approaches.

Future work will examine various types of operators, different techniques, and different methodological approaches within other complex fuzzy set frameworks [39-44] and investigate their applications to artificial intelligence, machine learning, game theory, neural networks applications, and other recent decision-making models [45-52].

Author Contributions

Conceptualization, T. and A.A.; methodology, T. and A.A.; software, T. and K.A.; validation, T., A.A., and M.R.; formal analysis, T. and A.A.; investigation, T., M.R., K.A., and H.A.; resources, A.A. and M.R.; data curation, T. and K.A.; writing—original draft preparation, T.; writing—review and editing, T., A.A., M.R., K.A., and H.A.; visualization, T. and H.A.; supervision, A.A.; project administration, T. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement

No external datasets were used in this study. All information and materials discussed in this research are presented within the manuscript.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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