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Supplier Selection for a Power Generator Sustainable Supplier Park: Interval-Valued Neutrosophic SWARA and EDAS Application

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Abstract: Power generator manufacturers play a critical role in maintaining electric flow for sustainable product and service production. The aim of this study is to extract the criteria necessary for a generator manufacturer to evaluate and select its suppliers for its sustainable supplier park, and to prioritize them to form the supply network. The methodology of this research covers the phases as (i) extracting the criteria affecting the supplier selection decision process of a power generator company via an in-depth literature and industrial report review, (ii) evaluating these criteria by industry experts, (iii) identifying the weights of each criterion via SWARA ("step-wise weight assessment ratio analysis"), (iv) prioritizing the alternative suppliers fitting to the criteria so that the power generator company can construct its sustainable supplier park via IVN EDAS ("interval valued neutrosophic Evaluation Based on Distance from Average Solution"), (v) conducting a sensitivity analysis to check for the robustness of the results by changing the weights, and (vi) applying a comparative analysis to validate the methodology's accuracy by comparing the results with IVN TOPSIS and IVN CODAS. Moreover, this paper contributes to the literature by elaborating on the integration details of the IVN SWARA and IVN EDAS as the first research paper of the author' knowledge. A practitioner can understand which factors to consider prominently in forming a sustainable supplier park, or in deciding on which suppliers to select to plan the strategic operations of a power generator company.

Keywords: interval-valued neutrosophic sets; SWARA; EDAS; sustainable supplier park; sustainable industrial park; power generator industry; supplier selection

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1. Introduction

The energy industry is of paramount of importance owing to the use of primary energy supplies that are natural resources, such as crude oil, fuels, coal, natural gas, and wind, by the largest consumer countries in the world, like China with 157.65 exajoules in 2021 [1]. Indeed, although there is an increasing need for energy by the cutting-edge technologies' development for e-mobility (like electric cars/vehicles/scooters/buses, etc.), the worldwide energy crisis of 2021 affected energy prices, led to inflation, and had ramifications for households, businesses, and the economy as a whole [2,3]. Regardless of the severity of the energy supply problems, energy must be provided continuously, for example, in the health sector; in foods that are transferred through the cold chain; and in products that need to be protected by electrical devices, including any kind of perishable goods [4–7].

Power generators (i.e., "electric generators" or simply "generators") are the devices that transform mechanical energy or fuel-based energy into electric power for use in an external circuit. Steam turbines, gas turbines, water turbines, internal combustion engines, wind turbines, and even hand cranks are examples of mechanical energy sources [8,9]. Since energy production, distribution, and usage should be as technologically efficient as possible, power generators play a critical role in maintaining the electric flow [10]. In addition, the well-known power generator manufacturers, such as Armstrong, Atlas Copco, Caterpillar, Cummins, Detroit Diesel, Generac, John Deere, Kohler, Kubota, MQ Power, MTU, Olympian, and Triton, are all globally well-known producers [11] that are leading providers of diesel and natural gas generators, with USD 1 to USD 250 million in revenue annually [12]. Indeed, the related authorities declare an increasing "market uncertainty" of power generator production due to "shortage of raw materials" and "rising motor parts prices". Hence, the industry emphasizes that there is a need for creating "industrial parks", including the required suppliers of the power generator manufacturers [13].

The supplier parks (i.e., industrial parks) strengthen communication and coordination with customers/suppliers of suppliers [14], provide sustainable developments [15], rearrange the production plans of existing orders [16], increase online marketing, and even open up new markets [17] and create global markets via using the close relationships [18]. The current "supplier park literature" and "sustainable supplier park literature" cover Integer Linear Programming (ILP) for truck scheduling [19], a Stackelberg game model for energy pricing of an industrial park [20], a Stackelberg Game for supply and demand balance [20], a branch-cut-and-price algorithm for direct deliveries' scheduling [21], Exploratory Factor Analysis to investigate the key performance indicators [22], exploratory case studies [16,23–25], in-depth comprehensive literature reviews [26,27], semi-structured interviews [28], and the Analytic Network Process (ANP) for build-to-order supplier selection scenarios [29].

As the literature review demonstrates, the amount of up-to-date research is limited, and the approaches are mostly systematic literature reviews, case studies, and mathematical programming models for scheduling vehicles in the supply network [30,31]. Furthermore, the quantity of multi-criteria decision-making (MCDM) research publications is very few. Moreover, there is a clear gap in the publications for both "sustainable supplier park of a power generator manufacturer" and "sustainable supplier selection for supplier park" in the literature.

Hence, the aim of this study is to extract the criteria necessary for a generator manufacturer to evaluate and select its suppliers for its sustainable supplier park, and to prioritize them to construct the supply network. The methodology of this research covers the phases as (i) extracting the criteria affecting the supplier selection decision process of a power generator company via an in-depth literature and industrial report review, (ii) evaluating these criteria by industry experts, (iii) identifying the weights of each criterion via SWARA ("step-wise weight assessment ratio analysis"), (iv) prioritizing the alternative suppliers fitting to the criteria so that the power generator company can construct its supplier park via IVN EDAS ("interval valued neutrosophic Evaluation Based on Distance from Average Solution"), (v) conducting a sensitivity analysis to check for the robustness of the results by changing the weights, and (vi) applying a comparative analysis to validate the methodology's accuracy by comparing the results with IVN TOPSIS and IVN CODAS.

The reason behind why interval-valued neutrosophic sets are preferred is based on the ability of these sets in accounting for the inconsistency and uncertainty in the decision-making processes of the experts [32]. In addition, the SWARA method has been proven to be an effective subjective method for determining the criteria importance weights as a simple method that is easy to implement and not time consuming [33,34]. Moreover, the EDAS technique has gained significant attention since it performs well in the presence of conflicting criteria by incorporating the ambiguity and intangibility existing in the decision makers' evaluations and eliminating the effects of biased assessments [35,36].

The findings of the examination illustrate that "delivery lead times" are the most important factors affecting the supplier selection decision of a power generator company. Next, "operation control" criterion, referring to the engagement level of the manufacturer in control of a supplier's operational activities, is the second important criterion in this case study. Following, the decision makers prioritize the "supplier location" as the third important criterion. And, the remaining ones have the ranking of "reliability", "product range", "raw material circularity", "technical capability", "criticality", "production facility and capacity", "price of products", "packaging quality", and "flexibility".

This paper contributes to the literature by providing a detailed list of factors influencing the supplier selection decision of a power generator company to construct a sustainable supplier park, by extracting the weight of these factors and evaluating the existing suppliers to decide on which supplier should be included for the supplier park first. Moreover, since there is a gap in the literature in applying SWARA and EDAS methodologies with interval-valued neutrosophic sets, this paper also makes a theoretical contribution by elaborating the integration details of these methodologies. Moreover, this research also provides a sensitivity analysis to check the robustness of the proposed technique and compares the proposed approach with the existing one to validate the accuracy.

The following sections cover an in-depth literature review, proposed methodology, case study, sensitivity analysis, and comparative analysis.

2. Literature Review

"Supplier parks" (i.e., "vendor parks") bring particular industry, with plenty of manufacturers ranging in scale and closeness to provide materials or semi-finished components to that specific field of industry [37]. "Supplier parks" have significant examples, especially for the automotive industry [24], which also refers to an "industrial symbiosis" by co-locating the component vendors in a specific area. Industrial symbiosis is a proven practice that provides a competitive advantage [38]. The "resource network" of a particular industry is important for interdependencies of network relationships by supporting the supply base of a company to enhance the competencies [39].

"Global sourcing" is a key term in the supply chain studies, standing for an activity of obtaining products and services from the global market beyond geographical boundaries [40]. Furthermore, it might require a "re-location" for the particular business activity or might need innovative solutions to handle the global sourcing for small- and medium-sized enterprises [41]. For example, just-in-time logistics [42,43] is one of the innovative solutions to deal with the global sourcing problem for the supplier parks. Moreover, logistics data processing [44] and truck scheduling [19,21] are the other alternative solutions to source globally.

The "industrial ecosystem" for modular production/modular supply requires the supplier parks to enable the build-to-order direct deliveries in a more convenient way [23,45]. Indeed, mass customization is also possible and feasible as a business policy to keep up with the economic trends of the markets [46–48] within these supplier parks. In addition, many countries attach importance to eco-industrial parks for sustainable development. They are trying to transform existing industrial parks into eco-industrial parks or symbiotic industrial areas, such as Kalundborg Symbiosis [49], Eco-industrial park in Rio de Janeiro, Brazil [50].

In order to examine how one supplier fits another one, the "mutual compatibility index" is utilized to determine the suitability of these collaborations [29]. By doing so, OEMs (Original Equipment Manufacturers) can be grouped and co-located to a specific business area [51]. In addition, as it is in the "supplier park" literature, the automotive industry is a special case by highlighting the OEMs having build-to-order possibilities with mass customization and just-in-time deliveries [25,26] by bringing, for example, engine components suppliers and engineering service firms together.

Moreover, cooperation and integration concepts are must haves to "localize" the sourcing [52], to "innovate" the business [53], and to tackle the "conflicts" [54]. Clustering [55] and proximity [56] are the key terms in this field of study to group the particular suppliers so that they can cooperate and integrate their business. For instance, "disposal parks" integrate transport, allocate storage capacities, and plan the investments for cooperation between waste producers and disposal enterprises [57]. Disposal parks can not only provide a more sustainable environment with less energy usage and effort, but also reduce serious health risks for residents [58].

The existing "supplier park" literature utilizes Integer Linear Programming (ILP) for truck scheduling [19], a transformed Stackelberg game model into a mixed ILP problem through employing the Karush–Kuhn–Tucker optimality for energy pricing of an industrial park [20], Stackelberg Game for supply and demand balance [20], branch-cut-and-price algorithm for direct deliveries' scheduling [21], Exploratory Factor Analysis to investigate the key performance indicators of a supply chain [22], exploratory case studies [16,23–25], in-depth comprehensive literature reviews [26,27], semi-structured interviews and triangulation [28], and Analytic Network Process (ANP) for build-to-order supplier selection scenarios [29].

As it is clear with the literature review, the number of recent studies is very few, and the methodologies are mainly systematic literature reviews, case studies, and mathematical programming models for scheduling the vehicles within the supply network. Moreover, the number of research papers of multi-criteria decision-making (MCDM) analysis is limited.

Furthermore, there is an emphasis on the "energy/power industry" of the supplier park literature [20,59] as a research gap. Additionally, the "supplier park for energy sector" literature discusses energy management and material flows, energy cascading, and pricing issues [60]. However, there is no paper to create a supplier park for an existing company in the energy/power industry. Hence, this study focuses on the energy-focused multi-criteria decision-making analysis with a case study of a power generator company by applying MCDM.

In order to extract the required criteria to rank the supplier alternatives of the case study of a power generator company, the "supplier selection" and "inventory management" literature is examined in detail for the energy sector. Accordingly, Table 1 states the extracted criteria to be used in MCDM. After considering the criteria, all criteria must be determined a "Cost" or "Benefit". A high level of a criterion defined as "Cost" has a negative impact on the evaluation, while a high level of a criterion defined as "Benefit" has a positive impact on the evaluation.

Table 1. The criteria in creating a sustainable supplier park for a power generator company.

Criteria	Publication
C1.1 Delivery lead time	[61–63]
C1.2 Supplier location	[64–66]
C1.3 Product range	[67,68]
C1.4 Production facilities and capacity	[69,70]
C1.5 Technical capability—product quality	[71–73]
C1.6 Criticality	[74,75]
C2.1 Raw material circulation—usage rate	[76–78]
C2.2 Price of products	[79–81]
C2.3 Flexibility	[82,83]
C2.4 Packaging quality—condition	[84,85]
C3.1 Reliability	[82,86,87]
C3.2 Operation controls	[88–90]

The following section utilizes these extracted criteria in the methodology to derive the findings.

3. Methodology

Decision-making processes incorporate various types of uncertainties, which may be a result of reasons such as a lack of knowledge and information, the intangibility of the decision-making process, and ambiguity involved in linguistic expressions of preferences and evaluations. Ref. [91] has introduced fuzzy sets to deal with uncertainty, which has been extended to interval-valued fuzzy sets by [92] to enable assigning a range of values as the grade of membership. Further, intuitionistic fuzzy sets are developed by [93] to incorporate the information on both the membership and non-membership degrees, enabling an enrichment in the information representation. However, the intuitionistic fuzzy sets fail to represent the indeterminacy, which has been addressed by the hesitant fuzzy sets developed by [94]. As an extension of intuitionistic fuzzy sets, ref. [32] introduced neutrosophic logic and neutrosophic sets. A neutrosophic set represents the degree of membership, degree of indeterminacy (i.e., hesitancy), and degree of non-membership, each defined for the interval (0, 1), and where the sum of the lower value of each parameter equals three at most. Therefore, the neutrosophic sets can represent both the indeterminacy and the conflicting information that is present in data. In this study, interval-valued neutrosophic (IVN) sets are preferred to account for the inconsistency and uncertainty in the decision-making processes. To derive the weights for criteria importance, the SWARA method is employed, and IVN EDAS is used to determine the final ranking of alternatives. The rest of this section gives the preliminaries of interval-valued neutrosophic sets and the classical SWARA and fuzzy EDAS methods and concludes with the proposed IVN SWARA & EDAS methodology.

3.1. Preliminaries on Interval-Valued Neutrosophic Sets

Definition 1. *In the universal discourse X, an interval-valued neutrosophic (IVN) set x is defined by three parameters: the membership $T_N(x)$, indeterminacy $I_N(x)$, and non-membership $F_N(x)$, where these parameters have an interval range as $T_N = \left[T\binom{L}{N(x)}, T\binom{U}{N(x)} \subseteq [0,1]\right]$, $I_N(x) = \left[I\binom{L}{N(x)}, I\binom{U}{N(x)} \subseteq [0,1]\right]$, and $F_N(x) = \left[F\binom{L}{N(x)},\ F\binom{U}{N(x)} \subseteq [0,1]\right]$.*

An interval-valued neutrosophic number (IVNN) must hold the condition $0 \leq T\binom{L}{N(x)} + I\binom{L}{N(X)} + F\binom{L}{N(x)} \leq 3$. An IVN set denoted by x is then given as follows [95]:

$$N = \left\{ \left\langle x,\ \left[T\left(\begin{matrix}L\\N(x)\end{matrix}\right), T\left(\begin{matrix}U\\N(x)\end{matrix}\right)\right], \left[I\left(\begin{matrix}L\\N(x)\end{matrix}\right), I\left(\begin{matrix}U\\N(x)\end{matrix}\right)\right],\ \left[F\left(\begin{matrix}L\\N(x)\end{matrix}\right), F\left(\begin{matrix}U\\N(x)\end{matrix}\right)\right] \right\rangle \middle| x \in X \right\} \quad (1)$$

Definition 2. *If $a = \left[T\binom{L}{a}, T\binom{U}{a}\right], \left[I\binom{L}{a}, I\binom{U}{a}\right],\ \left[F\binom{L}{a}, F\binom{U}{a}\right]$ and $b = \left[T\binom{L}{b}, T\binom{U}{b}\right], \left[I\binom{L}{b}, I\binom{U}{b}\right]$, $\left[F\binom{L}{b}, F\binom{U}{b}\right]$ are two IVNNs, then the mathematical operations are represented as follows [96]:*

$$a^c = \left\langle \left[T\binom{L}{a}, T\binom{U}{a}\right], \left[1 - I\binom{L}{a}, 1 - I\binom{U}{a}\right],\ \left[F\binom{L}{a}, F\binom{U}{a}\right] \right\rangle \quad (2)$$

$$a \oplus b = \left\langle \left[T\binom{L}{a} + T\binom{L}{b} - T\binom{L}{a}T\binom{L}{b}, T\binom{U}{a} + T\binom{U}{b} - T\binom{U}{a}T\binom{U}{b}\right], \left[I\binom{L}{a}I\binom{L}{b},\ I\binom{U}{a}I\binom{U}{b}\right],\ \left[F\binom{L}{a}F\binom{L}{b},\ F\binom{U}{a}F\binom{U}{b}\right] \right\rangle \quad (3)$$

$$a \otimes b = \left\langle \left[T\binom{L}{a}T\binom{L}{b}, T\binom{U}{a}T\binom{U}{b}\right], \left[I\binom{L}{a} + I\binom{L}{b} - I\binom{L}{a}I\binom{L}{b}, I\binom{U}{a} + I\binom{U}{b} - I\binom{U}{a}I\binom{U}{b}\right], \left[F\binom{L}{a} + F\binom{L}{b} - F\binom{L}{a}F\binom{L}{b}, F\binom{U}{a} + F\binom{U}{b} - F\binom{U}{a}F\binom{U}{b}\right] \right\rangle \quad (4)$$

Definition 3. *The following conditions hold for two IVNNs [97]:*
$a \subseteq b$ if and only if $T\binom{L}{a} \leq T\binom{L}{b}$, $T\binom{U}{a} \leq T\binom{U}{b}$; $I\binom{L}{a} \geq I\binom{L}{b}$, $I\binom{U}{a} \geq I\binom{U}{b}$; $F\binom{L}{a} \geq F\binom{L}{b}$, $F\binom{U}{a} \geq F\binom{U}{b}$
$a = b$ if and only if $a \subseteq b$ and $b \subseteq a$.

Definition 4. *The interval-valued neutrosophic number-weighted averaging operator (INNWA) of dimension n, defined as given in Equation (5) [98], is used to aggregate n IVNNs weighted by the weight vector $Y = (y_1, \ldots, y_j, \ldots, y_n)$ and $\sum_{j=1}^{n} y_j = 1$.*

$$\begin{aligned} INNWA\left(x_1,\ldots,x_j,\ \ldots,x_n\right) &= \sum_{j=1}^{n} y_j x_j \\ &= \left\langle \left[1-\prod_{j=1}^{n}\left(1-T\left(\begin{smallmatrix}L\\ j\end{smallmatrix}\right)\right)^{y_j},\ 1 \right.\right. \\ &\left.\left. -\prod_{j=1}^{n}\left(1-T\left(\begin{smallmatrix}U\\ j\end{smallmatrix}\right)\right)^{y_j}\right] \left[\prod_{j=1}^{n}\left(I\left(\begin{smallmatrix}L\\ j\end{smallmatrix}\right)\right)^{y_j},\ \prod_{j=1}^{n}\left(I\left(\begin{smallmatrix}U\\ j\end{smallmatrix}\right)\right)^{y_j}\right], \left[\prod_{j=1}^{n}\left(F\left(\begin{smallmatrix}L\\ j\end{smallmatrix}\right)\right)^{y_j},\ \prod_{j=1}^{n}\left(F\left(\begin{smallmatrix}U\\ j\end{smallmatrix}\right)\right)^{y_j}\right]\right\rangle \end{aligned} \quad (5)$$

Definition 5. *The deneutrosophication of an IVNN is calculated by using Equation (6) [33]:*

$$\mathfrak{D}(A) = \left(\frac{\left(T\left(\begin{smallmatrix}L\\ A\end{smallmatrix}\right)+T\left(\begin{smallmatrix}U\\ A\end{smallmatrix}\right)\right)}{2} + \left(1-\frac{\left(I\left(\begin{smallmatrix}L\\ A\end{smallmatrix}\right)+I\left(\begin{smallmatrix}U\\ A\end{smallmatrix}\right)\right)}{2}\right)\left(I\left(\begin{matrix}U\\ A\end{matrix}\right)\right) - \left(\frac{\left(F\left(\begin{smallmatrix}L\\ A\end{smallmatrix}\right)+F\left(\begin{smallmatrix}U\\ A\end{smallmatrix}\right)\right)}{2}\right)\left(1-F\left(\begin{matrix}U\\ A\end{matrix}\right)\right)\right) \quad (6)$$

3.2. SWARA Method

The SWARA method introduced by [99] has been proven to be an effective subjective method for determining the criteria importance weights. The SWARA method is considered as a simple method that is easy to implement and not time consuming. It directly allows for the decision makers to reflect their own subjective assessments and enables the derivation of a compromise solution [100,101]. The SWARA method first ranks the criteria based on their relative importance to each other and arranges them from the most important to the least important criterion. Then, the comparative significance values and comparative coefficients are calculated. The weights are then recalculated and normalized to derive the final importance weights of the criteria. The steps of the classical SWARA method are given below:

Step 1. The set of criteria is established according to the importance for the problem objective.

Step 2. The criteria are arranged in the order of the decision maker's preference from the most important to the least important criterion.

Step 3. The relative importance value x_j is assigned for each criterion $(j = 1, \ldots, m)$, which is defined for [0, 1].

Step 4. The comparative importance value s_j of the criteria are then computed by taking the difference of the relative importance values x_j from its prior criterion, as defined in Equation (7):

$$s_j = \begin{cases} 0 & j = 1 \\ x_{j-1} - x_j & j > 1 \end{cases}; \quad (7)$$

Step 5. The comparative coefficient k_j of each criterion is calculated as follows:

$$k_j = \begin{cases} 1 & j = 1 \\ s_j + 1 & j > 1 \end{cases} \quad (8)$$

Step 6. Then the recalculated weights q_j are found by using Equation (9):

$$q_j = \begin{cases} 1 & j = 1 \\ \frac{q_{j-1}}{k_j} & j > 1 \end{cases} \quad (9)$$

Step 7. The recalculated weights q_j are then normalized to derive the final criteria weights q_j, as given in Equation (10):

$$w_j = \frac{q_j}{\sum_{j=1}^{m} q_j} \quad (10)$$

3.3. Fuzzy EDAS Method

The EDAS method introduced by [102] is extended to the fuzzy environment using trapezoidal fuzzy numbers by [103]. This method is a method that calculates the average solution based on two distance measures. These distances are PDA (Positive Distance from Average) and NDA (Negative Distance from Average), and options with higher PDA values and lower NDA values are considered as the best options. Compared to the existing MCDM methods, such as VIKOR, ELECTRE, TOPSIS, PROMETHEE, GRA, MULTIMOORA, TODIM, etc., the EDAS model considers the intangibility of decision makers and the uncertainty of the decision-making environment to achieve more valid and useful aggregation results [35]. Also, this method has gained significant attention since it performs well in the presence of conflicting criteria. The final ranking is derived by the computation of the average solution for each criterion. Therefore, it incorporates the ambiguity and intangibility existing in the decision makers' evaluations and reduces the effects of biased assessments [35].

The rest of this section presents the steps of fuzzy EDAS as given in [103]. Suppose that there is the set of m alternatives $X = \{X_1, X_2, \ldots, X_i, \ldots, X_m\}$ evaluated based on n criteria $C = \{C_1, C_2, \ldots, C_j, \ldots, C_n\}$ by K decision makers $D = \{D_1, D_2, \ldots, D_k, \ldots, D_K\}$. It is assumed that the decision makers have equal importance in the decision-making process.

Step 1. The linguistic evaluations are collected from the decision makers regarding the criteria importance and alternatives' performance with respect to the predefined criteria. The linguistic evaluations are then converted to the corresponding fuzzy numbers.

Step 2. The average decision matrix is obtained as follows:

$$X^{avg} = \left[\tilde{x}_{ij}\right]_{m \times n} \tag{11}$$

$$\tilde{x}_{ij} = \frac{1}{K} \bigoplus_{k=1}^{K} \tilde{x}_{ijk} \tag{12}$$

where $\tilde{x}_{ijk}$ represents the corresponding fuzzy number for the linguistic assessment of alternative i with respect to criterion j submitted by decision maker k.

Step 3. The matrix of criteria importance weights is calculated by:

$$W^{avg} = \left[\tilde{w}_j\right]_{1 \times n} \tag{13}$$

$$\tilde{w}_j = \frac{1}{K} \bigoplus_{k=1}^{K} \tilde{w}_{jk} \tag{14}$$

where $\tilde{w}_{jk}$ denotes the corresponding fuzzy number for the linguistic assessment given by decision maker k regarding the importance of criterion j considering its contribution to the objective of the decision-making problem.

Step 4. Considering the equal importance of decision makers, the average solutions matrix is obtained by computing the fuzzy average of alternatives' performances with respect to each criterion as follows:

$$AV = \left[\tilde{av}_j\right]_{1 \times n} \tag{15}$$

$$\tilde{av}_j = \frac{1}{m} \bigoplus_{i=1}^{m} \tilde{x}_{ij} \tag{16}$$

Step 5. The positive distance to average solution (PDA) and negative distance to average solution (NDA) are calculated for each alternative based on each criterion, according to the type of criterion as defined by Equations (17)–(20):

$$PDA = \left[\tilde{pda}_{ij}\right]_{m \times n} \tag{17}$$

$$NDA = \left[\widetilde{nda}_{ij} \right]_{m \times n} \tag{18}$$

$$\widetilde{pda}_{ij} = \begin{cases} \frac{\varphi\left(\widetilde{x}_{ij} \ominus \widetilde{av}_j\right)}{\mathfrak{H}\left(\widetilde{av}_j\right)} & \text{if } j \in B \\ \frac{\varphi\left(\widetilde{av}_j \ominus \widetilde{x}_{ij}\right)}{\mathfrak{H}\left(\widetilde{av}_j\right)} & \text{if } j \in C \end{cases} \tag{19}$$

$$\widetilde{nda}_{ij} = \begin{cases} \frac{\varphi\left(\widetilde{av}_j \ominus \widetilde{x}_{ij}\right)}{\mathfrak{H}\left(\widetilde{av}_j\right)} & \text{if } j \in B \\ \frac{\varphi\left(\widetilde{x}_{ij} \ominus \widetilde{av}_j\right)}{\mathfrak{H}\left(\widetilde{av}_j\right)} & \text{if } j \in C \end{cases} \tag{20}$$

where the function $\varphi(.)$ returns a fuzzy zero $\widetilde{0}$ if the defuzzified input value is less than or equal to zero; else, it gives the fuzzy input value, and the function $\mathfrak{H}$ computes the defuzzification of the input.

Step 6. The weighted sum of *PDA* and *NDA* are computed for each alternative, as defined in Equations (21) and (22):

$$\widetilde{sp}_i = \bigoplus_{j=1}^{n} \left(\widetilde{w}_j \otimes \widetilde{pda}_{ij}\right) \tag{21}$$

$$\widetilde{sn}_i = \bigoplus_{j=1}^{n} \left(\widetilde{w}_j \otimes \widetilde{nda}_{ij}\right) \tag{22}$$

Step 7. The weighted sum of *PDA* and *NDA* calculated in Step 6 are then normalized by linear normalization as follows:

$$\widetilde{nsp}_i = \frac{\widetilde{sp}_i}{\max_i\left(\mathfrak{H}\left(\widetilde{sp}_i\right)\right)} \tag{23}$$

$$\widetilde{nsn}_i = 1 - \frac{\widetilde{sn}_i}{\max_i\left(\mathfrak{H}\left(\widetilde{sn}_i\right)\right)} \tag{24}$$

Step 8. The appraisal score of each alternative is calculated by taking the fuzzy average of $\widetilde{nsp}_i$ and $\widetilde{nsn}_i$.

$$\widetilde{as}_i = \frac{1}{2}\left(\widetilde{nsp}_i \oplus \widetilde{nsn}_i\right) \tag{25}$$

Step 9. The alternatives are ranked in descending order of the appraisal score.

3.4. Proposed IVN SWARA & EDAS Methodology

This section presents the applied IVN SWARA & EDAS methodology, which consists of two phases. In the first phase, the data preparation is performed, and the criteria weights are determined by the SWARA method. In the second phase, the alternatives are evaluated by employing the IVN EDAS method. The proposed methodology addresses a group decision-making problem that is under the assumption that there is the set of m alternatives $X = \{X_1, X_2, \ldots, X_i, \ldots, X_m\}$ evaluated based on n criteria $C = \{C_1, C_2, \ldots, C_j, \ldots, C_n\}$ by K decision makers $D = \{D_1, D_2, \ldots, D_k, \ldots, D_K\}$. In the rest of this section, the steps of the proposed IVN SWARA & EDAS methodology are presented.

Phase 1: Preparation process and SWARA

Step 1. Define the set of criteria and the alternatives and determine the weights of decision makers $\lambda_k = (\lambda_1, \ldots, \lambda_k, \ldots, \lambda_K)$, $k = 1, \ldots, K$.

Step 2. Collect the linguistic evaluations from the decision makers regarding the criteria importance and the alternatives' performance with respect to the criteria.

Step 3. Transform the linguistic evaluations into interval-valued neutrosophic numbers by utilizing the linguistic-IVN scale given in Table 2, and construct the IVN criteria weights matrix in Equation (26) and the decision matrix for each decision maker as given in Equations (26) and (27), respectively:

$$W = \left[w_{jk}\right]_{1\times n},\ k = 1,\ldots,K \quad (26)$$

$$X = \left[x_{ijk}\right]_{m\times n},\ k = 1,\ldots,K \quad (27)$$

Table 2. Linguistic scale for assessment of criteria and alternatives [96].

Linguistic Term for Alternative Evaluation	Abb.	Linguistic Term for Criteria Evaluation	Abb.	⟨T,I,F⟩
Very High	VH	Very High Importance	AHI	⟨[0.65, 0.8], [0.5, 0.6], [0.15, 0.3]⟩
High	H	High Importance	VHI	⟨[0.55, 0.7], [0.4, 0.5], [0.25, 0.4]⟩
Above Average	AA	Above Average Importance	HI	⟨[0.45, 0.6], [0.3, 0.4], [0.35, 0.5]⟩
Average	A	Average Importance	SHI	⟨[0.4, 0.6], [0.1, 0.2], [0.4, 0.6]⟩
Below Average	BA	Below Average Importance	MI	⟨[0.35, 0.5], [0.3, 0.4], [0.45, 0.6]⟩
Low	L	Low Importance	SLI	⟨[0.25, 0.4], [0.4, 0.5], [0.55, 0.7]⟩
Very Low	VL	Very Low Importance	LI	⟨[0.15, 0.3], [0.5, 0.6], [0.65, 0.8]⟩
Certainly Low	CL	Certainly Low Importance	VLI	⟨[0.05, 0.2], [0.6, 0.7], [0.75, 0.9]⟩

Step 4. Aggregate the IVN matrix in Equation (26) by using the INNWA operator given in Equation (5) and obtain the aggregated IVN criteria importance matrix as follows:

$$W_{agg} = \left[w_j\right]_{1\times n} \quad (28)$$

Step 5. Use the deneutrosophication function in Equation (6) to deneutrosophicate the IVN matrix for the criteria weights in Equation (28) The deneutrosophicated values are defined as the score values of the criteria c_j for the following steps of the SWARA method.

Step 6. Arrange the criteria in the descending order of score values c_j.

Step 7. Calculate the comparative significance of each criterion s_j by finding the difference of its score value from the previous more significant criterion as in Equation (29):

$$s_j = \begin{cases} 0 & j = 1 \\ c_{j-1} - c_j & j > 1 \end{cases} \quad (29)$$

Step 8. Compute the comparative coefficient k_j of each criterion as given in Equation (8).

Step 9. Find the recalculated weights q_j of criteria as given in Equation (9).

Step 10. Normalize the recalculated weights q_j to derive the final weights w_j so that the sum of final weights of criteria equals to one, as defined in Equation (10).

Phase 2: IVN EDAS

Step 11. Normalize the IVN decision matrices X given in Equation (27) to X', according to the type of the criterion by the normalization approach adopted from [104]. The normalization is defined as follows:

$$X' = \left[x'_{ijk}\right]_{m\times n} = \left\{ \begin{array}{ll} \left\langle \left[\mathrm{T}\left(^{L}_{ij}\right), \mathrm{T}\left(^{U}_{ij}\right)\right], \left[\mathrm{I}\left(^{L}_{ij}\right), \mathrm{I}\left(^{U}_{ij}\right)\right], \left[\mathrm{F}\left(^{L}_{ij}\right), \mathrm{F}\left(^{U}_{ij}\right)\right] \right\rangle & \text{if} j \in B \\ \left\langle \left[\mathrm{F}\left(^{L}_{ij}\right), \mathrm{F}\left(^{U}_{ij}\right)\right], \left[\mathrm{I}\left(^{L}_{ij}\right), \mathrm{I}\left(^{U}_{ij}\right)\right], \left[\mathrm{T}\left(^{L}_{ij}\right), \mathrm{T}\left(^{U}_{ij}\right)\right] \right\rangle & \text{if} j \in C \end{array} \right\} \quad (30)$$

Step 12. Aggregate the normalized IVN decision matrices by using the INNWA operator in Equation (5) to obtain the aggregated decision matrix:

$$X'_{agg} = \left[x'_{ij}\right]_{\mathrm{m}\times n} \tag{31}$$

Step 13. Determine the average solution (AV) for each criterion and obtain the average solution matrix as defined by Equation (32), which is modified from [104]:

$$AV = \left[AV_j\right]_{1\times n} = \begin{Bmatrix} \langle \left[1-\prod_{i=1}^{m}\left(1-\mathrm{T}(^{L}_{ij})\right)^{\frac{1}{m}}, 1-\prod_{i=1}^{m}\left(1-\mathrm{T}(^{U}_{ij})\right)^{\frac{1}{m}}\right], \left[\prod_{i=1}^{m}\left(\mathrm{I}(^{L}_{ij})\right)^{\frac{1}{m}}, \prod_{i=1}^{m}\left(\mathrm{I}(^{U}_{ij})\right)^{\frac{1}{m}}\right], \\ \left[\prod_{i=1}^{m}\left(\mathrm{F}(^{L}_{ij})\right)^{\frac{1}{m}}, \prod_{i=1}^{m}\left(\mathrm{F}(^{U}_{ij})\right)^{\frac{1}{m}}\right] \rangle \end{Bmatrix} \tag{32}$$

Step 14. Calculate the positive distance from the average solution (*PDA*) and the negative distance from the average solution (*NDA*) of each alternative with respect to each criterion by using Equations (33) and (34), respectively:

$$PDA = \left[PDA_{ij}\right]_{m\times n} = \left\{ \frac{\max\left(0, \left(x'_{ij} - AV_j\right)\right)}{AV_j} \right\} \tag{33}$$

$$NDA = \left[NDA_{ij}\right]_{m\times n} = \left\{ \frac{\max\left(0, \left(AV_j - x'_{ij}\right)\right)}{AV_j} \right\} \tag{34}$$

For convenience, for the calculation of *PDA* and *NDA*, Equations (34) and (35) can be modified by using deneutrosophication in accordance with the approach in [104], as defined in Equations (35) and (36):

$$PDA = \left[PDA_{ij}\right]_{m\times n} = \left\{ \frac{\max\left(0, \left(\mathfrak{D}\left(x'_{ij}\right) - \mathfrak{D}\left(AV_j\right)\right)\right)}{\mathfrak{D}\left(AV_j\right)} \right\} \tag{35}$$

$$NDA = \left[NDA_{ij}\right]_{m\times n} = \left\{ \frac{\max\left(0, \left(\mathfrak{D}\left(AV_j\right) - \mathfrak{D}\left(x'_{ij}\right)\right)\right)}{\mathfrak{D}\left(AV_j\right)} \right\} \tag{36}$$

Step 15. Calculate the weighted sum of positive and negative distances SP_i and SN_i as follows:

$$SP_i = \sum_{j=1}^{n} w_j PDA_{ij} \tag{37}$$

$$SN_i = \sum_{j=1}^{n} w_j NDA_{ij} \tag{38}$$

Step 16. Calculate the normalized values of SP_i and SN_i as given in Equations (39) and (40), respectively:

$$NSP_i = \frac{SP_i}{\max_i(SP_i)} \tag{39}$$

$$NSN_i = 1 - \frac{SN_i}{\max_i(SN_i)} \tag{40}$$

Step 17. Compute the appraisal score (*AS*) by taking the average of NSP_i and NSN_i as given in Equation (41) and rank the alternatives in the descending order of the appraisal scores.

$$AS_i = \frac{1}{2}(NSP_i + NSN_i) \tag{41}$$

4. Case Study

4.1. Description of the Problem

The problem handles the evaluation of potential suppliers for a power generator company to establish a sustainable supplier park, while aiming at cost and waste reduction and decreased delivery lead times, as well as improved accuracy and efficiency in its operations.

Based on the title and experience, potential decision makers have been assessed from the company, and three decision makers have been determined as a Sales & Operations (S&OP) and Material Planning Manager, a Master Data Manager, and a Logistics and Warehouse Manager, with the corresponding weights as presented in Table 3. The Sales & Operations (S&OP) and Material Planning Manager holds extensive information on production planning and production scheduling. The Master Data Manager coordinates the data assets, such as customer data and product data, and ensures the uniformity, accuracy, and consistency in the master data assets. The Logistics and Warehouse Manager brings knowledge on the required storage conditions of goods and manages the logistics activities within the company, suppliers, and subcontractors.

Table 3. Decision makers and their weights.

Code	Explanation	Weights
DM1	Sales & Operations and Material Planning Manager	40%
DM2	Master Data Manager	25%
DM3	Logistics and Warehouse Manager	35%

Regarding the collection of the criteria set, first the relevant criteria have been identified through extensive research of articles. Then, the set of criteria is finalized by a screening process performed by the company managers and employees. The screening process includes the elimination of criteria that have a similar or the opposite sense. The description of the selected criteria and their type are given in Table 4. After the identification of the relevant criteria, 14 potential suppliers have been selected through a consultation with the decision makers.

Table 4. The description and the type of each criterion.

Criteria	Description	Type of Criterion
C1.1 Delivery lead time	The length of time starting from the order placement until its delivery	Cost
C1.2 Supplier location	The proximity of the supplier's location to the manufacturer's	Benefit
C1.3 Product range	The product variety of a supplier	Benefit
C1.4 Production facilities and capacity	The production capabilities of a supplier	Benefit
C1.5 Technical capability—product quality	The quality of the products served by a supplier	Benefit
C1.6 Criticality	The asset criticality of parts delivered by a supplier	Benefit
C2.1 Raw material circulation—usage rate	The usage rate of the parts	Benefit
C2.2 Price of products	The price of the products	Cost
C2.3 Flexibility	The ability of a supplier to handle disruptions	Benefit
C2.4 Packaging quality—condition	The delivery conditions of the product	Benefit
C3.1 Reliability	The consistency and quality of a supplier's deliveries	Benefit
C3.2 Operation controls	The level of engagement of the manufacturer in the control of the supplier's operational activities	Benefit

4.2. Numerical Application

The application of the methodology is presented through the evaluation of 14 potential suppliers most adequate for the respective generator company's production. The suppliers are assessed based on the pre-determined twelve criteria by three decision makers.

Phase 1: Preparation process and SWARA

Step 1. The set of criteria and alternatives is defined. The weights of decision makers are assigned by the problem owner(s) based on the qualification and experience of decision makers, as shown in Table 4.

Step 2. The linguistic evaluations of decision makers regarding the criteria importance and alternatives' performance are presented in Tables 5 and A1, respectively.

Table 5. Linguistic evaluations of decision makers with respect to criteria.

	DM1	**DM2**	**DM3**
C1	HI	VHI	VHI
C2	AA	HI	HI
C3	VHI	AI	AI
C4	BAI	AI	HI
C5	HI	AA	AI
C6	HI	BAI	AI
C7	AI	VHI	AA
C8	AI	VLI	LI
C9	LI	LI	LI
C10	VLI	LI	AI
C11	VHI	HI	VLI
C12	VHI	AA	VHI

Steps 3–5. The linguistic evaluations are transformed to IVN numbers using the scale in Table 2, and the IVN matrices regarding the criteria importance of decision makers are aggregated using the INNWA operator in Equation (5). Table 6 shows the aggregated IVN matrix of criteria importance and the deneutrosophicated score value c_j of each criterion.

Table 6. Aggregated IVN matrix of the criteria.

Criterion	$\langle \boldsymbol{T,I,F} \rangle$	$\mathfrak{D}(\boldsymbol{A})$
C1	<[0.613, 0.765], [0.457, 0.558], [0.184, 0.337]>	0.791
C2	<[0.512, 0.663], [0.357, 0.457], [0.286, 0.437]>	0.656
C3	<[0.516, 0.697], [0.19, 0.31], [0.27, 0.455]>	0.642
C4	<[0.44, 0.605], [0.252, 0.364], [0.356, 0.521]>	0.564
C5	<[0.477, 0.643], [0.229, 0.343], [0.321, 0.487]>	0.598
C6	<[0.454, 0.623], [0.229, 0.343], [0.341, 0.51]>	0.575
C7	<[0.491, 0.664], [0.22, 0.335], [0.299, 0.473]>	0.617
C8	<[0.292, 0.47], [0.243, 0.363], [0.505, 0.68]>	0.445
C9	<[0.25, 0.4], [0.4, 0.5], [0.55, 0.7]>	0.413
C10	<[0.271, 0.446], [0.269, 0.39], [0.526, 0.7]>	0.436
C11	<[0.492, 0.657], [0.473, 0.573], [0.285, 0.454]>	0.646
C12	<[0.608, 0.762], [0.44, 0.542], [0.185, 0.341]>	0.788

Steps 6–10. The criteria are arranged in the descending order of score values. Then, the comparative significance, comparative coefficient, recalculated weights, and final weights of criteria are computed and presented in Table 7.

Table 7. Results of SWARA steps and final weights of criteria.

Criterion	Score Values c_j	Comparative Significance Values s_j	Comparative Coefficient k_j	Recalculated Weights q_j	Final Criteria Weights w_j
C1	0.7909	0	1	1	0.0996
C12	0.7876	0.0033	1.0033	0.9967	0.0993
C2	0.6556	0.1320	1.1320	0.8805	0.0877
C11	0.6460	0.0096	1.0096	0.8721	0.0869
C3	0.6416	0.0044	1.0044	0.8683	0.0865
C7	0.6166	0.0251	1.0251	0.8471	0.0844
C5	0.5980	0.0186	1.0186	0.8316	0.0828
C6	0.5751	0.0229	1.0229	0.8131	0.0810
C4	0.5638	0.0113	1.0113	0.8040	0.0801
C8	0.4445	0.1193	1.1193	0.7183	0.0715
C10	0.4360	0.0085	1.0085	0.7122	0.0709
C9	0.4125	0.0235	1.0235	0.6959	0.0693

To exemplify, the calculation steps for the first two most significant criteria are given below:

$$c_1 = 0.7909, \; c_2 = 0.7876$$

$$s_2 = c_1 - c_2 = 0.7909 - 0.7876 = 0.0033$$

$$k_1 = 1, \quad k_2 = 1 + s_2 = 1.0033$$

$$q_1 = 1, \quad q_2 = \frac{q_1}{k_2} = \frac{1}{1.0033} = 0.9967$$

$$\sum_{j=1}^{n} q_j = 10.0398, \quad w_1 = \frac{1}{10.0398} = 0.0996\,, \quad w_2 = \frac{0.9967}{10.0398} = 0.0993$$

Phase 2: IVN EDAS

Steps 11 and 12. The IVN decision matrices are normalized as given in Equation (6) and aggregated to obtain the IVN decision matrix. The aggregated and normalized decision matrix is given in Table A2.

Step 13. The average solution (AV) is determined by using Equation (32), as presented in Table 8.

Table 8. Average solution and its deneutrosophicated value.

Criterion	$\langle T,I,F \rangle$	$\mathfrak{D}(A)$
C1	<[0.314, 0.496], [0.213, 0.331], [0.482, 0.661]>	0.453
C2	<[0.412, 0.585], [0.315, 0.426], [0.358, 0.541]>	0.560
C3	<[0.479, 0.661], [0.177, 0.293], [0.307, 0.494]>	0.591
C4	<[0.406, 0.578], [0.281, 0.396], [0.377, 0.553]>	0.546
C5	<[0.519, 0.698], [0.232, 0.35], [0.252, 0.443]>	0.663
C6	<[0.477, 0.647], [0.235, 0.348], [0.309, 0.484]>	0.604
C7	<[0.499, 0.679], [0.239, 0.356], [0.27, 0.461]>	0.642
C8	<[0.345, 0.529], [0.186, 0.303], [0.451, 0.635]>	0.467
C9	<[0.419, 0.595], [0.228, 0.344], [0.367, 0.547]>	0.545
C10	<[0.441, 0.621], [0.257, 0.373], [0.328, 0.519]>	0.583
C11	<[0.517, 0.675], [0.347, 0.451], [0.27, 0.432]>	0.667
C12	<[0.492, 0.672], [0.194, 0.311], [0.293, 0.478]>	0.613

Step 14. The *PDA* and *NDA* are calculated using Equations (35) and (36) and given in Table A3.

Step 15. The weighted sum of positive and negative distances SP_i and SN_i are computed for each criterion using Equations (37) and (38), respectively. Table 9 shows the SP_i and SN_i values.

Table 9. SP_i and SN_i of alternatives.

	Al1	Al2	Al3	Al4	Al5	Al6	Al7	Al8	Al9	Al10	Al11	Al12	Al13	Al14
SP	0.254	0.254	0.073	0.07	0.026	0.004	0.009	0.036	0.005	0.001	0.009	0.014	0.005	0.072
NP	0.048	0.058	0.028	0.047	0.034	0.081	0.15	0.059	0.096	0.062	0.134	0.177	0.121	0.015

Step 16. The normalized values of SP_i and SN_i are then calculated and given in Table 10.

Table 10. NSP_i and NSN_i of alternatives.

	Al1	Al2	Al3	Al4	Al5	Al6	Al7	Al8	Al9	Al10	Al11	Al12	Al13	Al14
NSP	1	1	0.288	0.278	0.102	0.014	0.036	0.143	0.018	0.003	0.036	0.054	0.021	0.283
NSN	0.728	0.672	0.843	0.737	0.805	0.542	0.150	0.665	0.457	0.650	0.245	0	0.316	0.917

Step 17. The appraisal score of alternatives is calculated. The alternatives are then ranked in the descending order of the appraisal scores. Table 11 shows the appraisal scores and the final ranking of the alternatives.

Table 11. The appraisal score of the alternatives.

	Al1	Al2	Al3	Al4	Al5	Al6	Al7	Al8	Al9	Al10	Al11	Al12	Al13	Al14
AS	0.864	0.836	0.566	0.507	0.454	0.278	0.093	0.404	0.237	0.327	0.140	0.027	0.169	0.600
Rank	1	2	4	5	6	9	13	7	10	8	12	14	11	3

The order of alternatives is as follows: Al1 $\succ$ Al2 $\succ$ Al14 $\succ$ Al3 $\succ$ Al4 $\succ$ Al5 $\succ$ Al8 $\succ$ Al10 $\succ$ Al6 $\succ$ Al9 $\succ$ Al13 $\succ$ Al11 $\succ$ Al7 $\succ$ Al12. According to the proposed IVN SWARA-EDAS methodology, Al1 should be considered as the best alternative, closely followed by Al2 as the second-best alternative.

5. Sensitivity Analysis

In order to check for the robustness of the results, a one-at-a-time sensitivity analysis is conducted. At each time, the importance weight of a criterion is increased by 50%, while decreasing the weights of the rest of the criteria equally. It has been observed that the results are completely robust for the increase in the criteria weights by 50%. Figure 1 presents the change in appraisal scores with respect to the change in each criterion weight.

The increase in each criterion weight by 50% does not result in any change in the initial ranking, yet the ranking may change when the criterion weights are varied greater than 50%. For instance, from Figure 1, it has been observed that the individual variation of C4 and C9 has resulted in the convergence of the appraisal scores of the third- and fourth-ranked alternatives. Similarly, the variation of C3 and C8 has led to a decreasing difference between the appraisal scores of the fourth- and fifth-ranked alternatives. To present the accuracy of the above estimations, as an example, the criterion weights of C4 and C9 are varied to the extent at which a change in ranking is observed. The change is observed around the increased criterion weight of C4 by 125% and of C9 by 150%. Table 12 shows the resulting appraisal scores and ranking.

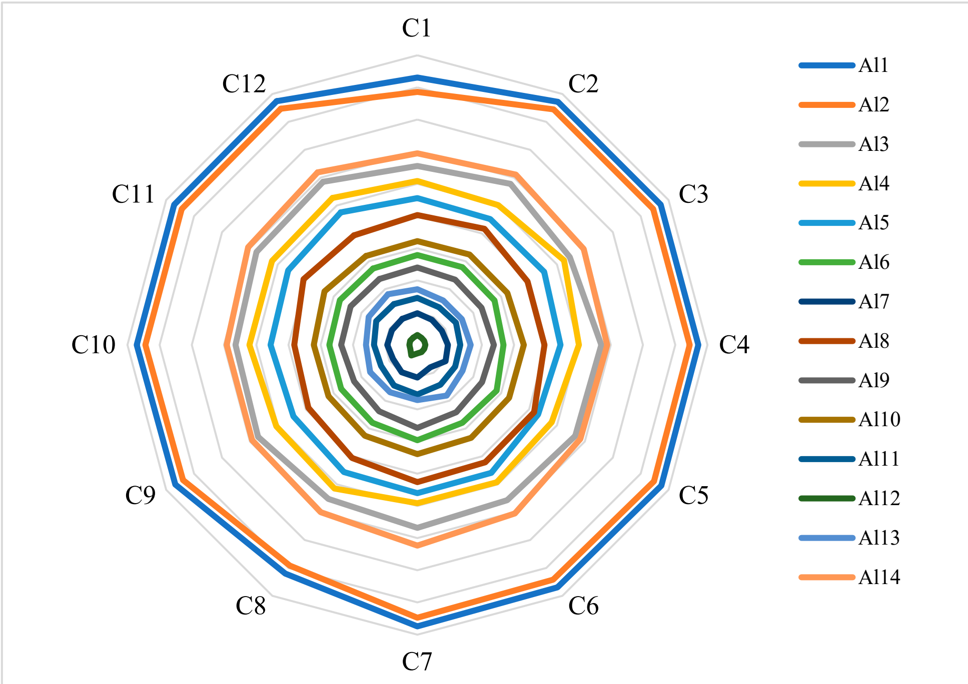

Figure 1. Appraisal score of alternatives under 50% increase of each criterion weight.

Table 12. Two cases for sensitivity analysis.

Rank	Initial Problem		C4 Increased by 125%		C9 Increased by 150%	
	Alternative	AS	Alternative	AS	Alternative	AS
1	Al1	0.8642	Al1	0.8821	Al1	0.8747
2	Al2	0.8359	Al2	0.8570	Al2	0.8479
3	Al14	0.6003	Al3	0.5772	Al3	0.5811
4	Al3	0.5657	Al14	0.5726	Al14	0.5752
5	Al4	0.5074	Al4	0.4922	Al4	0.5016
6	Al5	0.4538	Al5	0.4300	Al5	0.424
7	Al8	0.4040	Al8	0.3798	Al8	0.364
8	Al10	0.3265	Al10	0.3348	Al10	0.3024
9	Al6	0.2781	Al6	0.2501	Al6	0.2637
10	Al9	0.2372	Al9	0.2375	Al9	0.2043
11	Al13	0.1686	Al13	0.1598	Al13	0.1709
12	Al11	0.1404	Al11	0.1223	Al11	0.1097
13	Al7	0.0930	Al7	0.0974	Al7	0.0757
14	Al12	0.0269	Al12	0.0218	Al12	0.0228

6. Comparative Analysis

In order to check for the accuracy of the applied IVN EDAS method, we employed distance-based MCDM methods, namely, the IVN TOPSIS and IVN CODAS methods, for comparison of the results. In the comparative analysis, we used the criteria weights obtained by the SWARA method given in Table 7. Table 13 shows the final ranking results obtained by these three methods. The comparison indicates that the ranking of the first three alternatives with the best performance is stable, yet the ranking of alternatives on positions from fourth to seventh varies among the applied methods. It has been observed that between the rankings of the IVN EDAS and IVN CODAS methods, the alternatives have been interchanged on the fourth and fifth, and sixth and seventh positions. The IVN EDAS and IVN TOPSIS methods are in complete agreement, except for the fourth- and fifth-ranked alternatives, which might be explained by the relatively low difference between the closeness coefficients.

Table 13. Comparison of the results with IVN TOPSIS and IVN CODAS.

Rank	IVN TOPSIS		IVN CODAS		IVN EDAS	
	Closeness Coefficient	Alternative	Relative Assessment Score	Alternative	Appraisal Score	Alternative
1	0.7848	Al1	0.3563	Al1	0.8642	Al1
2	0.7581	Al2	0.2969	Al2	0.8359	Al2
3	0.6127	Al14	0.0677	Al14	0.6003	Al14
4	0.5682	Al4	0.0473	Al4	0.5657	Al3
5	0.5475	Al3	0.0419	Al3	0.5074	Al4
6	0.5287	Al5	0.0073	Al8	0.4538	Al5
7	0.4987	Al8	0.0058	Al5	0.4040	Al8
8	0.4571	Al10	−0.0415	Al10	0.3265	Al10
9	0.4277	Al6	−0.0789	Al9	0.2781	Al6
10	0.4180	Al9	−0.0850	Al6	0.2372	Al9
11	0.3630	Al13	−0.1146	Al11	0.1686	Al13
12	0.3566	Al11	−0.1159	Al13	0.1404	Al11
13	0.3403	Al7	−0.1281	Al7	0.0930	Al7
14	0.2789	Al12	−0.2592	Al12	0.0269	Al12

The Spearman's rank correlation coefficient (r_s) is calculated for the pairwise comparison of the results of these methods. The r_s-value between the ranks IVN CODAS and IVN EDAS is measured as 0.898901, while the results of IVN TOPSIS and IVN EDAS show higher correlation with a r_s-value of 0.995604. The obtained Spearman's rank correlation coefficients indicate the high concordance of the final ranking results and, thus, implies that the IVN EDAS method is very consistent with the IVN CODAS and IVN TOPSIS methods.

7. Conclusions

The energy business is critical since the main consumer countries rely on basic energy supplies that are natural resources, such as crude oil, gasoline, coal, natural gas, and wind. Despite the fact that cutting-edge technologies for e-mobility (such as electric cars/vehicles/scooters/buses, etc.) are increasing the demand for energy, the global energy crisis of 2021 affected energy prices, caused inflation, and had ramifications for households, businesses, and the economy as a whole. Regardless of the severity of the energy supply difficulties, energy must be given continually, for example, in the health sector; in meals transported via the cold chain; and in items that must be preserved by electrical equipment, especially perishables.

As a result, the goal of this study is to extract the necessary criteria and sub-criteria for evaluating and prioritizing the suppliers of a power generator manufacturer in order to build the supply network. The methodology of this research includes the following phases: (i) extracting the criteria affecting a power generator company's supplier selection decision process through an in-depth literature and industrial report review, (ii) evaluating these criteria by industry experts, (iii) identifying the weights of each criterion via SWARA, (iv) prioritizing alternative suppliers that meet the criteria so that the power generator company can build its supplier park using IVN EDAS, (v) performing a sensitivity analysis to test the robustness of the results by changing the weights, and (vi) conducting a comparative analysis to validate the methodology's accuracy by comparing the results with IVN TOPSIS and IVN CODAS.

The research findings show that "delivery lead times" are the most crucial criteria influencing a power-generating company's supplier selection decision. The second key criterion in this case study is the "operation control" criterion, which refers to the amount of participation of the manufacturer in the control of the supplier's operational operations. The decision makers then emphasize "supplier location" as the third essential consideration. The remaining ones are ranked in the following order: "reliability", "product range", "raw material circularity", "technical capability", "criticality", "production facility and capacity", "price of products", "packaging quality", and "flexibility". The result shows that managers and practitioners should focus on "delivery lead time", "operation control", and "supplier location" when selecting sustainable suppliers. "Flexibility" and "packaging quality" are the last issues to be considered.

Robustness is checked with sensitivity analysis; each criterion was individually analyzed, with a 50% increase ranking completely robust, compared with IVN CODAS and IVN TOPSIS for comparative analysis; and Spearman's rank correlation coefficient was calculated and shows a high association between the ranking results, which indicates the veracity of the results obtained by the IVN EDAS method.

This paper adds to the literature by providing a detailed list of factors influencing a power generator company's supplier selection decision to build a supplier park, extracting the weight of these factors and evaluating the existing suppliers to determine which supplier should be included in the supplier park first. Furthermore, because there is a void in the literature in applying SWARA and EDAS techniques to interval-valued neutrosophic sets, this study contributes to theory by clarifying the integration details of these methodologies. Furthermore, this study includes a sensitivity analysis to test the resilience of the new strategy and compares it to the existing one to confirm the accuracy.

As a limitation, the related experts' number could be increased to result in a more generalized conclusion for the power generator industry. Moreover, subjectivity could be listed as a limitation; however, since the neutrosophic sets are strong in handling the ambiguity in decision makers' judgements, the proposed methodology tries to eliminate the subjectivity problems.

Further research ideas might cover more experts from the industry, apply different fuzzy sets, or combine different decision-making techniques in determining the criteria weights and in prioritizing the alternative suppliers.

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Data Availability Statement: No new data were created.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Linguistic decision matrices of decision makers.

							Decision Maker 1							
	Al1	**Al2**	**Al3**	**Al4**	**Al5**	**Al6**	**Al7**	**Al8**	**Al9**	**Al10**	**Al11**	**Al12**	**Al13**	**Al14**
C1	VH	VH	A	AA	AA	A	A	A	A	A	A	A	A	AA
C2	A	A	BA	BA	BA	L	L	L	L	L	L	L	L	A
C3	H	H	A	H	A	A	A	A	A	A	A	A	A	A
C4	H	H	A	A	A	L	L	L	L	L	L	L	L	A
C5	CH	CH	H	A	A	AA	AA	AA	A	AA	A	A	A	A
C6	AA	AA	A	A	A	A	A	AA	AA	AA	AA	AA	AA	AA
C7	BA	BA	A	A	A	BA	BA	AA	AA	A	A	A	A	H

Table A1. *Cont.*

							Decision Maker 1							
C8	CH	CH	H	A	A	A	A	A	A	A	A	A	A	A
C9	A	A	A	A	A	A	A	L	L	L	L	L	L	A
C10	BA	BA	BA	A	A	A	A	L	A	L	L	L	L	AA
C11	H	H	H	H	H	AA	AA	AA	AA	AA	AA	AA	AA	AA
C12	A	A	A	H	H	A	A	A	A	A	A	A	A	A
							Decision Maker 2							
	Al1	Al2	Al3	Al4	Al5	Al6	Al7	Al8	Al9	Al10	Al11	Al12	Al13	Al14
C1	CH	CH	CH	H	H	VH	AA	CH	H	H	AA	A	A	CH
C2	CH	CH	CH	H	H	H	AA	CH	H	H	AA	A	A	CH
C3	CH	CH	H	AA	AA	H	A	H	AA	H	AA	A	A	VH
C4	CH	CH	H	AA	AA	A	A	H	H	H	A	BA	AA	H
C5	CH	CH	H	H	H	H	A	CH	H	H	AA	A	AA	VH
C6	CH	CH	H	H	H	H	A	CH	H	H	A	BA	H	VH
C7	CH	CH	CH	H	CH	CH	AA	CH	VH	CH	VH	L	AA	CH
C8	CH	CH	H	AA	AA	AA	BA	AA	A	H	BA	L	AA	H
C9	CH	CH	H	A	AA	AA	A	AA	A	H	AA	H	AA	H
C10	CH	CH	H	A	AA	AA	A	A	A	H	AA	A	A	H
C11	CH	CH	VH	VH	H	H	H	VH	H	VH	H	AA	H	CH
C12	CH	CH	VH	H	H	H	AA	H	H	H	H	A	H	CH
							Decision Maker 3							
	Al1	Al2	Al3	Al4	Al5	Al6	Al7	Al8	Al9	Al10	Al11	Al12	Al13	Al14
C1	H	CH	VH	AA	AA	A	A	A	A	VH	A	A	A	AA
C2	H	H	BA	BA	A	BA	L	L	L	BA	L	L	L	BA
C3	VH	VH	A	VH	H	A	A	A	A	A	A	A	A	AA
C4	H	H	H	AA	A	L	BA	L	L	A	VL	L	L	A
C5	CH	CH	H	A	A	AA	AA	AA	A	AA	A	A	A	AA
C6	AA	AA	AA	A	H	AA	A	A	A	AA	AA	A	AA	AA
C7	H	H	A	A	A	BA	AA	AA	AA	A	A	A	AA	H
C8	CH	CH	H	BA	AA	A	A	A	A	A	A	A	A	A
C9	H	H	H	H	A	A	A	BA	BA	L	L	L	AA	A
C10	CH	CH	H	CH	H	A	BA	L	AA	BA	L	L	L	A
C11	AA	AA	H	H	H	AA	L	AA	AA	AA	AA	A	AA	AA
C12	H	H	VH	H	H	A	A	A	A	A	A	A	AA	H

Table A2. Aggregated normalized IVN decision matrix.

Criterion	Al1	Al2	Al3
C1	<[0.163, 0.314], [0.484, 0.585], [0.635, 0.786]>	<[0.091, 0.242], [0.558, 0.658], [0.708, 0.859]>	<[0.24, 0.421], [0.275, 0.402], [0.555, 0.734]>
C2	<[0.564, 0.744], [0.254, 0.377], [0.202, 0.396]>	<[0.564, 0.744], [0.254, 0.377], [0.202, 0.396]>	<[0.488, 0.666], [0.357, 0.46], [0.26, 0.456]>
C3	<[0.644, 0.802], [0.479, 0.58], [0.14, 0.304]>	<[0.644, 0.802], [0.479, 0.58], [0.14, 0.304]>	<[0.442, 0.628], [0.141, 0.251], [0.356, 0.542]>
C4	<[0.611, 0.772], [0.443, 0.544], [0.167, 0.336]>	<[0.611, 0.772], [0.443, 0.544], [0.167, 0.336]>	<[0.495, 0.663], [0.23, 0.347], [0.302, 0.47]>
C5	<[0.75, 0.9], [0.6, 0.7], [0.05, 0.2]>	<[0.75, 0.9], [0.6, 0.7], [0.05, 0.2]>	<[0.55, 0.7], [0.4, 0.5], [0.25, 0.4]>

Table A2. *Cont.*

Criterion	Al1	Al2	Al3
C6	<[0.548, 0.717], [0.357, 0.46], [0.215, 0.398]>	<[0.548, 0.717], [0.357, 0.46], [0.215, 0.398]>	<[0.458, 0.628], [0.208, 0.321], [0.339, 0.509]>
C7	<[0.55, 0.72], [0.395, 0.497], [0.211, 0.396]>	<[0.55, 0.72], [0.395, 0.497], [0.211, 0.396]>	<[0.518, 0.717], [0.157, 0.274], [0.238, 0.456]>
C8	<[0.05, 0.2], [0.6, 0.7], [0.75, 0.9]>	<[0.05, 0.2], [0.6, 0.7], [0.75, 0.9]>	<[0.25, 0.4], [0.4, 0.5], [0.55, 0.7]>
C9	<[0.564, 0.744], [0.254, 0.377], [0.202, 0.396]>	<[0.564, 0.744], [0.254, 0.377], [0.202, 0.396]>	<[0.495, 0.663], [0.23, 0.347], [0.302, 0.47]>
C10	<[0.634, 0.81], [0.455, 0.56], [0.12, 0.31]>	<[0.634, 0.81], [0.455, 0.56], [0.12, 0.31]>	<[0.479, 0.632], [0.357, 0.457], [0.316, 0.47]>
C11	<[0.583, 0.748], [0.4, 0.503], [0.188, 0.364]>	<[0.583, 0.748], [0.4, 0.503], [0.188, 0.364]>	<[0.577, 0.729], [0.423, 0.523], [0.22, 0.372]>
C12	<[0.564, 0.744], [0.254, 0.377], [0.202, 0.396]>	<[0.564, 0.744], [0.254, 0.377], [0.202, 0.396]>	<[0.566, 0.736], [0.263, 0.387], [0.222, 0.396]>
	Al4	Al5	Al6
C1	<[0.326, 0.477], [0.322, 0.423], [0.473, 0.624]>	<[0.326, 0.477], [0.322, 0.423], [0.473, 0.624]>	<[0.345, 0.54], [0.15, 0.263], [0.452, 0.645]>
C2	<[0.407, 0.56], [0.322, 0.423], [0.389, 0.542]>	<[0.423, 0.593], [0.219, 0.332], [0.373, 0.542]>	<[0.372, 0.527], [0.362, 0.462], [0.421, 0.577]>
C3	<[0.567, 0.72], [0.402, 0.504], [0.227, 0.382]>	<[0.469, 0.638], [0.214, 0.328], [0.328, 0.497]>	<[0.442, 0.628], [0.141, 0.251], [0.356, 0.542]>
C4	<[0.431, 0.6], [0.193, 0.303], [0.369, 0.538]>	<[0.413, 0.6], [0.132, 0.238], [0.387, 0.573]>	<[0.291, 0.458], [0.283, 0.398], [0.508, 0.674]>
C5	<[0.442, 0.628], [0.141, 0.251], [0.356, 0.542]>	<[0.442, 0.628], [0.141, 0.251], [0.356, 0.542]>	<[0.477, 0.628], [0.322, 0.423], [0.322, 0.473]>
C6	<[0.442, 0.628], [0.141, 0.251], [0.356, 0.542]>	<[0.495, 0.663], [0.23, 0.347], [0.302, 0.47]>	<[0.458, 0.628], [0.208, 0.321], [0.339, 0.509]>
C7	<[0.442, 0.628], [0.141, 0.251], [0.356, 0.542]>	<[0.518, 0.717], [0.157, 0.274], [0.238, 0.456]>	<[0.488, 0.666], [0.357, 0.46], [0.26, 0.456]>
C8	<[0.406, 0.577], [0.193, 0.303], [0.393, 0.563]>	<[0.37, 0.543], [0.193, 0.303], [0.429, 0.6]>	<[0.388, 0.577], [0.132, 0.238], [0.412, 0.6]>
C9	<[0.457, 0.638], [0.162, 0.276], [0.339, 0.521]>	<[0.413, 0.6], [0.132, 0.238], [0.387, 0.573]>	<[0.413, 0.6], [0.132, 0.238], [0.387, 0.573]>
C10	<[0.558, 0.754], [0.187, 0.31], [0.193, 0.408]>	<[0.469, 0.638], [0.214, 0.328], [0.328, 0.497]>	<[0.413, 0.6], [0.132, 0.238], [0.387, 0.573]>
C11	<[0.577, 0.729], [0.423, 0.523], [0.22, 0.372]>	<[0.55, 0.7], [0.4, 0.5], [0.25, 0.4]>	<[0.477, 0.628], [0.322, 0.423], [0.322, 0.473]>
C12	<[0.55, 0.7], [0.4, 0.5], [0.25, 0.4]>	<[0.55, 0.7], [0.4, 0.5], [0.25, 0.4]>	<[0.442, 0.628], [0.141, 0.251], [0.356, 0.542]>
	Al7	Al8	Al9
C1	<[0.388, 0.577], [0.132, 0.238], [0.412, 0.6]>	<[0.327, 0.524], [0.157, 0.274], [0.468, 0.664]>	<[0.366, 0.557], [0.141, 0.251], [0.433, 0.624]>
C2	<[0.306, 0.458], [0.372, 0.473], [0.491, 0.644]>	<[0.43, 0.617], [0.443, 0.544], [0.302, 0.512]>	<[0.34, 0.495], [0.4, 0.5], [0.452, 0.609]>
C3	<[0.4, 0.6], [0.1, 0.2], [0.4, 0.6]>	<[0.442, 0.628], [0.141, 0.251], [0.356, 0.542]>	<[0.413, 0.6], [0.132, 0.238], [0.387, 0.573]>
C4	<[0.325, 0.491], [0.256, 0.368], [0.473, 0.638]>	<[0.34, 0.495], [0.4, 0.5], [0.452, 0.609]>	<[0.34, 0.495], [0.4, 0.5], [0.452, 0.609]>
C5	<[0.438, 0.6], [0.228, 0.336], [0.362, 0.523]>	<[0.548, 0.717], [0.357, 0.46], [0.215, 0.398]>	<[0.442, 0.628], [0.141, 0.251], [0.356, 0.542]>
C6	<[0.4, 0.6], [0.1, 0.2], [0.4, 0.6]>	<[0.534, 0.717], [0.243, 0.361], [0.225, 0.424]>	<[0.461, 0.628], [0.219, 0.332], [0.337, 0.504]>
C7	<[0.412, 0.563], [0.3, 0.4], [0.387, 0.538]>	<[0.548, 0.717], [0.357, 0.46], [0.215, 0.398]>	<[0.509, 0.664], [0.341, 0.443], [0.283, 0.44]>
C8	<[0.413, 0.6], [0.132, 0.238], [0.387, 0.573]>	<[0.388, 0.577], [0.132, 0.238], [0.412, 0.6]>	<[0.4, 0.6], [0.1, 0.2], [0.4, 0.6]>
C9	<[0.4, 0.6], [0.1, 0.2], [0.4, 0.6]>	<[0.34, 0.491], [0.337, 0.437], [0.458, 0.61]>	<[0.325, 0.491], [0.256, 0.368], [0.473, 0.638]>
C10	<[0.383, 0.568], [0.147, 0.255], [0.417, 0.6]>	<[0.291, 0.458], [0.283, 0.398], [0.508, 0.674]>	<[0.418, 0.6], [0.147, 0.255], [0.382, 0.563]>
C11	<[0.417, 0.571], [0.357, 0.457], [0.377, 0.532]>	<[0.509, 0.664], [0.341, 0.443], [0.283, 0.44]>	<[0.477, 0.628], [0.322, 0.423], [0.322, 0.473]>
C12	<[0.413, 0.6], [0.132, 0.238], [0.387, 0.573]>	<[0.442, 0.628], [0.141, 0.251], [0.356, 0.542]>	<[0.442, 0.628], [0.141, 0.251], [0.356, 0.542]>
	Al10	Al11	Al12
C1	<[0.283, 0.462], [0.248, 0.369], [0.513, 0.69]>	<[0.388, 0.577], [0.132, 0.238], [0.412, 0.6]>	<[0.4, 0.6], [0.1, 0.2], [0.4, 0.6]>
C2	<[0.372, 0.527], [0.362, 0.462], [0.421, 0.577]>	<[0.306, 0.458], [0.372, 0.473], [0.491, 0.644]>	<[0.291, 0.458], [0.283, 0.398], [0.508, 0.674]>
C3	<[0.442, 0.628], [0.141, 0.251], [0.356, 0.542]>	<[0.413, 0.6], [0.132, 0.238], [0.387, 0.573]>	<[0.4, 0.6], [0.1, 0.2], [0.4, 0.6]>
C4	<[0.39, 0.562], [0.246, 0.363], [0.404, 0.577]>	<[0.259, 0.428], [0.306, 0.424], [0.538, 0.706]>	<[0.276, 0.427], [0.372, 0.473], [0.523, 0.674]>
C5	<[0.477, 0.628], [0.322, 0.423], [0.322, 0.473]>	<[0.413, 0.6], [0.132, 0.238], [0.387, 0.573]>	<[0.4, 0.6], [0.1, 0.2], [0.4, 0.6]>
C6	<[0.477, 0.628], [0.322, 0.423], [0.322, 0.473]>	<[0.438, 0.6], [0.228, 0.336], [0.362, 0.523]>	<[0.409, 0.577], [0.204, 0.314], [0.391, 0.558]>
C7	<[0.518, 0.717], [0.157, 0.274], [0.238, 0.456]>	<[0.476, 0.664], [0.15, 0.263], [0.313, 0.505]>	<[0.366, 0.557], [0.141, 0.251], [0.433, 0.624]>
C8	<[0.366, 0.557], [0.141, 0.251], [0.433, 0.624]>	<[0.413, 0.6], [0.132, 0.238], [0.387, 0.573]>	<[0.442, 0.628], [0.141, 0.251], [0.356, 0.542]>
C9	<[0.34, 0.495], [0.4, 0.5], [0.452, 0.609]>	<[0.306, 0.458], [0.372, 0.473], [0.491, 0.644]>	<[0.34, 0.495], [0.4, 0.5], [0.452, 0.609]>
C10	<[0.372, 0.527], [0.362, 0.462], [0.421, 0.577]>	<[0.306, 0.458], [0.372, 0.473], [0.491, 0.644]>	<[0.291, 0.458], [0.283, 0.398], [0.508, 0.674]>
C11	<[0.509, 0.664], [0.341, 0.443], [0.283, 0.44]>	<[0.477, 0.628], [0.322, 0.423], [0.322, 0.473]>	<[0.433, 0.6], [0.204, 0.314], [0.367, 0.533]>
C12	<[0.442, 0.628], [0.141, 0.251], [0.356, 0.542]>	<[0.442, 0.628], [0.141, 0.251], [0.356, 0.542]>	<[0.4, 0.6], [0.1, 0.2], [0.4, 0.6]>

Table A2. *Cont.*

Criterion	Al1	Al2	Al3
	Al13	Al14	
C1	<[0.4, 0.6], [0.1, 0.2], [0.4, 0.6]>	<[0.285, 0.438], [0.357, 0.46], [0.511, 0.664]>	
C2	<[0.291, 0.458], [0.283, 0.398], [0.508, 0.674]>	<[0.504, 0.694], [0.23, 0.349], [0.248, 0.456]>	
C3	<[0.4, 0.6], [0.1, 0.2], [0.4, 0.6]>	<[0.491, 0.664], [0.22, 0.335], [0.299, 0.473]>	
C4	<[0.306, 0.458], [0.372, 0.473], [0.491, 0.644]>	<[0.442, 0.628], [0.141, 0.251], [0.356, 0.542]>	
C5	<[0.413, 0.6], [0.132, 0.238], [0.387, 0.573]>	<[0.491, 0.664], [0.22, 0.335], [0.299, 0.473]>	
C6	<[0.477, 0.628], [0.322, 0.423], [0.322, 0.473]>	<[0.509, 0.664], [0.341, 0.443], [0.283, 0.44]>	
C7	<[0.431, 0.6], [0.193, 0.303], [0.369, 0.538]>	<[0.611, 0.772], [0.443, 0.544], [0.167, 0.336]>	
C8	<[0.388, 0.577], [0.132, 0.238], [0.412, 0.6]>	<[0.366, 0.557], [0.141, 0.251], [0.433, 0.624]>	
C9	<[0.377, 0.53], [0.337, 0.437], [0.419, 0.572]>	<[0.442, 0.628], [0.141, 0.251], [0.356, 0.542]>	
C10	<[0.291, 0.458], [0.283, 0.398], [0.508, 0.674]>	<[0.461, 0.628], [0.219, 0.332], [0.337, 0.504]>	
C11	<[0.477, 0.628], [0.322, 0.423], [0.322, 0.473]>	<[0.548, 0.717], [0.357, 0.46], [0.215, 0.398]>	
C12	<[0.458, 0.628], [0.208, 0.321], [0.339, 0.509]>	<[0.564, 0.744], [0.254, 0.377], [0.202, 0.396]>	

Table A3. *PDA* and *NDA* of alternatives with respect to criteria.

	PDA													
	Al1	**Al2**	**Al3**	**Al4**	**Al5**	**Al6**	**Al7**	**Al8**	**Al9**	**Al10**	**Al11**	**Al12**	**Al13**	**Al14**
C1	0	0	0	0.017	0.017	0.009	0.047	0	0.027	0	0.047	0.039	0.039	0
C2	0.305	0.305	0.167	0	0	0	0	0.071	0	0	0	0	0	0.17
C3	0.423	0.423	0	0.235	0	0	0	0	0	0	0	0	0	0.042
C4	0.465	0.465	0.138	0	0	0	0	0	0	0	0	0	0	0
C5	0.463	0.463	0.063	0	0	0	0	0.087	0	0	0	0	0	0
C6	0.192	0.192	0	0	0.029	0	0	0.143	0	0.007	0	0	0.007	0.081
C7	0.133	0.133	0.002	0	0.002	0.019	0	0.122	0.017	0.002	0	0	0	0.247
C8	0	0	0	0.093	0.024	0.014	0.06	0.014	0.006	0	0.06	0.137	0.014	0
C9	0.342	0.342	0.14	0.021	0	0	0	0	0	0	0	0	0	0
C10	0.456	0.456	0.06	0.219	0.004	0	0	0	0	0	0	0	0	0
C11	0.147	0.147	0.113	0.113	0.056	0	0	0	0	0	0	0	0	0.079
C12	0.193	0.193	0.183	0.149	0.149	0	0	0	0	0	0	0	0	0.193
	NDA													
C1	0.206	0.307	0.06	0	0	0	0	0.005	0	0.025	0	0	0	0.036
C2	0	0	0	0.044	0.038	0.09	0.192	0	0.134	0.09	0.192	0.208	0.208	0
C3	0	0	0.102	0	0.011	0.102	0.205	0.102	0.162	0.102	0.162	0.205	0.205	0
C4	0	0	0	0.023	0.093	0.188	0.157	0.112	0.112	0.047	0.214	0.214	0.171	0.027
C5	0	0	0	0.199	0.199	0.083	0.171	0	0.199	0.083	0.253	0.291	0.253	0.07
C6	0	0	0.056	0.121	0	0.056	0.222	0	0.047	0	0.091	0.146	0	0
C7	0	0	0	0.173	0	0	0.169	0	0	0	0.103	0.276	0.169	0
C8	0.385	0.385	0.117	0	0	0	0	0	0	0.006	0	0	0	0.006
C9	0	0	0	0	0.091	0.091	0.138	0.128	0.156	0.11	0.17	0.11	0.066	0.026
C10	0	0	0	0	0	0.15	0.185	0.239	0.132	0.125	0.224	0.239	0.239	0.012
C11	0	0	0	0	0	0.089	0.172	0.022	0.089	0.022	0.089	0.193	0.089	0
C12	0	0	0	0	0	0.134	0.192	0.134	0.134	0.134	0.134	0.234	0.07	0

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