Multi-criteria Decision Making based on EDAS Approach for Business Risk Assessment in Electricity Retail Companies

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Abstract

This paper introduce a multi- criteria decision making (MCDM) perfect to assess business risk in electricity retail company to decrease risk loss and mange risks of business. The evaluation of business risk in electricity company included many conflicting criteria such as risk of political, risk of economic, and risk of market. So, this paper presented an Evaluation based on distance from average solution (EDAS) MCDM method to compute the weights of these criteria and rank the alternatives. Distances between each option and the mean answer on each criteria form the basis of EDAS. It expedites the decision-making process by streamlining the computation of distances to the deal solution. But in this evaluation, there are many imperfect and unclear data. So, the neutrosophic sets is presented to overcome this vague information. The interval valued neutrosophic sets (IVNSs) is a type of neutrosophic sets is presented in this work.

Keywords: Business Risk; Electricity Retail; EDAS; MCDM;

1. Introduction

After the reformation of the energy sales system, major developments include liberalising the retail energy market, fostering more rivalry, and developing a novel "multi-buyer-multi-seller" structure. At the same time as they guarantee a secure and stable energy supply, reforms might improve the standard of retail electrical services and boost customers' happiness. Reforming in the right way could help improve resource distribution[1]–[3].

Concurrent with the implementation of this reform, the first market transactions in the electricity sector were under way. To begin with, the system's focus was on yearly and monthly trading cycles for physical transactions on the intermediate to long term. Then, over time, a spot market emerged. While the electrical spot market is still in its early stages of growth and has only been trialled in a few shires, mid- and long-term purchasing local are already being done on the power market on a national scale. There has been no preliminary work on the electrical derivatives market (options market, futures market, etc.). Monthly focused request dealings, monthly nominal quotation transactions[4]–[6].

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The dangers of real-time price changes and consumer demand unpredictability provide challenges for retailers with a direct interest in transactions geared toward the power market. For risk management purposes, these stores engage in a wide range of activities. Distributors of energy in the modern day must devise plans for procuring power from the standard electricity market. As retailers adjust to changes in load characteristics and customer purchasing habits, they must also deal with the challenge of developing and distributing flexible and diversified electrical retail contracts.

The power retail industry has a unique set of risks, hence an index system was developed to evaluate these dangers. Furthermore, a novel cross MCDM approach is developed for the business risk assessment of energy retail firm, taking into account numerous risk factors. The evaluation of the risk business contains the vague information. So the neutrosophic sets is a best tool to overcome this vague data.[7]–[9]

Smarandache extended intuitionistic fuzzy sets with neutrosophic logic and neutrosophic sets (NSs) to address this shortcoming. In the neutrosophic set, the degrees of truthiness, indeterminacy, and falsehood of each cosmological element are all between]0,1+[. While degrees of togetherness and quasi and indeterminacy value were factored in as relativity or absoluteness, in the neutrosophic sets, uncertainty is given as truthfulness and falsity numbers. Neutrosophic sets use this notation to do more than only deal with the system's uncertainty; it also helps people make better decisions when faced with contradictory data. As a result, the degrees of membership and non-membership correspond to the truth and falsehood values, respectively, whereas the degree of uncertainty corresponds to the indeterminacy value.

The EDAS approach was recently introduced by Keshavarz Ghorabaee and colleagues. It uses the positivity detachment from mean (PDA) and the negativity distance from mean (NDA) to locate the optimal answer (NDA). If two options are comparable in terms of NDA, the one with the greater PDA is chosen as the best. For the first time, the EDAS approach is augmented with neutrosophic sets, bringing with them benefits like reflecting the relative and absolute nature of experts and the independence of a set's constituent parts. The independence gives specialists more leeway in determining the worth of subgroups. When compared to other fuzzy set types, neutrosophic sets have several benefits, and the suggested neurotrophic EDAS approach incorporates all of them[10]–[12].

In this research, we apply the EDAS technique to the valuation of the electrical industry's business risk, using a novel interval-valued neutrosophic approach. An expert panel settles on the criteria and the alternatives, and their consensus informs the criterion weights and the decision matrix scores[13], [14].

2. Mathematical equations

Definition 1[15]–[17]:

The INS:

$$T_A(x) = [\inf T_A(s), \sup T_A(s)], I_A(s) = [\inf I_A(s), \sup I_A(s)],$$

$$F_A(x) = [\inf F_A(s), \sup F_A(s)] \subseteq [0,1] \text{and}$$

$$0 \leq \sup T_A(s) + \sup I_A(s) + \sup F_A(s) \leq 3, x \in X.$$

Definition 2[18]–[22]:

$$\text{Let two INNs be } a = \left\langle \begin{matrix} [\inf T_a(s), \sup T_a(s)], \\ [\inf I_a(s), \sup I_a(s)], \\ [\inf F_a(s), \sup F_{a(s)}] \end{matrix} \right\rangle,$$

$$\text{nf}T_b(s), \sup T_b(s)], [\inf I_b(S), \sup I_b(s)], [\inf F_b(s), \sup F_b(s)]\rangle, \text{and } \lambda > 0.$$

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$$\lambda a = \left\langle \begin{array}{c} \langle[1-(1-infT_a(s))\lambda, \\ 1-(1-supT_a(s))\lambda], \\ [(infI_a(s))\lambda, (supI_a(s))\lambda], \\ [(infF_a(s))\lambda, (supF_a(s))\lambda]\rangle; \end{array} \right\rangle$$

$$a^{\lambda} = \left\langle \begin{array}{c} \langle[(infT_a(s))\lambda, (supT_a(s))]\lambda, \\ [1-(1-infI_a(s))\lambda, \\ 1-(1-supI_a(s))\lambda], \\ [1-(1-infF_a(s))\lambda, \\ 1-(1-supF_a(s))\lambda]\rangle; \end{array} \right\rangle$$

$$a + b = \left\langle \begin{array}{c} \langle[infT_a(s) + infT_b(s) - infT_a(s) \cdot infT_b(s), \\ supT_a(s) + supT_b(s) - supT_a(s) \cdot supT_b(s)], \\ [infT_a(s) \cdot infI_b(s), supI_a(s) \cdot supI_b(s)], \\ [infF_a(s) \cdot infF_b(s), supF_a(s) \cdot supF_b(s)]\rangle; \end{array} \right\rangle$$

$$a \cdot b = \left\langle \begin{array}{c} \langle[infT_a(s) \cdot infT_b(s), supT_a(s) \cdot supT_b(s)], \\ \begin{bmatrix} infT_a(s) + infI_b(s) - infT_a(s) \cdot infI_b(s), \\ supI_a(s) + supI_b(s) - supI_a(s) \cdot supI_b(s) \end{bmatrix}, \\ [infF_a(s) + infF_b(s) - infF_a(s) \cdot infF_b(s), \\ supF_a(s) + supF_b(s) - supF_a(s) \cdot supF_b(s)]\rangle. \end{array} \right\rangle$$

Definition 3:

$$Given\ two\ INNs\ a\ and\ b, where\ \left\langle \begin{array}{c} a = \langle[infT_a, supT_a], [infI_a, supI_a], [infF_a, supF_a]\rangle, \\ and\ b = \langle[infT_b, supT_b], [infI_b, supI_b], [infF_b, supF_b]\rangle \end{array} \right\rangle.$$

Let

$$\left\langle \begin{array}{c} g(a) = (infT_a + supT_a) - (infI_a + supI_a) - (infF_a + supF_a), \\ g(b) = (infT_b + supT_b) - (infI_b + supI_b) - (infF_b + supF_b), \\ g(T_{ab}) = (infT_a + supT_a) - (infT_b + supT_b), g(I_{ab}) = (infI_a + supI_a) - (infI_b + supI_b), \\ and\ g(F_{ab}) = (infF_b + supF_b) - (infF_a + supF_a). \\ Assume\ that\ g(a,b) = g(a) - g(b) = g(T_{ab}) + g(I_{ab}) + g(F_{ab}). \end{array} \right\rangle$$

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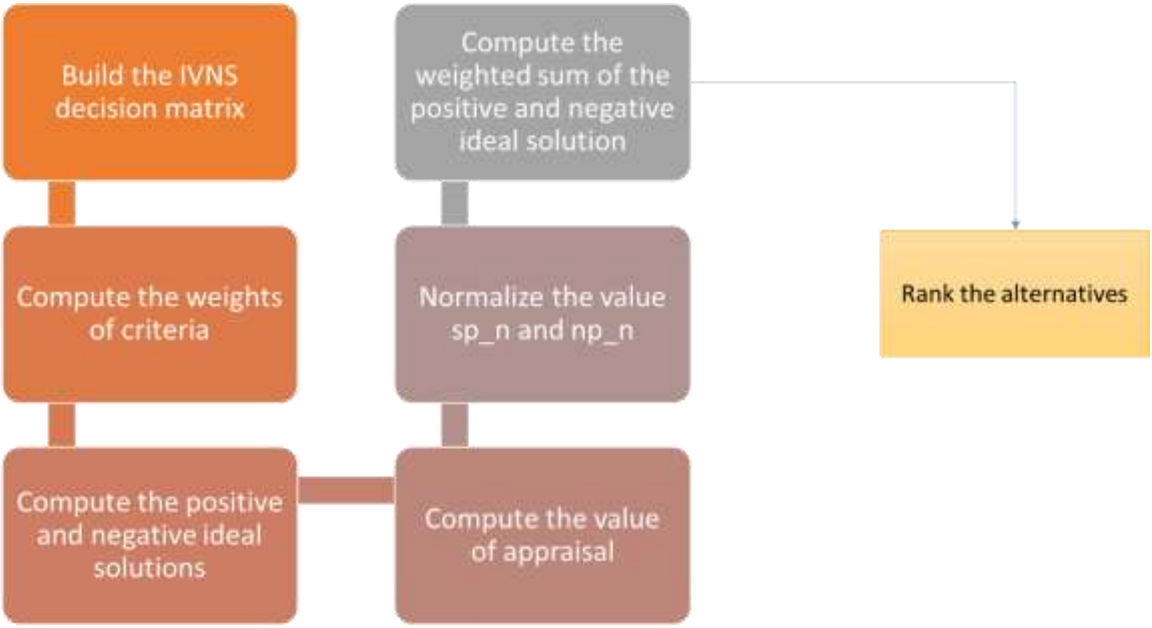

Figure 1: The steps of the EDAS method.

3. The EDAS Method

To get around the system's insufficiency, indeterminacy, and irregularity in this part, we use IVNSs inside the EDAS methodology. Figure 1 shows the proposed methodology. Here are the expanded procedure's measures:

Step 1: Build the IVNS judgement background

Based on the opinions of experts with the interval valued neutrosophic numbers, the decision matrix is built between factors and options. The interval values neutrosophic numbers

$$x\_j_{mn} = \langle [T_j^L, T_j^U], [I_j^L, I_j^U], [F_j^L, F_j^U] \rangle$$

Step 2: Compute the weights of factors

The weights of criteria are computed using the average decision matrix.

Step 3: Compute the optimistic and bad perfect results

With the positive criteria and negative criteria, the optimistic and bad ideal result is computed.

$$PDA = pda_{mn}$$

$$NDA = nda_{mn}$$

Where the PDA refers to the positive ideal solutions and NDA refers to the negative ideal solutions.

$$pda_{mn} = \frac{Z(x_{mn} \ominus av_n)\kappa(av_n)}{Z(av\_n \ominus x\_mn)\kappa(av_n)} if m \in B if m \in C$$

$$nda_{mn} = \frac{Z(av_n \ominus x_{mn})\kappa(av_n)}{Z(x_{mn} \ominus av_n)\kappa(a_{vn})} if m \in B if m \in C$$

Step 4: Compute the weighted sum of the optimistic and bad ideal solutions

$$sp_n = \sum_{n=1}^{l} w_j \otimes pda_{mn}$$

$$sn_n = \sum_{n=1}^{l} w_j \otimes Nda_{mn}$$

Step 5: Normalize the value sp_n and np_n

$$nsp_n = sp_n / \max\left(\kappa(sp_n)\right)$$

$$nsn_n = sn_n / \max\left(\kappa(sn_n)\right)$$

Step 6: Compute the value of appraisal as

$$as_n = \frac{1}{2}(nsp_n \oplus nsn_n)$$

Step 7: order the options

The options are ordered based on the value of appraisal

4. Results

Step 1: Build the IVNS judgement background

There are five factors such as risk of policy implementation, risk of policy vague, economic risk, climate risks of business, and competition risks. There are four electricity retail companies (alternatives). The experts used the interval valued neutrosophic numbers to value the previous criteria and alternatives.

Step 2: Compute the weights of factors

The weights of factors are computed using the average method as shown in figure 2. The criterion 3 is the highest weight and criterion 1 is the lowest weight.

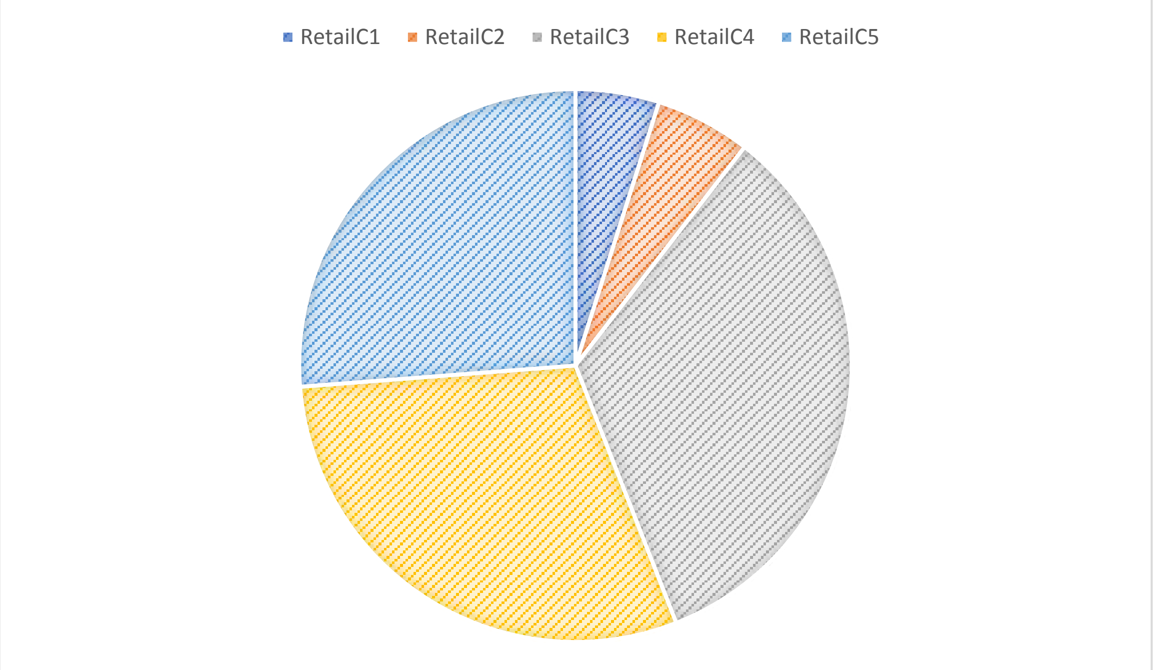

Figure 2: The weights of 5 factors.

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Step 3: Compute the optimistic and bad ideal results

The optimistic and bad ideal results are computed as shown in tables 1,2

Table 1: The PDA Values

	RetailC1	RetailC2	RetailC3	RetailC4	RetailC5
RetailA1	0.776824	0.746835	0.248677	0.083636	0
RetailA2	0	0	0	0.301818	0
RetailA3	0	0	0	0.04	0.750973
RetailA4	0.381974	0	1.031746	0	0

Table 2: The NDA Values

	RetailC1	RetailC2	RetailC3	RetailC4	RetailC5
RetailA1	0	0	0	0	0
RetailA2	0.648069	0.265823	0.68254	0	0.648069
RetailA3	0.51073	0.316456	0.597884	0	0.51073
RetailA4	0	0.164557	0	0.425455	0

Step 4: Compute the weighted sum of the optimistic and bad ideal results

The weighted sum of optimistic and bad ideal results are computed as shown in tables 3, 4

Table 3: The weighted sum of NDA Values

	RetailC1	RetailC2	RetailC3	RetailC4	RetailC5
RetailA1	0.038026	0.041781	0.083472	0.024857	0
RetailA2	0	0	0	0.089701	0
RetailA3	0	0	0	0.011888	0.196933
RetailA4	0.018698	0	0.34632	0	0

Table 4: The weighted sum of NDA Values

	RetailC1	RetailC2	RetailC3	RetailC4	RetailC5
RetailA1	0	0	0	0	0.056121
RetailA2	0.031724	0.014871	0.229104	0	0.043876
RetailA3	0.025001	0.017704	0.200688	0	0
RetailA4	0	0.009206	0	0.126446	0.096936

Step 5: Normalize the value sp_n and np_n

The weighted sum optimistic and bad ideal results are normalized.

Step 6: Compute the value of appraisal as

The value of appraisal is computed

Step 7: order the options

The (company) 4 is the best alternatives and alternative 1 is the worst alternatives.

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Figure 3 shows the rank of four criteria.

Figure 3: The rank of alternatives.

6. Conclusion

More energy retail firms have been created as a result of the liberalisation of the electricity retail industry, which is expected to increase consumer choice and lower prices. Meanwhile, modern energy retail businesses confront not just the traditional risks associated with running a business, but also the additional dangers of the market and politics. Therefore, it is crucial to conduct an analysis of the dangers that face electrical retailers so that they may better prepare for them, lessen their impact, and foster long-term growth.

In order to solve MCDM issues, EDAS has been widely used. Multiple decision-making issues have been solved using variants of this technique that use intuitionism and type-2 fuzzy logic. Experts' degree of indeterminacy is overlooked none these expansions, however. The purpose of this research was to create and implement an IVN EDAS methodology for assessing the dangers facing energy distributors and retailers. IVN EDAS uses expert opinion to aggregate the weight of each criterion and assigns each option a score depending on how well it meets that criterion.

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