Financial Risks Appraisal based on Dynamic Appraisal Framework

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Abstract

Recently, New Energy Vehicle (NEV) consider eco-friendly and become the strategic option for balancing economic, social, and ecological goals. Therefore, this study contributed to construct a dynamic appraisal framework (DAF). Deploying Combined Compromise Solution (CoCoSo) methods and single-valued neutrosophic sets (SNNSs) in DAF to appraise financial risk for seven enterprises based on determined nine criteria. The CoCoSo method is used within the context of the SVN to decide which enterpise is the otimal. In addition, an example case study of financial risk evaluation is explored to highlight the entire execution process of the suggested framework.

Keywords: New Energy Vehicle; Financial Risk; Combined Compromise Solution (CoCoSo); MCDM, Single-Valued Neutrosophic Sets.

1. Introduction and surveyed studies

Climate change and fostering green development in [1] are strong incentives for developing new energy vehicles (NEVs). The vehicle sector is generally acknowledged to be one of the major contributors to energy consumption and carbon emissions. Demonstrated that [2] where China pledged to reach the highest level of carbon dioxide emissions by 2030, Pursuant to the Paris Agreement. It is already widely acknowledged as mentioned in [3] that the future of the automotive industry will be dominated by the development of new energy vehicles (NEVs). Due to Ref [4] is described NEVs as the prudent choice for fusing economic, social, and ecological goals. Other studies adopted the same prespective of [4].For example, [5] emphasized that EVs are an alternate way to utilize low-carbon transportation systems; due to constant challenges with environmental contamination and the scarcity of fossil fuels globally. Also, [6] Carbon dioxide (CO_2) emissions are supposedly reduced by using EVs. Whereas some nations are moving to renewable energy as their main source, their relative impact on the environment is more sustaining. By [7] leveraging contemporary technology, EVs constitute a significant step towards a clean and sustainable energy.Although NEVs are crucial for reducing emissions and conserving energy, [8] are debated some challenges as in Figure 1. According to this Figure, Thees challenges can be viewed from both a financial and a non-financial perspective.

From financial perspective [9], the NEV industry requires a sizable sum for Research and Development (R&D), manufacturing, sales, after-sales, and other linkages.

From a non-financial perspective [10], NEV enterprises are often impacted by changes in legislation or policy changes, market competition, and technological circumstances.

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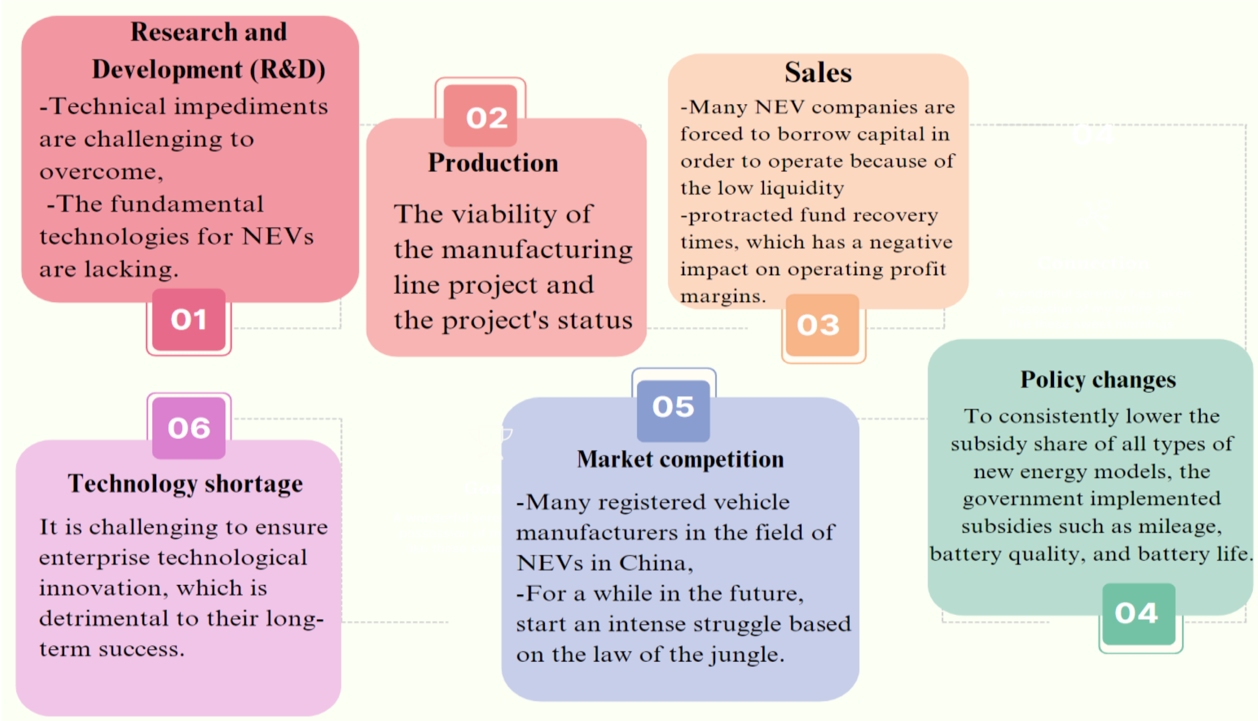

Figure 1: New Energy Vehicles

It is crucial to comprehend how to reduce risks. So, scholars and recent studies based [11] are rather basic and less focused, showing just the financial risk evaluation of a single NEV enterprise and lacking in any ranking or rating of several NEV enterprises. Additionally, appraising the financial risk in various NEV enteprises is important for social capital to reach a rational decision. Herein, the appraisal process for NEV enterprises is vital whether for choicing optimality or controlling financial risk.

Therefore this study is exploiting the earier scholars's ideas and employed methods for appraising NEV enterprise' financial risk. Also, appraising NEVs and select optimal one based on set of identified criteria . For example [12] applied Muti-Criteria Decision Making (MCDM) methods specifically, best worst method (BWM), Multi-Objective Optimisation by Ratio Analysis plus Full Multiplicative Form (MULTIMOORA), and Evaluation based on Distance from Average Solution (EDAS) hybrid technique are employed.These MCDM methods deployed for selecting optimal NEV among set of NEVs through rating these NEVs based on set of certain criteria in appraising process. And [13] enhanced consumer sales of battery electric vehicles (BEVs) in China through employing Decision making trial and evaluation laboratory (DEMATEL) and VIekriterijumsko KOmpromisno Rangiranje (VIKOR) of MCDM to to assess ten types of BEV alternatives. MCDM methods conduct based on judgements and preferences of mankind. But, Liu etal. [14] noticed that human judgements during the evaluation process involve foggy preferences and may not inherently reflect total logic.In order to avoid such issue, using fuzzy linguistic sets to convey the thought processes and experiences of experts makes more sense. Due to ability of fuzzy set (FS) to measure membership function degree[15] .By way of example, [16] execute MULTIMOORA method under environment of Triangular fuzzy set (TFS) to rank alternatives of battery swapping station (BSS). Others applied advanced theory for treating with uncertainity situations as [17] investigated MCDM methods for evaluating financial risk performance and determined the ranking order and best alternative through merging MCDM methods with under a neutrosophic environment. Due to the Efficiency of neutrosohic theory in dealing with uncertainty and vagueness situations. Because of, NSs take into account both the truth membership , false membership and indeterminacy otherwise FSs measure truth membership and intuitionistic FSs (IFSs) measure truth membership , false membership[18],[19].

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Form conducted surveys for earier used methods in our interested area.We capitalise on abiliity of neutrosohic theory to treat with vagueness environments as merket and financial environment. So, we are volunteering this theory to appraise financial risk of NEVs.

Herein,we contribute to appraise the the risks of financial in NEV through allocating single-valued neutrosophic sets (SVNSs) which is one of neutrosophic types. Combining this theory with combined compromise solution (CoCoSo) method to build robust dynamic appraisal framework (DAF).

This study organizes into set of sections. Section two present the definitions and some mathematical equation on the single-valued neutrosophic sets. In section 3 we define the steps of generating DAF. In section 4 we presented the results and interpretation of DAF . Finally, the conclusion of this study represents in section 5.

2. Preliminary of volunteered methods

This section encompasses the basic definitions and mathematical equations are volunteering in this study.

Definition 1

There are two single-valued neutrosophic numbers (SVNNs) $u = (u_1, u_2, u_3)$ and $n = (n_1, n_2, n_3)$ where the u_1, u_2, u_3 presents the truth, indeterminacy, and falsity of membership degrees for the first SVNN and n_1, n_2, n_3 presents the truth, indeterminacy, and falsity of membership degrees for the first SVNN. We can make some operations on these numbers:

$$u^c = (u_3, 1 - u_2, u_1) \quad (1)$$

$$u \cup n = (\max\{u_1, n_1\}, \min\{u_2, n_2\}, \min\{u_3, n_3\}) \quad (2)$$

$$u \cap n = (\min\{u_1, n_1\}, \max\{u_2, n_2\}, \max\{u_3, n_3\}) \quad (3)$$

$$u \oplus n = (u_1 + n_1 - u_1 n_1,\ u_2 n_2, u_3 n_3) \quad (4)$$

$$u \otimes n = (u_1 n_1, u_2 + n_2 - u_2 n_2, u_3 + n_3 - u_3 n_3) \quad (5)$$

$$\eta u = \left(1 - (1 - u_1)^{\eta}, u_2^{\eta}, u_3^{\eta}\right) \quad (6)$$

$$u^{\eta} = \left(u_1^{\eta}, 1 - (1 - u_2)^{\eta}, 1 - (1 - u_3)^{\eta}\right) \quad (7)$$

Definition 2

This definition illstrates the score function to obtain the crisp value. The score function can be computed as:

$$S(u) = \frac{2 + u_1 - u_2 - u\_3}{3} \quad (8)$$

Where $S(u) \in [0,1]$

Definition 3

Based on this definition, we compute the single-valued neutrosophic weighted arithmetic (SVNWA) and single-valued neutrosophic weighted geometric (SVNWG). We can define the set of weight vectors as $w = (w_1, w_2 \dots \dots \dots \dots . w_m)^T$ and $\sum_{i=1}^{m} w_i = 1$

$$SVNWA\ (u_1, u_2, \dots u_m) = \underset{i=1}{\overset{m}{\oplus}} (w_j, u_j) = (1 - \prod_{i=1}^{m}(1 - u_1)^{w_i}, \prod_{i=1}^{m}(u_2)^{w_i}, \prod_{i=1}^{m}(u_3)^{w_i}) \quad (9)$$

$$SVNWG\ (u_1, u_2, \dots u_m) = \underset{i=1}{\overset{m}{\otimes}} (w_j, u_j) = (\prod_{i=1}^{m}(u_1)^{w_i}, \prod_{i=1}^{m}(1 - u_2)^{w_i}, \prod_{i=1}^{m}(1 - u_3)^{w_i}) \quad (10)$$

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Definition 4

We can compute the distance between two sets S, T as:

$$D_h(S,T) = \frac{1}{3m}\sum_{i=1}^{m}\left(\left|u_{1_S}(Z_i) - u_{1_T}(Z_i)\right| + \left|u_{2_S}(Z_i) - u_{2_T}(Z_i)\right| + \left|u_{3_S}(Z_i) - u_{3_T}(Z_i)\right|\right) \quad (11)$$

3. Dynamic Appraisal Framework

We utilized one of the popoluar method of MCDM methods is CoCoSo method. Our choicing for this method is due to apply it in many fields For instance, the evaluation of medical waste, green growth assessment, selection of WEEE recycling partners, etc.

This section too Figure 2 introduces the steps of executing CoCoSo method under SVNs to generate DAF. The major purpose of DAF is ranking and evaluating financial risks also, ranking the alternatives based set of criteria. The generation of DAF has been done through following steps.

Step 1: decision matrix construction

we we constructing the decision matrix between the set of criteria $FRC = (FRC_1, FRC_2, \ldots \ldots FRC_v)$ and set of alternatives $FRA = (FRA_1, FRA_2, \ldots \ldots FRA_m)$. The experts use the linguist scale to ratethe criteria and alternatives. Then replace the linguistic term with the SVNNs.

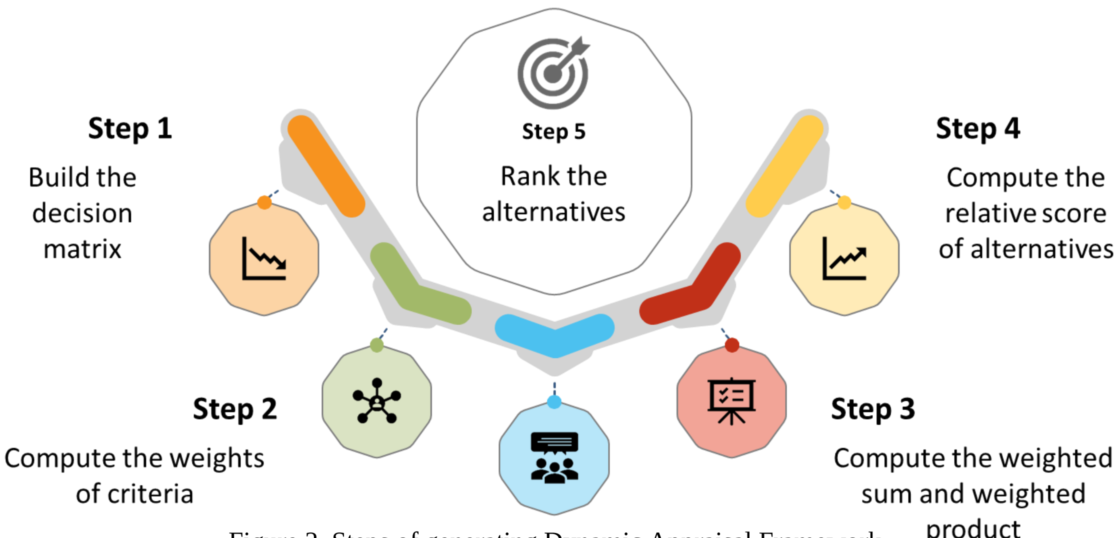

Figure 2. Steps of generating Dynamic Appraisal Framework

Step 2: Compute the weights of the criteria.

Step 3: Compute the weighted sum and weighted product.

The CoCoSo method is employed with integration with two other methods (simple additive weighted and weighted product model). So, the weighted sum and product can be computed as:

$$WS = \bigoplus_{j=1}^{m} w_j u_{ij} \quad (12)$$

$$WP = \bigotimes_{i=1}^{m} w_j u_{ij} \quad (13)$$

Step 4: Compute the relative score of alternatives

In this step, we used the three scores of evaluations to obtain the score of relative alternatives

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$$EV^{(1)} = \frac{S(WS_i)+S(WP_i)}{\sum_{i=1}^{m}(S(WS_i)+S(WP_i))} \quad (14)$$

$$EV^{(2)} = \frac{S(WS_i)}{\min_i S(WS_i)} + \frac{S(WP_i)}{\min_i S(WP_i)} \quad (15)$$

$$EV^{(3)} = \frac{\eta S(WS_i)+(1-\eta)S(WP_i)}{\eta \max_i S(WS_i)+(1-\eta)\max_i S(WP_i)} \quad (16)$$

Where $S(WS_i)$ *and* $S(WP_i)$ refers to the score function of weighted sum and product, and $\eta \in [0,1]$ refers to the compromise coefficient.

Step 5: Ranking process for the alternatives

The alternatives are ranked according to the highest value of EV_i

$$EV_i = \left(EV^{(1)}EV^{(2)}EV^{(3)}\right)^{1/3} + \frac{1}{3}\left(EV^{(1)} + EV^{(2)} + EV^{(3)}\right) \quad (17)$$

4. Empirical results and Interpretation

NEVs a significant component of the new energy sector, have garnered a lot of attention in recent years due to the pressures related to climate change, energy concerns, and the demand to convert and upgrade industrial processes. New energy automotive enterprises in the domestic market are proliferating like bamboo shoots after a spring shower thanks to the assistance of the government and the positive growth possibilities they provide. NEV centerprises are considered to be part of the high-tech sector, which necessitates the expenditure of a significant quantity of capital. A significant amount of capital expenditure often results in a high level of financial risk. When analyzing the NEV's potential financial risk, the organization must adhere to the tenets of comprehensiveness, practicability, and quantification.

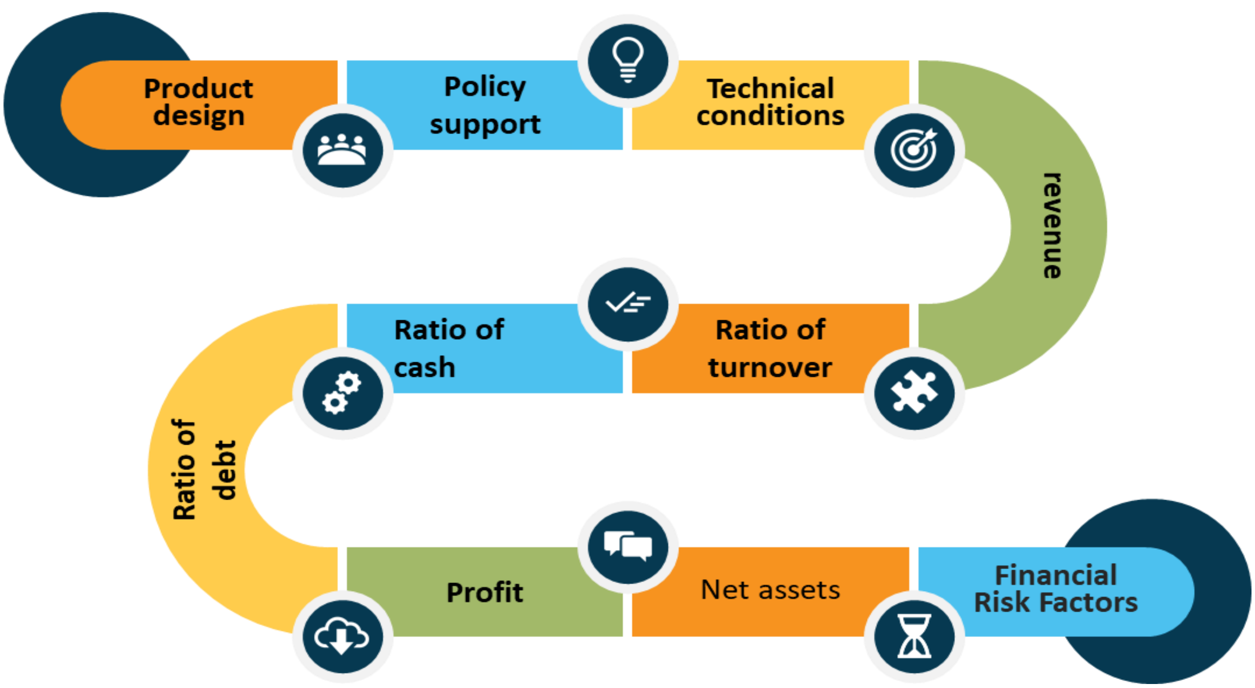

Figure 3: The financial risks factors.

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As a result, the criteria for assessment are constructs, as is seen in Figure 3 in particular. Table 1 illstrates the constructed decision matrix based on the linguistic scale. Then compute the weights of the criteria. The valuation criteria's weights is representing in Figure 4.

Then compute the weighted sum and weighted product by using Eqs. (12,13) as shown in Table 2 and Table 3. Then compute the relative score of alternatives by using Eqs. (14,16). Then rank the alternatives by the largest value of EV_i as shown in Figure 5. Alternative 2 is the best otherwise alternative 1 is the worst.

Table 1: The constructed decision matrix.

	FRC$_1$	**FRC$_2$**	**FRC$_3$**	**FRC$_4$**	**FRC$_5$**
FRA$_1$	(0.20, 0.90, 0.80)	(0.30, 0.65, 0.60)	(0.50, 0.50, 0.50)	(0.60, 0.40, 0.30)	(0.20, 0.90, 0.80)
FRA$_2$	(0.80, 0.30, 0.20)	(0.90, 0.10, 0.10)	(0.80, 0.30, 0.20)	(0.80, 0.30, 0.20)	(0.90, 0.10, 0.10)
FRA$_3$	(0.60, 0.40, 0.30)	(0.30, 0.65, 0.60)	(0.60, 0.40, 0.30)	(0.90, 0.10, 0.10)	(0.90, 0.10, 0.10)
FRA$_4$	(0.90, 0.10, 0.10)	(0.80, 0.30, 0.20)	(0.30, 0.65, 0.60)	(0.20, 0.90, 0.80)	(0.20, 0.90, 0.80)
FRA$_5$	(0.20, 0.90, 0.80)	(0.30, 0.65, 0.60)	(0.60, 0.40, 0.30)	(0.60, 0.40, 0.30)	(0.80, 0.30, 0.20)
FRA$_6$	(0.90, 0.10, 0.10)	(0.80, 0.30, 0.20)	(0.90, 0.10, 0.10)	(0.90, 0.10, 0.10)	(0.30, 0.65, 0.60)
FRA$_7$	(0.90, 0.10, 0.10)	(0.80, 0.30, 0.20)	(0.60, 0.40, 0.30)	(0.50, 0.50, 0.50)	(0.30, 0.65, 0.60)
	FRC$_6$	**FRC7**	**FRC$_8$**	**FRC$_9$**	
FRA$_1$	(0.50, 0.50, 0.50)	(0.30, 0.65, 0.60)	(0.50, 0.50, 0.50)	(0.50, 0.50, 0.50)	
FRA$_2$	(0.30, 0.65, 0.60)	(0.30, 0.65, 0.60)	(0.80, 0.30, 0.20)	(0.80, 0.30, 0.20)	
FRA$_3$	(0.60, 0.40, 0.30)	(0.20, 0.90, 0.80)	(0.90, 0.10, 0.10)	(0.90, 0.10, 0.10)	
FRA$_4$	(0.30, 0.65, 0.60)	(0.60, 0.40, 0.30)	(0.60, 0.40, 0.30)	(0.80, 0.30, 0.20)	
FRA$_5$	(0.90, 0.10, 0.10)	(0.90, 0.10, 0.10)	(0.60, 0.40, 0.30)	(0.90, 0.10, 0.10)	
FRA$_6$	(0.20, 0.90, 0.80)	(0.20, 0.90, 0.80)	(0.30, 0.65, 0.60)	(0.60, 0.40, 0.30)	
FRA$_7$	(0.20, 0.90, 0.80)	(0.80, 0.30, 0.20)	(0.90, 0.10, 0.10)	(0.90, 0.10, 0.10)	

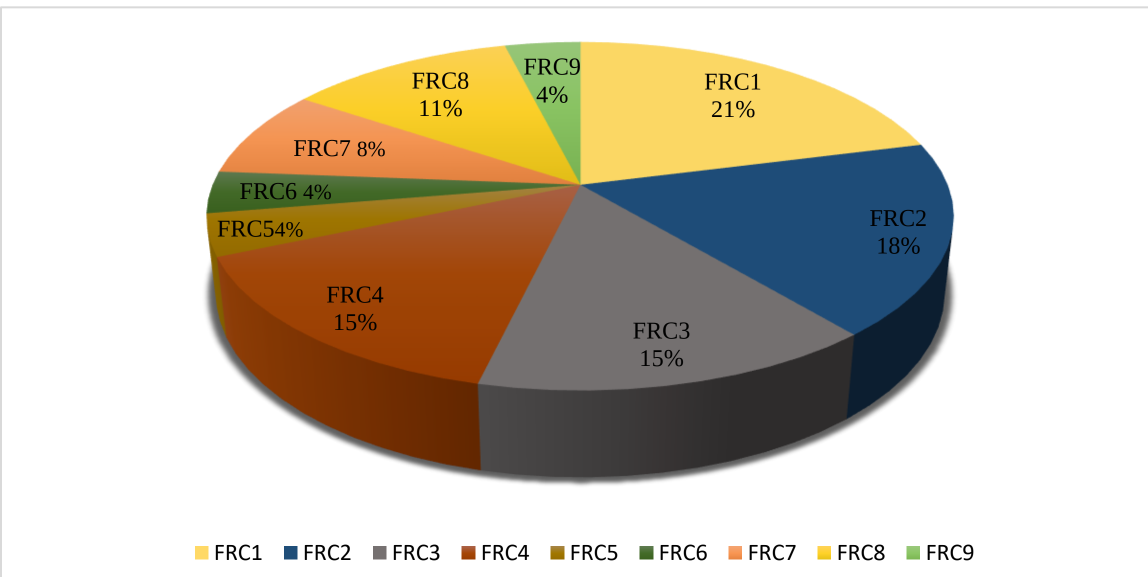

Figure 4: Valuation weights of criteria.

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Table 2: The weighted sum matrix.

	FRC1	FRC2	FRC3	FRC4	FRC5	FRC6	FRC7	FRC8	FRC9
FRA1	0	0	0.040323	0.094077	0	0.017689	0.020425	0.031835	0
FRA2	0.171919	0.178993	0.112016	0.120974	0.038918	0.009728	0.020425	0.088439	0.025948
FRA3	0.133696	0	0.076156	0.14785	0.038918	0.024763	0	0.11673	0.038918
FRA4	0.210113	0.135612	0	0	0	0.009728	0.051993	0.060126	0.025948
FRA5	0	0	0.076156	0.094077	0.031843	0.038918	0.081711	0.060126	0.038918
FRA6	0.210113	0.135612	0.14785	0.14785	0.009728	0	0	0	0.012969
FRA7	0.210113	0.135612	0.076156	0.067201	0.009728	0	0.066857	0.11673	0.038918

Table 3: The weighted product matrix.

	FRC1	FRC2	FRC3	FRC4	FRC5	FRC6	FRC7	FRC8	FRC9
FRA1	0	0	0.825225	0.935345	0	0.969779	0.892895	0.859276	0
FRA2	0.958722	1	0.959795	0.970773	1	0.947473	0.892895	0.968121	0.984349
FRA3	0.909383	0	0.906572	1	1	0.98256	0	1	1
FRA4	1	0.951534	0	0	0	0.947473	0.963734	0.925483	0.984349
FRA5	0	0	0.906572	0.935345	0.992223	1	1	0.925483	1
FRA6	1	0.951534	1	1	0.947473	0	0	0	0.958136
FRA7	1	0.951534	0.906572	0.889958	0.947473	0	0.98374	1	1

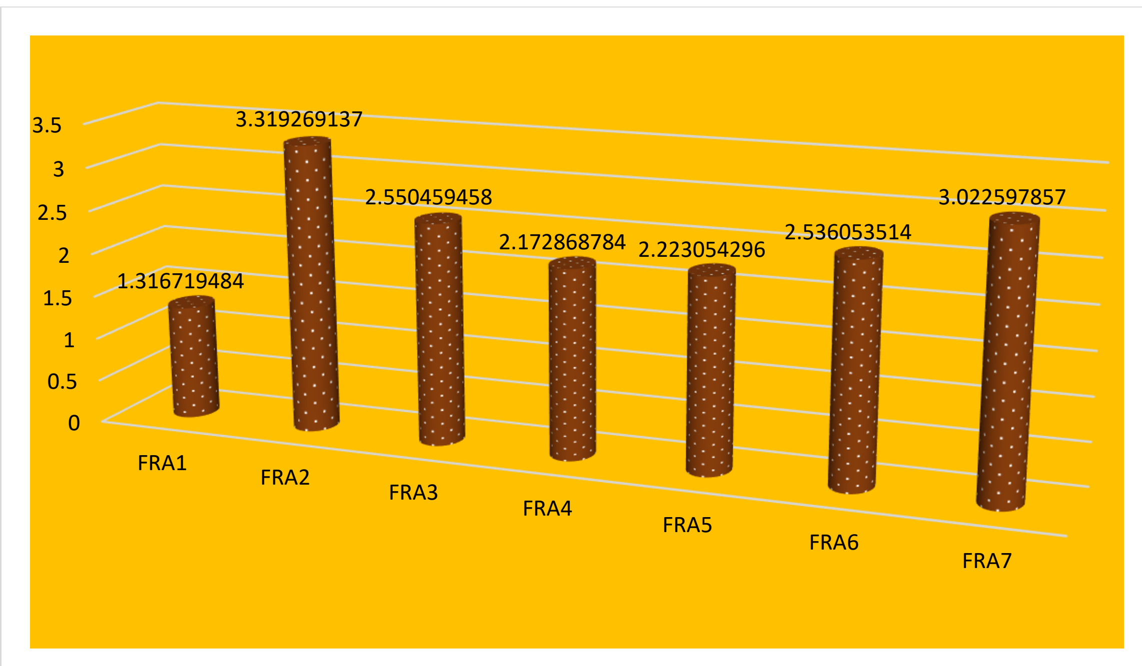

Figure 5: Alternatives ranking

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5. Conclusions

The robust motivators for adopting the notion of NEV in this study are the worsening energy crisis and increasing environmental damage. NEVs are saving energy and reduce emissions Compared with traditional vehicles. Moreever, appraising the risk of innovations in the NEV supply chain has grown to be an urgent issue.

As a result,this study suggests DAF for apprasisng financial risks and alternatives. In DAF, we volunteering MCDM methods especially CoCoSo method as supportive tool for decision makers (DMs) in appraising process. Another volunteer in this framework is neutrosophic theory which has ability to utilize in dynamic and imprecisie environments.

We experiment our DAF on seven enterprise (alternatives) with nine criteria and the results from this experiment indicated that A_2 is the optimal alternative otherwise A_1 is the worst one

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