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An Intelligent Model for Heating Source Selection under uncertainty

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***Abstract*— The selection of heating source source is a vital problem in decision making. It has many of factors and conflict criteria must take into consideration when develop this problem. So this problem is multi criteria decision making (MCDM). In this paper used MCDM methods to select best heating source such AHP and MOORA under neutrosophic sets. The AHP method is used to compute the weights of criteria and MOORA to rank alternatives. The numerical example is presented to select optimal heating source.**

***Keywords*— MCDM, MOORA, AHP, Neutrosophic, Heating source.**

I. INTRODUCTION

Selection the heating source is considered a vital problem. Many of firms are concerned to this problem and attempt to introduce the best in this field. This problem has many factors and criteria. So firms take into consideration this criteria.

Decision making is important and necessary to these firms. Decision making including criteria and alternatives to choose best alternative with consideration the opinions of experts and decision makers in this field.

Criteria need to be measured. So need to understand different method of measurements [1]. This problem is MCDM. The MCDM is widely used in many fields[2-4]. MCDM is used to rank criteria and alternatives. MCDM methods are AHP, TOPSIS , MOORA, PROMETHEE, VICKOR and more[5].

Used neutrosophic set to deal with uncertainty and inconsistent information[6, 7]. AHP method is used to calculate the weights of criteria[8-10]. Wang et al applied the AHP method for extent analysis method[11].

Then Applying the MOORA method to determine the rank of alternatives. WK Brauers et. Applying the MOORA method to privatization in a transition economy[12].

The rest of this paper prearranged as follow: Section II refers to Methodology. Section III presented Application and results of methodology. Section IV presented the conclusion of this paper.

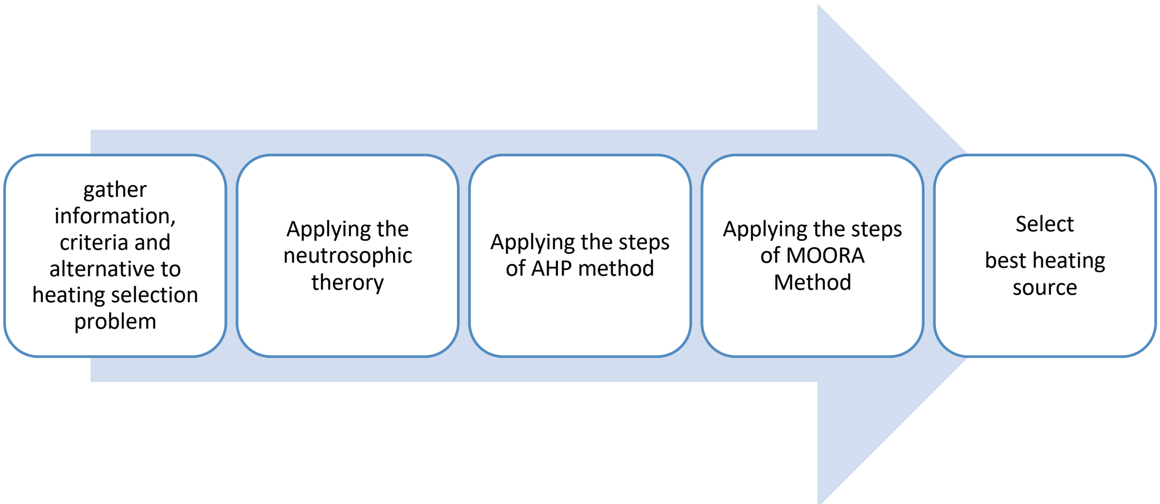

Fig 1. This study Methodology.

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II. METHODOLOGY

The steps of AHP method as

Step 1. Collect criteria and alternatives where l refers to criteria $(l = 1,2,3, \ldots \ldots a)$, where krefers to alternative $(\mathrm{k} = 1,2,3, \ldots \ldots \mathrm{b})$

Step 2. Build the pairwise comparison matrix by using Eq. (1):

$$\mathrm{h}^{\mathrm{p}} = \begin{bmatrix} \mathrm{h}_{11}^{\mathrm{p}} & \cdots & \mathrm{h}_{1l}^{\mathrm{p}} \\ \vdots & \ddots & \vdots \\ \mathrm{h}_{\mathrm{k}1}^{p} & \cdots & \mathrm{h}_{\mathrm{lk}}^{\mathrm{p}} \end{bmatrix} \quad (1)$$

Where p refers to decision makers

Step 3. Obtain the crisp value by applying this score function by using Eq. (2)

$$\mathrm{s}(\mathrm{h}_{\mathrm{lk}}^{\mathrm{e}}) = \frac{2 + \mathrm{T}_{\mathrm{lk}}^{\mathrm{p}} - \mathrm{I}_{\mathrm{lk}}^{\mathrm{p}} - \mathrm{F}_{\mathrm{lk}}^{\mathrm{p}}}{3} \quad (2)$$

$\mathrm{T}_{\mathrm{lk}}^{\mathrm{p}}$, $\mathrm{I}_{\mathrm{lk}}^{\mathrm{p}}$, $\mathrm{F}_{\mathrm{lk}}^{\mathrm{p}}$, presents truth, indeterminacy and falsity of the SVNNs.

Step 4. Combine the opinions of decision makers by using Eq. (3):

$$h_{lk} = \frac{\sum_{p=1}^{p} h_{lk}}{p} \quad (3)$$

Step 5. Construct the combined pairwise comparison matrix by using Eq. (4):

$$\mathrm{h} = \begin{bmatrix} \mathrm{h}_{11} & \cdots & \mathrm{h}_{1l} \\ \vdots & \ddots & \vdots \\ \mathrm{h}_{\mathrm{k}1} & \cdots & \mathrm{h}_{\mathrm{lk}} \end{bmatrix} \quad (4)$$

Step 6. Obtain the normalized pairwise decision matrix by using Eq. (5):

$$\mathrm{w}_{\mathrm{k}}^{\mathrm{b}} = \frac{\mathrm{w}_{\mathrm{k}}}{\sum_{\mathrm{k}=1}^{\mathrm{a}} \mathrm{w}_{\mathrm{k}}} \quad (5)$$

Step 7. The weights of criteria is computed by using Eq. (6):

$$\mathrm{w}_{l} = \frac{\sum_{\mathrm{l}=1}^{\mathrm{a}} (\mathrm{h}_{\mathrm{lk}})}{\mathrm{a}} \quad (6)$$

Step 8. The consistency ration is checked by using Eq. (7).

$$CR = \frac{CI}{RI} \text{ And } CI = \frac{\lambda_{max} - a}{a - 1} \quad (7)$$

Where a present the number of criteria. λ_{max} Is the maximum eigenvalue. CI is consistency index and RI is random index. If the CR is less or equal to 0.1 the opinion of experts is accepted otherwise the value of opinion experts not consistent then reevaluate the matrix.

The steps of MOORA method as [13]

Step 9. Build combined decision matrix by using Eqs. (1,2,3,4)

Step 10. Normalized the combined decision matrix

$$R_{lk} = \frac{h_{lk}}{\sqrt{\sum_{l=1}^{a} h_l}} \quad (8)$$

Step 11. Calculate the weighted normalized decision matrix

$$T_{lk} = R_{lk} * \mathrm{w}_{l} \quad (9)$$

Step 12. Compute the classification of cost and positive criteria

$$\sum_{l=1}^{g} T_l \ for\ positive\ criteria \quad (10)$$

$$\sum_{k=g+1}^{b} T_k \ for\ negative\ criteria \quad (11)$$

Step 13. Compute the continuation index and rank alternatives

$$B_l = \sum_{l=1}^{g} T_l - \sum_{k=g+1}^{b} T_k \quad (12)$$

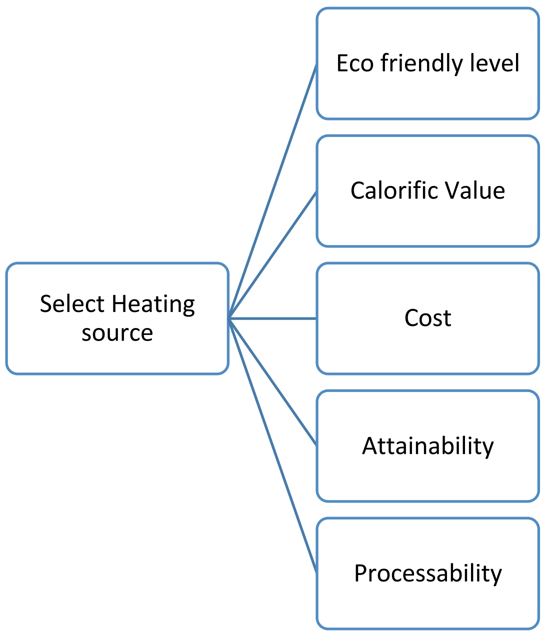

Fig 2. The criteria of this work

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III. APPLICATION AND RESULTS

In this Application show the results of this problem. Applying AHP and MOORA methods to determine the best heating source. Fig 1. Present the model of this paper. Start with five criteria in Fig 2. And four heating source (alternatives) (Coal, Natural gas, Diesel and Electricity).

The weights of crania are determined by applying the AHP method. Using the single valued neutrosophic numbers in Table I to build the pairwise comparison matrix with two decision makers. Then combined the opinions of decision makers into one pairwise comparison matrix into Table II. Then the values of normalized the decision matrix into Table III. Then the weights of criteria in Table IV. Fig 3. show the weights of criteria. Then CR is checked the value of CR = 0.01615 then CR is less than 0.1 the opinions of experts is consistent.

TABLE I The neutrosophic numbers scale

Linguistic term	<T,I,F> SVNNs
Very Deprived	<0.30,0.75,0.70>
Deprived	<0.40,0.65,0.60>
Equal	<0.50,0.50,0.50>
Moral	<0.70,0.25,0.30>
Very Moral	<0.80,0.15,0.20>

TABLE II The aggregated the pairwise comparison matrix

C_e	C_1	C_2	C_3	C_4	C_5
C_1	0.5	0.6	0.2833	0.7667	0.55
C_2	1.9166	0.5	0.7167	0.55	0.5
C_3	3.5298	1.39528	0.5	0.6	0.2833
C_4	1.3098	2.00210	1.91668	0.5	0.5
C_5	2.0021	2.46255	3.52982	2.46255	0.5

TABLE III The Normalized value of Pairwise comparison matrix

C_e	C_1	C_2	C_3	C_4	C_5
C_1	0.0540	0.08620	0.04078	0.15713	0.23571
C_2	0.2070	0.07184	0.10317	0.11272	0.21428
C_3	0.3812	0.20047	0.07197	0.12297	0.12141
C_4	0.1414	0.28766	0.27592	0.10247	0.21428
C_5	0.2162	0.35381	0.50814	0.50469	0.21428

TABLE IV The Criteria weights

C_e	Weights
C_1	0.11477
C_2	0.14180
C_3	0.17961
C_4	0.20436
C_5	0.35943

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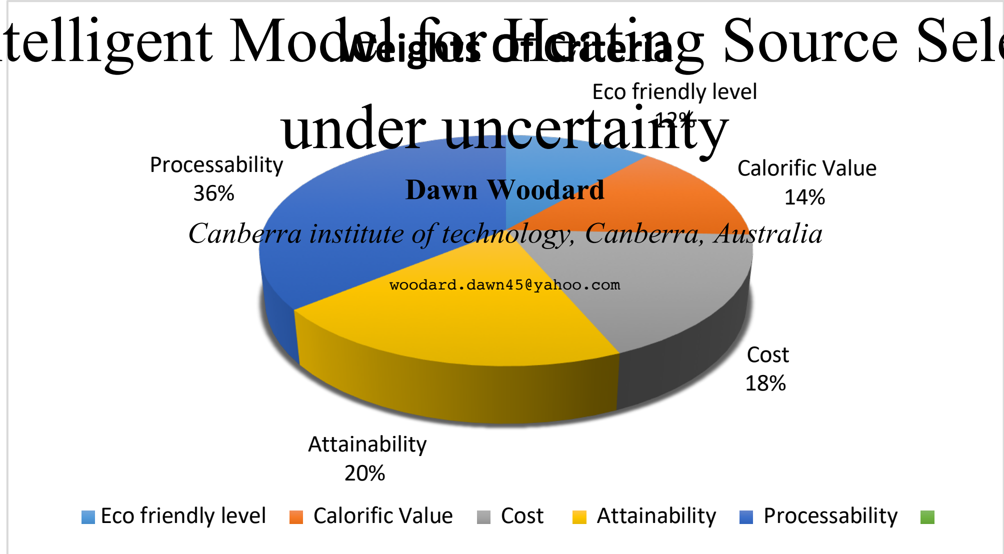

Fig 3. The Criteria weights

Take the weights of criteria and rank alternatives using MOORA method. Then build the decision matrix with opinions of two experts then combine two matrix into one matrix. Table V presented the combined decision matrix values.

Then compute the normalized matrix into Table VI. Then compute the weighted normalized matrix in Table VII. Then compute the classification for negative criteria (cost criteria) and positive criteria (all rest of criteria are positive) into Table 8. Finally rank the alternative into Table VIII.

TABLE V The Aggregated decision matrix

	C_1	C_2	C_3	C_4	C_5
A_1	0.5	0.55	0.55	0.55	0.7167
A_2	0.8167	0.8167	0.7167	0.55	0.55
A_3	0.55	0.6	0.8167	0.7167	0.3333
A_4	0.3833	0.5	0.55	0.3833	0.7167

TABLE VI The normalized decision matrix

	C_1	C_2	C_3	C_4	C_5
A_1	0.42773	0.43762	0.41158	0.48889	0.59706
A_2	0.69866	0.64983	0.53633	0.48889	0.45818
A_3	0.47051	0.47741	0.61117	0.63707	0.27766
A_4	0.32790	0.39784	0.41158	0.34071	0.59706

TABLE VII The weighted normalized decision matrix

	C_1	C_2	C_3	C_4	C_5
A_1	0.04909	0.06205	0.07392	0.09991	0.21460
A_2	0.08018	0.09215	0.09633	0.09991	0.16469
A_3	0.054	0.06770	0.10977	0.13019	0.09980
A_4	0.03763	0.05641	0.07392	0.06963	0.21460

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TABLE VII The Classification for positive, negative criteria and rank of alternatives

	Leaving Outranking	Entering Outranking	Net Outranking	Rank
A_1	0.425671	0.073929	0.351742	4
A_2	0.436942	0.096336	0.340606	3
A_3	0.3517	0.109778	0.241923	1
A_4	0.378289	0.073929	0.30436	2

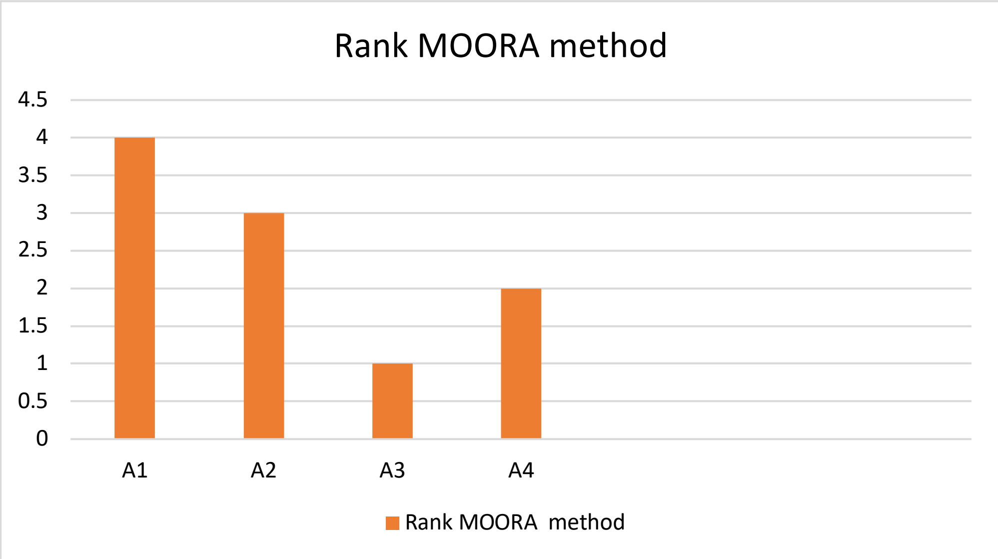

Fig 4. The rank of MOORA method

IV. CONCLUSIONS

In this study proposed the single valued neutrosophic set with AHP and MOORA method to select the heating source. The AHP is applied first for computing the weights of criteria. Then the MOORA method is applied to compute the rank of alternatives.

The future work use large scale of data and other MCDM methods.

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