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Selection Process of Onshore Wind Turbine Model Based On Hesitant Bipolar Intuitionistic Fuzzy Set

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***Abstract* -** Wind technology is the most widely used form of energy, promising to replace the traditional energy system. Countries that primarily meet their energy needs from fossil fuels to rely on new, renewable and environmentally friendly energy sources. Changing climate and earth warming have raised awareness to protect the world. Wind power is an alternative to traditional fuels for affordable and pure energy. Selecting the best onshore wind turbine for all life cycles plays an important role in effectively designing a wind turbine project. In this paper we introduce a new extension of hesitant bipolar intuitionistic fuzzy set (HBIFs) with the help of multi criteria decision making process. Here we develop the normalized Euclidean distance measure in hesitant bipolar intuitionistic fuzzy set and then applying MULTIMOORA ranking method.

INTRODUCTION

Comparing all the renewable energy sources, wind power has the key potential to produce pure, affordable, secure, abundant and effective energy for sustainable development. Similarly, wind power has recently become one of the fastest growing, most commercially attractive and widely used renewable energy sources for generating electricity. Thus it becomes particular focus on business and eco-friendliness.

Torra (2010)[8] proposed the hesitant fuzzy set. Hesitant fuzzy set is the extension set of fuzzy set. Wei et al.,(2017)[9] investigated the multiple attribute decision making problems based on the aggregation operators with hesitant bipolar fuzzy information. Al-Quran et al., (2019)[1]proposed a hesitant bipolar-valued neutrosophic set (HBVNS) based on the combination of bipolar neutrosophic sets and hesitant fuzzy sets. Aydemir et al.,(2020)[2] proposed Dombi prioritized aggregation of q-rung orthopair fuzzy sets and introduced operators of q-rung orthopair fuzzy sets. Also, Dombi prioritized weighted averaging operator and d weighted geometric operator. These operators are used in MULTIMOORA method. Buyukozkan and Guler(2021)[3] proposed efficient supply chain analytics (SCA) tool for evaluation of new integrated evaluation techniques. This techniques develop in AHP and MULTIMOORA techniques with fuzzy envelope.

Liao et al., (2018)[4]proposed a new novel score function of hesitant fuzzy linguistic term set and derived the term based weight finding method. Mandal et al., (2018)[5] discussed ideas for hesitant bipolar value ambiguous packages and bipolar value hesitant ambiguous packages. Systematic framework with ARAS and HFSs for drug selection problem is adopted and also novel procedure is proposed to determine the criteria weights using new divergence measure by Mishra et al., (2021)[6]. Onar et al.,(2015)[7] proposed method is relatively more efficient than the existing method and its based on multi-expert hierarchical multicriteria fuzzy method using linguistic terms. It can aggregate the linguistic assessments of more than one expert. An interval-valued intuitionistic fuzzy pairwise comparison based evaluation using a new linguistic scale.

In the present study, we proposed a new extension of hesitant fuzzy set to hesitant bipolar fuzzy set, and then to hesitant bipolar intuitionistic fuzzy set. Fuzzy set is basic set for many new derived set. It is based on membership function. Also, the fuzzy set define the uncertainty condition, whenever the uncertainty occurs that times fuzzy set helps to solve the uncertainty. Many researchers solved the extension of fuzzy set. It has many extensions like intuitionistic fuzzy set, Pythagorean fuzzy set, interval valued fuzzy set and type-2 fuzzy set and so on. These extension sets are defined with different type of multi criteria decision making method. Hesitant fuzzy set which helps to deliver the decision makers hesitation thoughts. In that purpose, decision makers take the perfect and undoubted decision. HBIFs is a new mathematical tool for the problem of uncertainty. This set too extended to many variances. Each extended set develop by different application with different multi criteria decision making methods. The model is very apt to describe the problem of uncertainty, which defines both membership and non membership degree and also deliver the decision makers membership positive and membership negative thoughts.

In this research article we proposed hesitant bipolar intuitionistic fuzzy set, defines both membership and non-membership positive, negative thoughts. Multi criteria decision making process helps to give the best decision, here we proposed hesitant bipolar intuitionistic fuzzy set -Normalized Euclidean distance measure and hesitant bipolar intuitionistic fuzzy set-MULTIMOORA method. Normalized Euclidean distance measure is one of the best distance finding method in multi criteria decision making method and also MULTIMOORA method is one of the best ranking method in multi criteria decision making. In this research paper we used two best multi criteria decision making method for determining the criteria weight and ranking the alternatives. The application is new to this set. By using these above extension for selecting the best onshore wind turbine model.

PRELIMINARIES

As specified by Zhang (1998), Torra (2010) and Wei et al.,(2017), we considered HBIFs and analysed the solution based on Hesitant Bipolar Intuitionistic Fuzzy set.

2.1 Operations and properties

Here, we define some new operations on the hesitant bipolar fuzzy numbers $\hat{h}, \hat{h}_1$ and $\hat{h}_2$:

(i) $\hat{h}^{\gamma} = \cup_{(\alpha_i^P,\alpha_i^N)\in(\alpha^P,\alpha^N)} \{((\alpha_i^P)^{\gamma}, -1+|1+\alpha_i^N|^{\gamma})\}, \gamma > 0;$

(ii) $\gamma\hat{h} = \cup_{(\alpha_i^P,\alpha_i^N)\in(\alpha^P,\alpha^N)} \{(1-(1-\alpha_i^P)^{\gamma}, -|\alpha_i^N|^{\gamma})\}, \gamma > 0;$

(iii)$\hat{h}_1 \oplus \hat{h}_2 = \cup_{(\alpha_i^P,\alpha_i^N)\in(\alpha_1^P,\alpha_1^N),(\alpha_i^P,\alpha_i^N)\in(\alpha_2^P,\alpha_2^N)} \{(\alpha_1^P+\alpha_2^P-\alpha_1^P\alpha_2^P, -|\alpha_1^N||\alpha_2^N|)\}$

(iv)$\hat{h}_1 \otimes \hat{h}_2 = \cup_{(\alpha_i^P,\alpha_i^N)\in(\alpha_1^P,\alpha_1^N),(\alpha_i^P,\alpha_i^N)\in(\alpha_2^P,\alpha_2^N)} \{(\alpha_1^P\alpha_2^P, \alpha_1^N+\alpha_2^N-\alpha_1^N\alpha_2^N)\}$

Definition 2.1

Let U be a fixed set, the hesitant bipolar intuitionistic fuzzy set on U is defined as follows,

$$B_{HIFS}^* = \{\langle u, h_{B^*}(u), h'_{B^*}(u)\rangle u \in U\} \qquad (1)$$

In above equation $h_{B^*}(u), h'_{B^*}(u)$ are represented as the membership and non-membership degree. Here, the membership degree is defined as the positive membership degree and negative membership degree. The positive membership degree is denoted as $\alpha_{B^*(u)}^P$ and the negative membership degree is denoted as $\alpha_{B^*(u)}^N$. The non-membership degree is defined as the positive membership degree and negative membership degree.The positive non-membership degree is denoted as $\beta_{B^*}^P(u)$ and the negative non-membership degree is denoted as $\beta_{B^*}^N(u)$.

Each element of membership degree $h_{B^*}(u) \in U$. And also the positive and negative membership degree is, $\alpha_{B^*}^P(u): U \to [0,1]$ and $\alpha_{B^*}^N(u): U \to [-1,0]$. Then, each element of non-membership degree $h'_{B^*}(u) \in U$ and also the positive and negative non-membership degree is, $\beta_{B^*}^P(u): U \to [0,1]$ and $\beta_{B^*}^N(u): U \to [-1,0]$.The hesitant bipolar intuitionistic fuzzy set is satisfies the following conditions that is, $0 \le \alpha_{B^*(u)}^P + \beta_{B^*(u)}^P \le 1$ and $-1 \le \alpha_{B^*(u)}^N + \beta_{B^*(u)}^N \le 0$. Mainly, we consider the positive non-membership degree $\beta_{B^*(u)}^P = 1 - \alpha_{B^*(u)}^P$ and negative non-membership degree $\beta_{B^*(u)}^N = 1 - \alpha_{B^*(u)}^N$.

Definition 2.2

Let consider $\alpha = \{\alpha^P, \alpha^N\}$ and $\beta = \{\beta^P, \beta^N\}$ are the two hesitant bipolar intuitionistic fuzzy set on $U =$

$\{u_1, u_2, \ldots, u_n\}$ then the distance measure between α and β are defined as $d(\alpha, \beta)$ with the following properties:

1. $0 \le d(\alpha, \beta) \le 1$;
2. $d(\alpha, \beta) = 0 iff d(\alpha = \beta)$
3. $d(\alpha, \beta) = d(\beta, \alpha)$
4. if we take three hesitnt bipolar intuitionistic hesitant fuzzy element, that is $\alpha \le \beta \le \theta$, then $d(\alpha, \beta) \le d(\alpha, \beta)$ and $d(\beta, \theta) \le d(\beta, \theta)$

Now, the hesitant bipolar intuitionistic fuzzy normalized Euclidean distance is defined as,

$$d = \sqrt{\frac{1}{n}\sum_{j=1}^{n}\left(\left(\alpha^{P}_{B^*(u)} - \alpha'^{P}_{B^*(u)}\right)\right)^2 + \left(\left(\beta^{N}_{B^*(u)} - \beta'^{N}_{B^*(u)}\right)\right)^2} \quad (2)$$

In above equation $\alpha^{P}_{B^*(u)}, \alpha'^{P}_{B^*(u)}$ and $\beta^{N}_{B^*(u)}, \beta'^{N}_{B^*(u)}$ are representing the positive and negative membership and non-membership degree.

Definition 2.3

For any two HBIFs, $\alpha = (\alpha^P, \alpha^N)$ and $\beta = (\beta^P, \beta^N)$ with set of five parameters in both membership and non-membership functions. The membership parameters are $\eta_\alpha, \vartheta_\alpha, \gamma_\alpha, \phi_\alpha, \theta_\alpha$. The non-membership parameters are $\eta_\beta, \vartheta_\beta, \gamma_\beta, \phi_\beta, \theta_\beta$. we define the normalized euclidean distance measure equation $B_E(\alpha, \beta)$ as,

$$B_E^*(\alpha, \beta) = \sqrt{\frac{1}{5}(((\eta_\alpha)^2 - (\eta_\beta)^2)^2 + ((\vartheta_\alpha)^2 - (\vartheta_\beta)^2)^2 + ((\gamma_\alpha)^2 - (\gamma_\beta)^2)^2 + (\phi_\alpha - \phi_\beta)^2 + (\sin(\theta_\alpha) - \sin(\theta_\beta))^2)}$$

Theorem 1:

For any two HBIFs, $\alpha = (\alpha^P, \alpha^N)$ and $\beta = (\beta^P, \beta^N)$ with set of five parameters in both membership and non-membership functions. The membership parameters are $\eta_\alpha, \vartheta_\alpha, \gamma_\alpha, \phi_\alpha, \theta_\alpha$. The non-membership parameters are $\eta_\beta, \vartheta_\beta, \gamma_\beta, \phi_\beta, \theta_\beta$. We can obtain $0 \le B_E^*(\alpha, \beta) \le 1$

Proof:

Since $(\gamma_{B^*})^2 = (\eta_{B^*})^2 + (\vartheta_{B^*})^2$ and $[(\eta_\alpha)^2 + (\vartheta_\alpha)^2]^2 = [(\eta_\alpha)^2]^2 + [(\vartheta_\alpha)^2]^2 + 2(\eta_\alpha)^2(\vartheta_\alpha)^2$, we can obtain $[(\eta_\alpha)^2 + (\vartheta_\alpha)^2]^2 \ge [(\eta_\alpha)^2]^2 + [(\vartheta_\alpha)^2]^2$.From $\theta_\alpha, \theta_\beta \in \left[0, \frac{\pi}{2}\right]$, $|\gamma_\alpha - \gamma_\beta| = \left(\frac{\pi}{2}\right) \times |\sin(\theta_\alpha) - \theta_\beta|$, it follows that $0 \le |\gamma_\alpha - \gamma_\beta| \le 1$ and $0 \le |\sin(\theta_\alpha) - \sin(\theta_\beta)| \le 1$ then,

$$B_E^*(\alpha, \beta) = \sqrt{\frac{1}{5}(((\eta_\alpha)^2 - (\eta_\beta)^2)^2 + ((\vartheta_\alpha)^2 - (\vartheta_\beta)^2)^2 + ((\gamma_\alpha)^2 - (\gamma_\beta)^2)^2 + (\phi_\alpha - \phi_\beta)^2 + (\sin(\theta_\alpha) - \sin(\theta_\beta))^2)}$$

$$=(\frac{1}{5}((\eta_\alpha)^2 - (\eta_\beta)^2)^2 + ((\vartheta_\alpha)^2 - (\vartheta_\beta)^2)^2 + ((\eta_\alpha)^2 - (\vartheta_\alpha)^2)^2 - ((\eta_\beta)^2 - (\vartheta_\beta)^2)^2 + ((2/\pi)(\theta_\alpha - \theta_\beta))^2 + (\sin(\theta_\alpha) - \sin(\theta_\beta))^2)^{\frac{1}{2}}$$

$$\le (\frac{1}{5}((\eta_\alpha)^2 + (\vartheta_\alpha)^2)^2 + ((\eta_\beta)^2 + (\vartheta_\beta)^2)^2 + ((\eta_\alpha)^2 + (\vartheta_\alpha)^2)^2 + ((2/\pi)(\theta_\alpha - \theta_\beta))^2 + (\sin(\theta_\alpha) - \sin(\theta_\beta))^2)^{\frac{1}{2}}$$

$$\le (\frac{1}{5}(1 + 1 + 1 + 1 + 1))^{\frac{1}{2}} = 1$$

Thus, $B_E^*(\alpha, \beta) \le 1$. Hence theorem 1 is valid and the proof is complete.

Theorem 2:

For any two HBIFs, $\alpha = (\alpha^P, \alpha^N)$ and $\beta = (\beta^P, \beta^N)$ with set of five parameters in both membership and non-membership functions. The membership parameters are $\eta_\alpha, \vartheta_\alpha, \gamma_\alpha, \phi_\alpha, \theta_\alpha$. The non-membership parameters are $\eta_\beta, \vartheta_\beta, \gamma_\beta, \phi_\beta, \theta_\beta$. We can obtain $B_E^*(\alpha, \beta) = 0$ iff $\alpha = \beta$

Proof:

Since each squared deviation in Theorem 1 is greater than or equal to 0. If $B_E^*(\alpha,\beta)=0$, then each squared deviation will be equal to 0. Namely, $((\eta_\alpha)^2-(\eta_\beta)^2)^2=0$, $((\vartheta_\alpha)^2-(\vartheta_\beta)^2)^2=0$, $((\gamma_\alpha)^2-(\gamma_\beta)^2)^2=0$, $(\phi_\alpha-\phi_\beta)^2=0$, $(\sin(\theta_\alpha)-\sin(\theta_\beta))^2=0$, then $\eta_\alpha=\eta_\beta$, $\vartheta_\alpha=\vartheta_\beta$, $\gamma_\alpha=\gamma_\beta$, $\phi_\alpha=\phi_\beta$ and $\theta_\alpha=\theta_\beta$. Hence , we get the results that $\alpha=\beta$.

PROPOSED METHOD-PROBLEM FORMULATION OF HESITANT BIPOLAR INTUITIONISTIC FUZZY MULTIMOORA METHOD

In this section, we proposed a hesitant bipolar intuitionistic fuzzy MULTIMOORA method with hesitant bipolar intuitionistic fuzzy normalized Euclidean distance measure based weights for solving MCDM problems.

Here, we consider the alternative as $A=\{A_1,A_2,\dots,A_m\}$ and the criteria as $C=\{C_1,C_2,\dots,C_n\}$ then the set of all m alternatives and n criteria. The alternative performances are assumed to be $A_i(i=1,2,\dots,m)$ and the criteria performances assumed to be $C_j(j=1,2,\dots,n)$ are measured by a hesitant bipolar intuitionistic fuzzy element.

$$B_{HIFS}^*=\{\langle u,h_{B^*}(u),h'_{B^*}(u)\rangle u\in U\} \quad (3)$$

$$=\left\{\left\langle u,\left(\alpha_{B^*}^P(u),\alpha_{B^*}^N(u)\right),\left(\beta_{B^*}^P(u),\beta_{B^*}^N(u)\right)\right\rangle h_{B^*}(u),h'_{B^*}(u)\in U\right\} \quad (4)$$

Here, we consider two or more decision makers give their point in same value, then the values come only once in the B_{HIFS}^*. where $(k=1,2,\dots,n)$ and n is the length of the $HBIFN$ or the number of decision makers. The hesitant bipolar intuitionistic fuzzy decision matrix given in Table 1.

Table 1: Hesitant Bipolar Intuitionistic Fuzzy Decision matrix

	C_1	C_2	$\cdots$	C_n
A_1	$(\alpha_{B_{11}^*}^P(u),\alpha_{B_{11}^*}^N(u))$, $(\beta_{B_{11}^*}^P(u),\beta_{B_{11}^*}^N(u))$	$(\alpha_{B_{12}^*}^P(u),\alpha_{B_{12}^*}^N(u))$, $(\beta_{B_{12}^*}^P(u),\beta_{B_{12}^*}^N(u))$	$\cdots$	$(\alpha_{B_{1n}^*}^P(u),\alpha_{B_{1n}^*}^N(u))$, $(\beta_{B_{1n}^*}^P(u),\beta_{B_{1n}^*}^N(u))$
A_2	$(\alpha_{B_{21}^*}^P(u),\alpha_{B_{21}^*}^N(u))$, $(\beta_{B_{21}^*}^P(u),\beta_{B_{21}^*}^N(u))$	$(\alpha_{B_{22}^*}^P(u),\alpha_{B_{22}^*}^N(u))$, $(\beta_{B_{22}^*}^P(u),\beta_{B_{22}^*}^N(u))$	$\cdots$	$(\alpha_{B_{2n}^*}^P(u),\alpha_{B_{2n}^*}^N(u))$, $(\beta_{B_{2n}^*}^P(u),\beta_{B_{2n}^*}^N(u))$
A_m	$(\alpha_{B_{m1}^*}^P(u),\alpha_{B_{m1}^*}^N(u))$, $(\beta_{B_{m1}^*}^P(u),\beta_{B_{m1}^*}^N(u))$	$(\alpha_{B_{m2}^*}^P(u),\alpha_{B_{m2}^*}^N(u))$, $(\beta_{B_{m2}^*}^P(u),\beta_{B_{m2}^*}^N(u))$	$\cdots$	$(\alpha_{B_{mn}^*}^P(u),\alpha_{B_{mn}^*}^N(u))$, $(\beta_{B_{mn}^*}^P(u),\beta_{B_{mn}^*}^N(u))$

Determine the hesitant bipolar intuitionistic fuzzy decision matrix

$$\tilde{B}^*=B_{HIFS}^*=\left[h_{B_{ij}^*}\right]_{m\times n}=\left\{\left\langle u,\left(\alpha_{B^*}^P(u),\alpha_{B^*}^N(u)\right),\left(\beta_{B^*}^P(u),\beta_{B^*}^N(u)\right)\right\rangle h_{B^*}(u),h'_{B^*}(u)\in U\right\} \quad (5)$$

3.1 Main Result I

The hesitant bipolar intuitionistic fuzzy element are categorized in two types, one is the beneficial criteria and other is cost criteria. The score values of beneficial and cost criteria for hesitant bipolar intuitionistic fuzzy element represented in R. Also, the score value is calculated by using Wei et al., (2017), its denoted by, $R\left(\oplus_{j\in C_1,C_2,\dots,C_s} h_{B^*}(u)\right)$ and $R\left(\oplus_{j\in C_{s+1},C_{s+2},\dots,C_n} h_{B^*}(u)\right)$ where,

$$R\left(\oplus_{j\in C_1,C_2,\dots,C_s} h_{B^*}(u)\right)=\sum_{j=1}^{s} w_j h_{B^*}(u)\Rightarrow \frac{1}{l}\sum_{j=1}^{s}\left\{\{1-(1-\alpha_{ij})^{w_j}\}-\{\beta_{ij}^{w_j}\}\right\} \quad (6)$$

$$R\left(\oplus_{j\in C_{s+1},C_{s+2},\dots,C_n} h_{B^*}(u)\right)=\sum_{j=s+1}^{n} w_j h_{B^*}(u)\Rightarrow \frac{1}{l}\sum_{j=1+s}^{n}\left\{\{1-(1-\alpha_{ij})^{w_j}\}-\{\beta_{ij}^{w_j}\}\right\} \quad (7)$$

Then, we calculate the score value of the selected alternatives by the using following equation as,

$$Z_i = R\left(\oplus_{j\in C_1,C_2,\ldots,C_s} h_{B^*}(u)\right) - R\left(\oplus_{j\in C_{s+1},C_{s+2},\ldots,C_n} h_{B^*}(u)\right) \qquad (8)$$

$$A^*_{BHIFRS} = \{Z_i | max_i Z_i\} \qquad (9)$$

The ranking order is sorted the alternative over all ratio values in the descending order.

3.2 Main Result II

Next, we consider the HBIF-MULTIMOORA method. By using reference point approach, we determined the optimal objective alternative. The reference point approach which helps to find the ideal alternative and the weighted hesitant bipolar intuitionistic fuzzy decision matrix G_{ij} was calculated first, that is,

$$\tilde{G}_{ij} = w_{ij} * G_{ij} \qquad (10)$$

The benefit criteria reference point values are calculated by following equation

$$Z_j = \left\{\max\{\alpha_{ij}\}, \frac{\min\{\beta_{ij}\}}{\alpha_{ij}}, \beta_{ij} \in h_{B^*_{ij}}\right\} \qquad (11)$$

Next, the cost criteria reference point values are calculated by following equation

$$Z_j = \left\{\min\{\alpha_{ij}\}, \frac{\max\{\beta_{ij}\}}{\alpha_{ij}}, \beta_{ij} \in h_{B^*_{ij}}\right\} \qquad (12)$$

The maximum deviation $d\left[\left(w_j * Z_j\right), \left(w_j * h_{B^*_{ij}}\right)\right]$ from the reference point are calculated by using the normalized Euclidean distance measure formula is given below,

$$d = \sqrt{\frac{1}{n}\sum_{j=1}^{n}\left(\left(\alpha^P_{B^*(u)} - \alpha'^P_{B^*(u)}\right)\right)^2 + \left(\left(\beta^N_{B^*(u)} - \beta'^N_{B^*(u)}\right)\right)^2} \qquad (13)$$

The optimal alternative based on this approach is:

$$A^*_{BHIFRP} = \{A_i | min_i D_i\} \qquad (14)$$

where, $D_i = \max \quad d\left[\left(w_j * Z_j\right), \left(w_j * h_{B^*_{ij}}\right)\right]$, the ranking order is based on an ascending order.

3 Main Result III

The hesitant bipolar intuitionistic fuzzy weighted multiplicative form, The following equation(15) and (16), the overall utility of the i^{th} alternative is obtained as,

$$R\left(\oplus_{j\in C_1,C_2,\ldots,C_s} h_{B^*}(u)\right) = \sum_{j=1}^{s} (h_{B^*}(u))^{w_j} \Rightarrow \frac{1}{l}\sum_{j=1}^{s}\left\{\{\alpha_{ij}^{w_j}\} - \{1-(1-\beta_{ij})^{w_j}\}\right\} \qquad (15)$$

$$R\left(\oplus_{j\in C_{s+1},C_{s+2},\ldots,C_n} h_{B^*}(u)\right) = \sum_{j=1}^{s} (h_{B^*}(u))^{w_j} \Rightarrow \frac{1}{l}\sum_{j=s+1}^{n}\left\{\{\alpha_{ij}^{w_j}\} - \{1-(1-\beta_{ij})^{w_j}\}\right\} \qquad (16)$$

$$V_i = \frac{R\left(\oplus_{j\in C_1,C_2,\ldots,C_s} h_{B^*}(u)\right)}{R\left(\oplus_{j\in C_{s+1},C_{s+2},\ldots,C_n} h_{B^*}(u)\right)} \qquad (17)$$

$$A^*_{BHIFMF} = \{V_i | max_i V_i\} \qquad (18)$$

The ranking order is sorted the alternative in the descending order.

ONSHORE WIND TURBINE MODEL

Today's onshore wind turbines are one of the most economical sources of electricity in most countries around the world, and they are the main driver of the new era of global energy change.

Types of wind turbine:

The size of the wind turbines varies greatly. The length of the rotor blades is a very important factor in determining the amount of electricity that a wind turbine can produce. Small wind turbines that can supply electricity to a home can generate 10 kilowatts (kW) of electricity. Larger operating wind turbines can generate up to megawatts (10 MW) of electricity and larger wind turbines are built. Large wind turbines are often integrated into wind turbines or turbines, which supply electricity to power grids.

Two basic type of wind turbine was used in all over India, they are

- Horizontal-axis turbines
- Vertical-axis

Onshore wind turbine model:

Onshore wind turbines are turbines that stand on the ground and generate electricity using wind. They are usually found in areas with low protection or habitat value.

Onshore wind turbine advantage:

- Onshore wind farm costs are relatively low, which allows for large wind farms.
- The short distance wiring between the wind turbine and the consumer indicates a low voltage drop.
- Wind turbine are installed very quickly. Unlike a nuclear power plant that has been in operation for more than twenty years, a wind turbine can be built in a matter of months.

Onshore wind turbine disadvantage:

- The biggest problem with coastal wind turbine is that many people breathe a sigh of relief.
- Natural barriers such as buildings or mountains.
- The noise generated by wind turbines can be compared to that of a lawn mower, which often causes noise pollution in the surrounding communities.

There are pros and cons to any action. But these types of wind farms never affect the environment. They are planted only in selected non-agricultural areas. This not only saves energy but also enhances the prosperity and economy of the country. Converting ubiquitous air into energy is a great idea. Proper use of such energy is also a good deed. Here we have selected onshore wind farms. There are different types of coastal wind farms, the types of which are capable of discharging large amounts of energy. For our Research, it we have selected a five type of onshore wind farms. Each of them has its own unique ability. They are classified by their power, properties, and characteristics and sorted by the method of multi criteria decision making method. The selected alternatives shown in Fig:1. Our selected onshore wind turbine models are listed below, there are

1. SG 2.6-114 2. SG 2.9-129 3. SG 3.4-132 4. SG 3.4-145 and 5. SG 4.7-155.

This type of wind turbine model is defined with the following criteria and then selected. Each of these has its own unique characteristics. Based on these, onshore wind turbine are selected. The selected wind turbine should be able to provide the best level of energy.The selected criteria are

1. **Environment,**
2. **Technical**
3. **Customer**
4. **Operation and maintenance**
5. **Economic.**

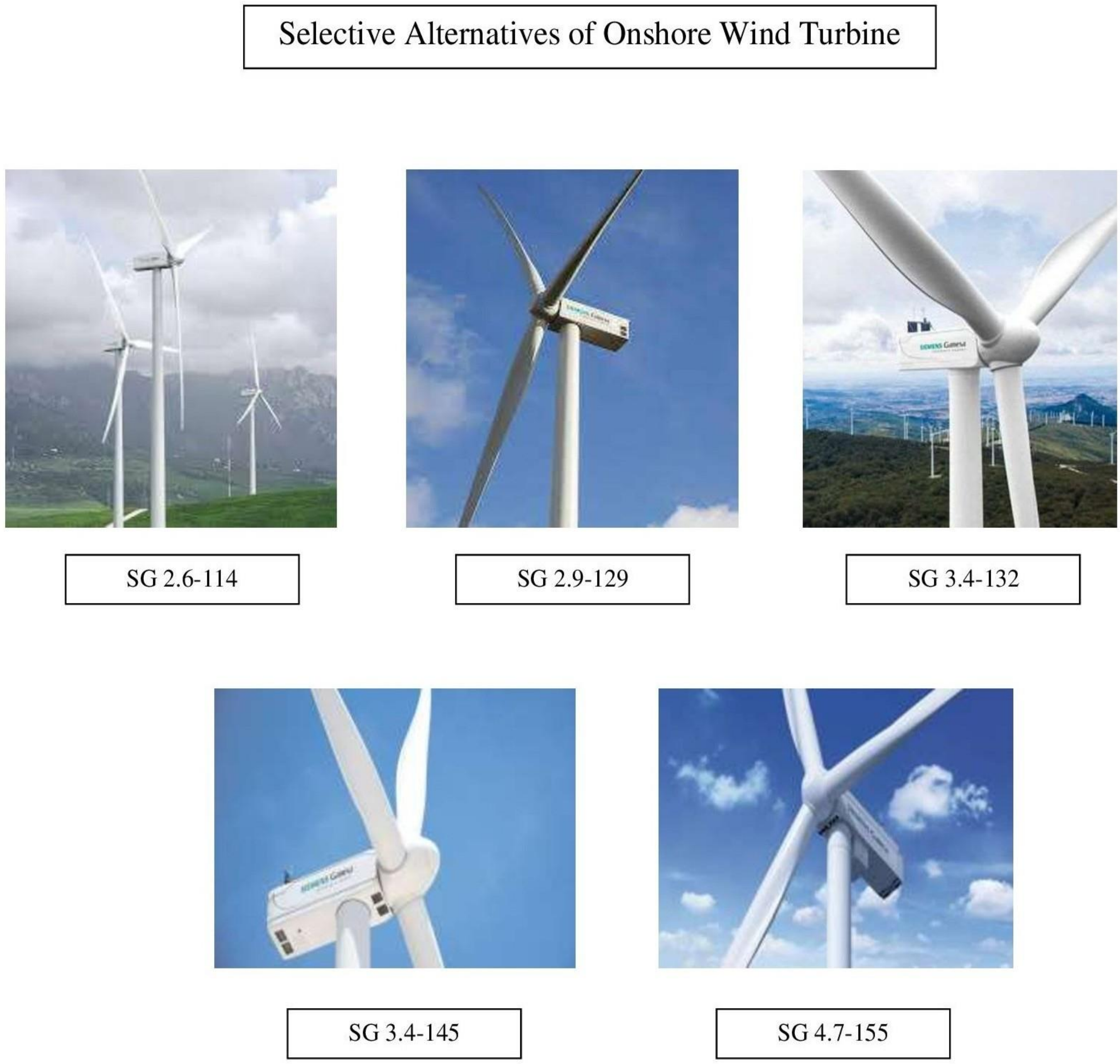

Figure 1: Selected Onshore wind turbine model

ADAPTATION OF PROPOSED METHOD IN SELECTION OF ONSHORE WIND TURBINE MODEL

A wind turbine is the one of the renewable energy resources. We have many types of renewable energy resources but wind is produced the largest amount of renewable energy. The production of renewable energy is differ from one model to another model of wind turbine. A production is based on model, capacity, rated power, generator, voltage, hub height and gearbox etc. A wind turbine selection process includes all the above factors. In this research paper, we selected the onshore wind turbine model selection process for real time application. This illustrative example is suitable for proposed mathematical method. Each wind turbine model has unique characteristics and advantages.

In this section, we selected the MULTIMOORA method to hesitant bipolar intuitionistic Fuzzy set. Here we select the alternatives and criteria based on one decision maker. A wind turbine has so many models but here we choose the particular models to our alternative. The best wind turbine model is selected by the use of the appropriate criteria. Here we select the best and some potential wind turbine model without any harm and produced high level power. For that purpose we proposed Hesitant Bipolar Intuitionistic Fuzzy-MULTIMOORA method. In that, the wind turbine model are the alternatives. The wind turbine installation characteristics are now considered as the criteria.

Table 1: The hesitant bipolar intuitionistic fuzzy decision matrix

Criteria					
Alternatives	C_1	C_2	C_3	C_4	C_5
A_1	{(0.5,0.6,0.7), (-0.3, -0.4, -0.3) (0.8,0.3,0.4), (-0.7,-0.5,-0.6)}	{(0.3,0.4,0.5), (-0.2,-0.3,-0.4), (0.5,0.6,0.7), (-0.1,-0.2,-0.3)}	{(0.4,0.3,0.4), (-0.1,-0.2,-0.3), (0.3,0.4,0.9), (-0.7,-0.4,-0.8)}	{(0.2,0.7,0.9), (-0.1,-0.2,-0.4), (0.9,0.8,0.8), (-0.4,-0.5,-0.6)}	{(0.3,0.6,0.9), (-0.6,-0.9,-0.8), (0.9,0.4,0.3), (-0.3,-0.7,-0.7)}
A_2	{(0.1,0.3,0.5), (-0.6,-0.7,-0.8), (0.1,0.16,0.25), (-0.5,-0.6,-0.7)}	{(0.2,0.7,0.8), (-0.25,-0.65,-0.75), (0.1,0.2,0.3), (-0.3,-0.5,-0.7)}	{(0.2,0.5,0.6), (-0.4,-0.7,-0.9), (0.3,0.6,0.9), (-0.7,-0.5,-0.5)}	{(0.6,0.7,0.7), (-0.1,-0.1,-0.4), (0.5,0.6,0.6), (-0.4,-0.5,-0.5)}	{(0.5,0.6,0.8), (-0.3,-0.4,-0.5), (0.1,0.7,0.9), (-0.8,-0.9,-0.9)}
A_3	{(0.5,0.7,0.8), (-0.5,-0.6,-0.9), (0.1,0.5,0.7), (-0.1,-0.3,-0.5)}	{(0.9,0.8,0.7), (-0.8,-0.6,-0.5), (0.4,0.7,0.73), (-0.35,-0.46,-0.37)}	{(0.15,0.4,0.5), (-0.1,-0.2,-0.3) (0.93,0.82,0.85), (-0.92,-0.76,-0.25)}	{(0.58,0.62,0.88), (-0.41,-0.49,-0.57), (0.357,0.58,0.97), (-0.62,-0.65,-0.73)}	{(0.2,0.4,0.6), (-0.2,-0.3,-0.6), (0.6,0.4,0.3), (-0.555,-0.4,-0.2)}
A_4	{(0.275,0.675,0.6), (-0.1,-0.4,-0.5), (0.7,0.6,0.5), (-0.375,-0.275,-0.4)}	{(0.5,0.8,0.9), (-0.475,-0.7,-0.956), (0.4,0.3,0.2), (-0.311,-0.285,-0.1)}	{(0.7,0.7,0.8), (-0.165,-0.5,-0.78), (0.3,0.4,0.5), (-0.925,0.275,0.375)}	{(0.3,0.4,0.5), (-0.295,-0.375,-0.425) (0.8,0.9,0.9), (-0.125,-0.888,-0.37)}	{(0.4,0.6,0.8), (-0.9,-0.925,-0.975), (0.6,0.7,0.8), (-0.511,-0.6,-0.7)}
A_5	{(0.925,0.75,0.665), (-0.6,-0.7,-0.5), (0.525,0.725,0.885), (-0.4,-0.5,-0.7)}	{(0.3,0.7,0.9), (-0.225,-0.675,-0.895), (0.2,0.6,0.9), (-0.115,-0.535,-0.88)}	{(0.2,0.33,0.44), (-0.11,-0.22,-0.33), (0.77,0.66,0.55), (-0.66,-0.55,-0.5)}	{(0.21,0.43,0.66), (-0.12,-0.93,-0.95), (0.65,0.7,0.8), (-0.35,-0.66,-0.99)}	{(0.7,0.7,0.8), (-0.5,-0.7,-0.95), (0.3,0.7,0.9), (-0.2,-0.6,-0.8)}

Our proposed hesitant bipolar intuitionistic fuzzy set is extension set of hesitant set. Nowadays hesitant set has many extension, here we select the set hesitant bipolar intuitionistic fuzzy set, this set having positive and negative membership degree. The hesitant bipolar intuitionistic fuzzy decision values are shown in following Table 2. The decision matrix values are described by the decision maker. The table value is considered for both membership positive and negative values and non-membership positive and negative values. The bipolar set is used to give clear and unambiguous membership and non-membership values. Its helps to take a best decision.

First, we want to calculate the score function of the hesitant bipolar intuitionistic fuzzy set based on the paper wei et al.,(2017). The score function of membership and non-membership function is calculated by using following equation, that is,

$$S(\hat{h}_i) = \frac{1}{\#\hat{h}_i}\sum_{i=1}^{\#\hat{h}_i} \frac{1+\alpha_i^P+\alpha_i^N}{2} \quad (19)$$

$$S(\hat{h}_i) = \frac{1}{\#\hat{h}_i}\sum_{i=1}^{\#\hat{h}_i} \frac{1+\beta_i^P+\beta_i^N}{2} \quad (20)$$

The score function of the membership and non-membership function values are shown in below.

	C_1	C_2	C_3	C_4	C_5
A_1	{0.63, 0.45}	{0.55, 0.7}	{0.58, 0.45}	{0.68, 0.67}	{0.42, 0.48}
A_2	{0.3, 0.285}	{0.51, 0.35}	{0.38, 0.52}	{0.73, 0.55}	{0.62, 0.35}
A_3	{0.5, 0.57}	{0.58, 0.61}	{0.58, 0.61}	{0.6, 0.48}	{0.51, 0.52}
A_4	{0.59, 0.63}	{0.5, 0.53}	{0.63, 0.43}	{0.52, 0.7}	{0.33, 0.55}
A_5	{0.59, 0.58}	{0.51, 0.53}	{0.56, 0.55}	{0.38, 0.53}	{0.51, 0.55}

Here, the criteria are categorized in two part one is benefit criteria and another one is cost criteria. MULTIMOORA method is described by the use of benefit and cost criteria. The list of benefit criteria is environment and economic.The list of cost criteria is technical, customer then operation and maintains. Benefit criteria has separate calculation and cost criteria has separate calculation.

Every multi-criteria decision making method has unique procedure and advantages. Mainly, multi criteria decision making method divided in two parts one is weight finding method and ranking methods. The weight value of the selected problem is piller of our multi-criteria techniques. The first procedure of multi criteria decision making methods is started with this weight finding method. So many weight finding techniques are used in multi-criteria decision making method. But, here we consider the weight value. The weight values are $W_1 = 0.2$, $W_2 = 0.4$, $W_3 = 0.5$, $W_4 = 0.6$ and $W_5 = 0.8$. The weight vector is denoted as $\left(W_j = W_1, W_2, W_3, W_4, W_5\right)$.

The hesitant decision matrix should be used for evaluating the alternatives which can help decision makers for expressing their hesitation thoughts and opinion clearly. Now, we started the our proposed mathematical model for hesitant bipolar intuitionistic fuzzy set. Basically, MULTIMOORA method divided in three category, that is ratio system, reference point and multiplicative form. Here, we develop these to our proposed mathematical model.

•***The hesitant bipolar intuitionistic fuzzy ratio system:***

The hesitant bipolar intuitionistic fuzzy elements are added for the benefit criteria and are the subtracted for the cost criteria. The benefit and cost criteria score values are given in Table.3 and the benefit and cost criteria score values are shown in Fig:2. Further, the benefit and cost criteria score values are calculated by using equations(6)&(7).

Table 3: Approach for ratio system score value

Alternatives	Benefit criteria score value	Cost criteria score value
A_1	-0.4374	-0.4012
A_2	-0.3010	-0.3573
A_3	-0.4610	-0.3925
A_4	-0.5471	-0.4162
A_5	-0.4592	-0.4554

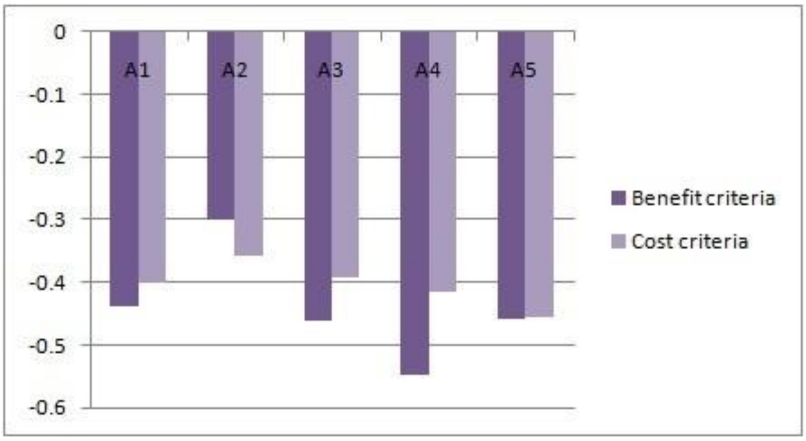

Figure 2: Score value of ratio system

Now, we determine the ratio score values of the alternative using the equation (8).

$$Z_i = \{-0.0362, 0.0563, -0.0685, -0.1309, -0.00380\}$$

The ranking order of the alternatives are sorted in descending order.

$$A^*_{BHIFRS} = \{0.0563, -0.0038, -0.0362, -0.0685, -0.1309\}$$

- ***The hesitant bipolar intuitionistic fuzzy reference point approach:***

In this part we proposed our mathematical model into MULTIMOORA method. The second part of this section is the hesitant bipolar intuitionistic fuzzy-MULTIMOORA method. The best alternatives are selected by the reference point value approach. The reference point approach which helps to find the ideal alternative and the weighted hesitant bipolar intuitionistic fuzzy decision matrix. The calculation of weighted matrix followed by equation(10). In that equation G_{ij} represents the score value of membership and non-membership values. The weighted hesitant bipolar intuitionistic fuzzy values are given below,

	C_1	C_2	C_3	C_4	C_5
A_1	{0.126, 0.09}	{0.22, 0.28}	{0.29, 0.225}	{0.408, 0.402}	{0.336, 0.384}
A_2	{0.06, 0.057}	{0.204, 0.14}	{0.19, 0.26}	{0.438, 0.33}	{0.496, 0.28}
A_3	{0.1, 0.114}	{0.232, 0.244}	{0.29, 0.305}	{0.36, 0.288}	{0.408, 0.416}
A_4	{0.118, 0.126}	{0.2, 0.212}	{0.315, 0.215}	{0.312, 0.42}	{0.264, 0.44}
A_5	{0.118, 0.116}	{0.204, 0.212}	{0.28, 0.275}	{0.228, 0.318}	{0.408, 0.44}

The benefit criteria reference point values are calculated by using the equation(11) and the cost criteria reference point values are calculated by using the equation(12).

The maximum deviation $d\left[\left(w_j * Z_j\right), \left(w_j * h_{B^*_{ij}}\right)\right]$ from the reference point are calculated by using the normalized Euclidean distance measure formula is given in equation(13). The optimal alternative based on this approach that is given in equation(14).

The best alternative values are give below,

$$D_1 = \{0.2605\}, D_2 = \{0.2743\}, D_3 = \{0.0867\}, D_4 = \{0.2292\}, D_5 = \{0.1176\}$$

where, the selected alternative ranking order based ascending order.

$$A^*_{BHIFRP} = \{0.0867, 0.1176, 0.2292, 0.2605, 0.2743\}$$

- ***The hesitant bipolar intuitionistic fuzzy weighted full multiplicative form:***

The hesitant bipolar intuitionistic fuzzy elements are divided in two category, one is benefit criteria and cost criteria. In this part the elements are multiplied by benefit criteria and the elements are divided by cost criteria.

Table 4: Approach for multiplicative form score value

Alternatives	Benefit criteria score value	Cost criteria score value
A_1	0.4456	0.4053
A_2	0.5559	0.4540
A_3	0.4273	0.4293
A_4	0.3297	0.4023
A_5	0.4260	0.3726

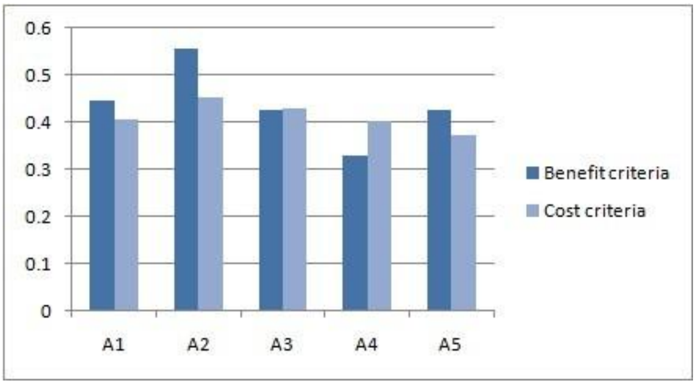

Figure 3: Score value of multiplicative form

The benefit criteria multiplicative form is calculated by using the equation(15) and the cost criteria multiplicative form is calculated by using equation(16). The value of benefit and cost criteria multiplicative form score function is given in Table.4 and the value of benefit and cost criteria multiplicative form score function is shown in Fig:3. The multiplicative form is based on overall utility of the i^{th} alternative. The utility of i^{th} alternative is calculated by using the equation(17).

$V_1 = \{1.0994\}, V_2 = \{1.2244\}, V_3 = \{0.9953\}, V_4 = \{0.8195\}, V_5 = \{1.1433\}$.The best alternative in the multiplicative form is,

$$A^*_{BHIFMF} = \{1.2244,1.1433,1.0994,0.9953,0.8195\}$$

The alternatives are ranked in the descending order. The hole ranking system is shown in Table.5 and result shown in Fig:4.

Table 5: Ranking the alternatives for onshore wind turbine model

Methods	A_1	A_2	A_3	A_4	A_5	Ranking
Ratio system	-0.0362	0.0563	-0.0685	-0.1309	-0.0038	$A_2 > A_5 > A_1 > A_3 > A_4$
Reference point approach	0.2605	0.2743	0.0867	0.2292	0.1176	$A_3 > A_5 > A_4 > A_1 > A_2$
Multiplicative form	1.0994	1.2244	0.9953	0.8195	1.1433	$A_2 > A_5 > A_1 > A_3 > A_4$

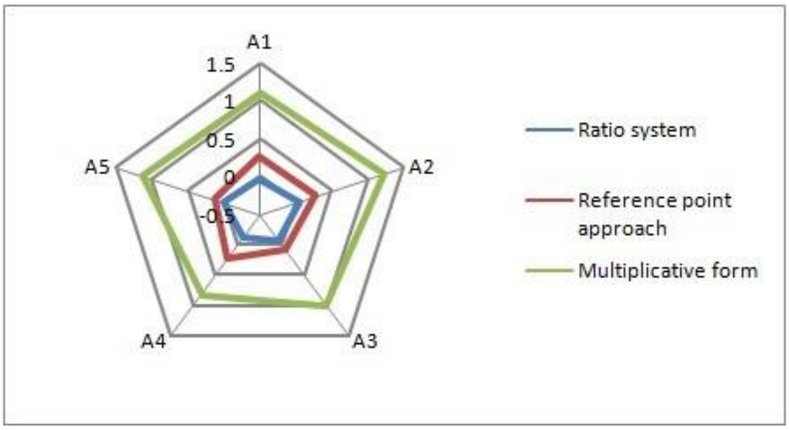

Figure 4: Ranking the alternatives for onshore wind turbine model

From the table.5 result we observed A_5(SG 4.7-155) showed the best performance of all the turbines. The alternative A_2 varies in all the three methods (ratio system approach, reference point approach, full multiplicative form). Thus, A_2 cannot be predicted as a best alternative. Instead, the alternative A_5 achieves the best balance between hub height, wind speed, and rotor diameter. So, we conclude that Alternative A_5 is best onshore wind turbine model. Because, in ratio system approach alternative A_5 is the best alternative. Then, according to the ratio system approach, reference point approach and multiplicative form approach the second position to alternative A_5. So maximum ranking possibility is alternative A_5(SG 4.7-155).

COMPARISON AND SENSITIVITY ANALYSIS

In this section, we declared the comparison of our proposed mathematical method. Multi criteria decision making method have many methods, but here we select the ARAS method. This ARAS method also defined both beneficial and non-beneficial of membership and non-membership values. The positive and negative value of membership is considered and also the positive and negative value of non-membership is considered. Here, the hesitant bipolar intuitionistic fuzzy-ARAS method also our proposed work. The comparison method and our proposed method both have their own unique characteristic. Both method mainly perform with benefit and cost criteria. The ranking based on the degree of the alternative utility degree. The comparison result given in Table.6 and the comparison result shown Fig:5. This comparison results gives the almost same result of our proposed work.

Table 6: The comparison result

Methods	A_1	A_2	A_3	A_4	A_5	Ranking
Ratio system	-0.0362	0.0563	-0.0685	-0.1309	-0.0038	$A_2 > A_5 > A_1 > A_3 > A_4$
Reference point approach	0.2605	0.2743	0.0867	0.2292	0.1176	$A_3 > A_5 > A_4 > A_1 > A_2$
Multiplicative form	1.0994	1.2244	0.9953	0.8195	1.1433	$A_2 > A_5 > A_1 > A_3 > A_4$
ARAS Method	0.5073	0.8549	-0.1231	-0.6462	0.5281	$A_2 > A_5 > A_1 > A_3 > A_4$

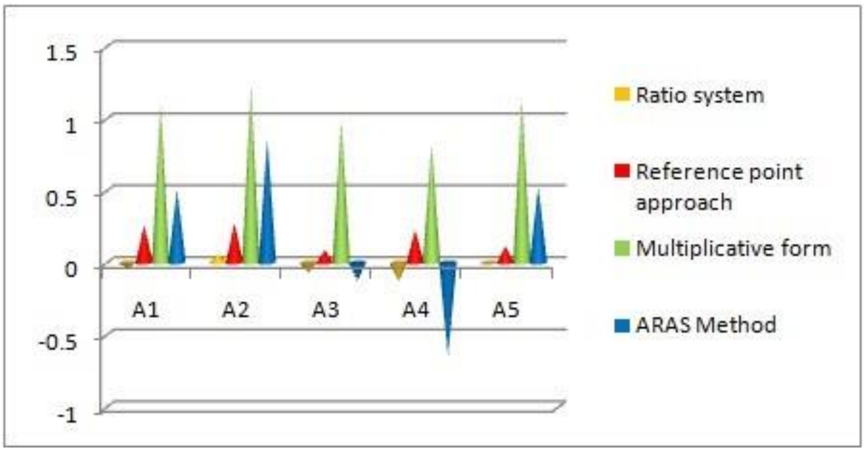

Figure 5: The comparison result

The sensitivity analysis already done. Because our proposed method have three different ordering method. That is ratio system, reference point approach and multiplicative form. The ranking process based on this three ordering methods, and then uses dominance theory to combine the three ranking into the single ranking. Our proposed method hesitant bipolar intuitionistic fuzzy -MULTIMOORA method does not any single part. The method having three different mathematical part, then the ranking results are combined into one ranking process by the use of dominance theory. The proposed method give the best result and it should helps to select the best alternative.

CONCLUSION

In general, the country's economy starts with the small resources around us. Nature around us has given us a beautiful setting. We turn it right and use it for our daily needs and the development of the country. There are five types of famines around us. Each offers a variety of resources and energy. We are forced to use it properly. The development of the country is dependent on those energies. In this paper, we recommended the onshore wind turbine model for best energy deliver to the country. The machine depends upon the category of onshore wind turbine model to improve our energy resources . The wind turbine model are described their own characteristic and specialty.

In this paper we develop a new method and extension of hesitant fuzzy set. The set hesitant bipolar intuitionistic fuzzy set is a extension set of hesitant set. The bipolar set deals with membership function of positive and negative value. Its exactly extension set of intuitionistic fuzzy set. Here, we extent the hesitant bipolar set to hesitant bipolar intuitionistic fuzzy set. In this set deals with both membership and non-membership function, and also their positive and negative values. Moreover the multi criteria decision making method MULTIMOORA which is proposed to our extension set of hesitant bipolar intuitionistic fuzzy-MULTIMOORA method. The method not only having one mathematical part, its having three part of mathematical model, then dominance theory also perform with this method. The proposed method have many advantages from the abilities of hesitant bipolar intuitionistic fuzzy sets to predict uncertainty information given by the experts in the onshore wind turbine model. The hesitant bipolar intuitionistic fuzzy-MULTIMOORA methods considers three different techniques to analyzing the selected alternative. Here, the alternative A_5 (SG 4.7-155) is best alternative.

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