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RESEARCH ARTICLE

ALGORITHMS AND OPTIMAL CHOICE FOR POWER PLANTS BASED ON M-POLAR FUZZY SOFT SET DECISION MAKING CRITERIONS

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ABSTRACT

Aim: The countries run to the energy, in this work we will put a suitable power plant. Therefore, we will develop a knowledge-based system in power plant to helps designers to find ways to improve the performance of a system in a many way. Methods: We extend the fuzzy soft set theory to fuzzy soft expert system and using FORTRAN program to put models to state suitable power plants stations. The way, (1) a fuzzication in which we transform real-valued inputs into fuzzy sets (2) take the reality values of Fossil power plant station, Nuclear power plant station, Wind power plant station, Solar power plant station, Hydro power plant station, Wave power plant station, Tidal range power plant, Biogas power plant, Coal under effective Renewable, Visual impact, Capital cost, Maintenance cost, Environmental impact, Green gas emissions, Implementation time, Cost Cent/Kwh, Danger of series accidents and Waste problem by use m-polar fuzzy soft set by using a technic transform to fuzzy soft expert system, (3) compute the corresponding resultant fuzzy soft set by using a combinations the parameters and talked the decision by algorithm to get the output data. Results: we shown the economic optimization of the power plants Fossil power plant station, Nuclear power plant station, Wind power plant station, Solar power plant station, Hydro power plant station, Wave power plant station, Tidal range power plant, Biogas power plant, Coal, under effective Renewable , Visual impact, Capital cost, Maintenance cost, Environmental impact, Green gas emissions, Implementation time, Cost Cent/Kwh, Danger of series accidents and Waste problem by use m-polar fuzzy soft set. Conclusion: In this work the energy from in the power plants is calculated based on model in m-polar fuzzy sets to determine the true system. The ways, first algorithms to state suitable power plants stations are introduced. In addition, we shown the economic optimization of the power plants Fossil power plant station, Nuclear power plant station, Wind power plant station, Solar power plant station, Hydro power plant station, Wave power plant station, Tidal range power plant, Biogas power plant, Coal, under effective Renewable , Visual impact, Capital cost, Maintenance cost, Environmental impact, Green gas emissions, Implementation time, Cost Cent/Kwh, Danger of series accidents and Waste problem by use m-polar fuzzy soft set.

KEYWORDS

Energy, Efficiency, Power Plants, Energy Losses, Optimization, Coal, AMS Classification: 03E72, 47S40.

1. INTRODUCTION

All power plants are created with the same goal: to produce electric power as efficiently as possible. However, as technology has evolved, the sources of energy used in power plant has evolved as well (Weisman and Joel, 1985). The introduction of more renewable/sustainable forms of energy has caused an increase in the improvement and creation of certain power plant (Weisman and Joel, 1985). Hydro power plant electric power plant generates power using the force of water to turn generators. They can be categorized into three different types; impoundment, diversion and pumped storage (Water Power Technologies offices, 2018). Thermal power plant are split into two different categories; those that create electricity by burning fuel and those that create electricity via prime mover. Equipment as well as the calculations (Soaknu, 2018). Solar power plant power plant derive their energy from sunlight, which is made accessible via photovoltaics (PV's). Photovoltaic panels, or solar power plant panels, are constructed using photovoltaic cells which are made of silica materials that release electrons when they are warmed by the thermal energy of the sun (Wagner and Vivian, 2018). Wind power plant power plant, also known as Wind power plant turbines, derive their energy from the Wind power plant by connecting a generator to the fan blades and using the rotational motion caused by Wind power plant to power the generator (Sokanu, 2018). Nuclear power plant engineers develops and research methods, machinery and systems concerning radiation and energy in subatomic levels.

The remainder of this paper is organized as follows:, firstly in sections 1 and 2 introduced some background of power plants and m-polar fuzzy sets, show and analyses the types of the Fossil power plant station, Nuclear power plant station, Wind power plant station, Solar power plant station, Hydro power plant station, Wave power plant station, Tidal range power plant, Biogas power plant, Coal, under effective Renewable , Visual

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impact, Capital cost, Maintenance cost, Environmental impact, Green gas emissions, Implementation time, Cost Cent/Kwh, Danger of series accidents and Waste problem. Also, in these sections explained soft set, fuzzy soft set and fuzzy polar soft set. In section 3 Analyses power plants and applications based on fuzzy sets and 2-polar fuzzy soft set decision making criterion are studied, in Problem Statement introduced algorithms and optimal choice for power plants based on 2-polar fuzzy soft set decision making criterions. In section 4, we development the studied to state a decision making to 3-polar Fuzzy soft set by take three measures. Also, the algorithms and optimal choice for power plants based on 2-polar fuzzy soft set decision making criterions are introduced. All results take by using the reality values for power plants, experimental examples with reality values is discussed to show the validity of the proposed concept. We used the scientific work places and excel programs in calculations. In section 5, Conclusion.

2. PRELIMINARIES

2.1 Soft sets and m-polar fuzzy soft set

The results of these analyses are studied by the proposed criterion, and a fuzzy soft set decision is reached by taking into account the values of all the analysis on the different S-boxes. On the other hand, Majumdar and Samanta presented the concept of generalized fuzzy soft sets, followed by studies on generalized multi-fuzzy soft sets, generalized intuitionistic fuzzy soft sets, generalized fuzzy soft expert set, and generalized interval valued fuzzy soft set (Majumdar and Samanta, 2010; Pal and Dey, 2015; Agarwal et al., 2013; Khalil, 2015; Hazaymeh et al., 2012; Alkhazaleh and Salleh, 2012). Recently, Zhu and Zhan proposed the concept of fuzzy parameterized fuzzy soft sets, along with decision making (Zhu and Zhan, 2016). A group researcher presented a novel decision-making approach based on intuitionistic fuzzy soft sets (Zhao et al., 2017). Deli [14] introduced the notion of interval-valued neutrosophic soft sets and its decision making (Deli, 2017). A group researchers extended models include N-soft sets, and hybrid models include interval-valued fuzzy soft sets and (dual) probabilistic soft sets (Fatimah et al., 2018; Fatimah et al., 2019). In view of these developments, we will highlight the notion of possibility m-polar fuzzy soft set, which can be seen as a new possibility m-polar fuzzy soft model. Let E be a non-empty finite set of attributes (parameters, characteristics or properties) which the objects in U possess and let $P(U)$ denote the family of all subsets of U. Then a soft set is defined with the help of a set-valued mapping as given below:

Definition 2.1.1 (Molodtsov) A pair (F, A) is called a soft set over U, where $A \subseteq E$ and $F: A \to P(U)$ is a set-valued mapping. In other words, a soft set (F, A) over U is a parameterized family of subsets of U where each parameter $e \in A$ is associated with a subset $F(e)$ of U (Fatimah et al., 2019). The set $F(i)$ contains the objects of U having the property i and is called the set of i-approximate elements in (F, A).

Definition 2.1.2 Elements $([0,1]^m)^X$ the set of all mappings from X to $[0,1]^m$ with the point – wise order are called an m-polar fuzzy sets, such that m is an arbitrary cardinality (Chen et al., 2014; Koczy, 1982). A subset $\mathcal{A} = \{\mathcal{A}_k\}_{k\in K} \subseteq ([0,1]^m)^X$ (or a mapping $\mathcal{A}: K \to ([0,1]^m)^X$ satisfying $\mathcal{A}(k) = \mathcal{A}_k \ \ \forall\, k \in K$) is called an an m-polar fuzzy soft set on X.

Example 2.1.1 Let $X = \{a_1, a_2\}$ be a two element set, $I = \{i_1, i_2, i_3\}$ be a four element set, the 2-polar fuzzy soft set $\mathcal{A} \in [([0,1]^2)^X \times ([0,1]^2)^X]^I$ defined by:

$$\mathcal{A}(a_1) = \left\{\frac{(0.6733,0.4325)}{i_1}, \frac{(0.2455,0.1985)}{i_2}, \frac{(0.8771,0.4765)}{i_3}\right\}$$

$$\mathcal{A}(a_2) = \left\{\frac{(0.9325,0.6325)}{i_1}, \frac{(0.7342,0.5675)}{i_2}, \frac{(0.0815,0.0421)}{i_3}\right\}$$

Definition 2.3 Let $\{\mathcal{A}_k\}_{k\in K} \in [([0,1]^m)^X]^{I_k}$. Define m-polar fuzzy soft sets $\vee\{\mathcal{A}_k\}_{k\in K} = \max\{\mathcal{A}_k\}_{k\in K}$ and $\wedge\{\mathcal{A}_k\}_{k\in K} = \min\{\mathcal{A}_k\}_{k\in K}$.

3. ANALYSES OF POWER PLANTS

In the next table explains the Analyses of power plants and the degree of all to state the optimal power plant, this degree is reality degree. Table 1, figures 1 and 2. Explains Analyses of power plants. (In table 1, follows table 1, figure 1 and follows 1 figure, we analysis a power plants from reality values of the stations)

Table 1: Analyses of power plants

Comparison approach	Renewable	Visual impact	Capital cost	Maintenance cost	Environmental impact
Fossil	0.0	0.9	0.3	0.9	0.9
Nuclear power plant	0.0	0.9	0.5	0.9	0.9
Wind power plant	0.9	0.1	0.9	0.3	0.5
Solar power plant	0.9	0.0	0.9	0.3	0.3
Hydro power plant	0.9	0.9	0.9	0.3	0.5
Wave power plant	0.9	0.0	0.9	0.3	0.3
Tidal range power plant	0.9	0.9	0.9	0.5	0.5
Biogas power plant	0.5	0.5	0.6	0.5	0.4
Coal	0.1	0.8	0.5	0.6	0.9

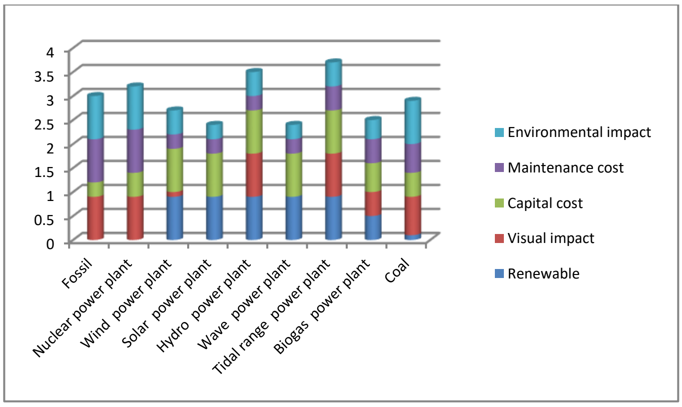

Figure 1: Analyses of power plants

Follows Table 1 Analyses of power plants

Comparison approach	Green gas emissions Gco2e/Kwh	Implementation time	Cost Cent/Kwh	Danger of series accidents	Waste problem
Fossil	6.0	18.0	11.5	0.6	0.5
Nuclear power plant	66.0	60.0	15.3	0.8	0.9
Wind power plant	10.0	20.0	8.9	0.4	0.3
Solar power plant	6.0	10.0	12.7	0.3	0.3
Hydro power plant	6.0	20.0	7.5	0.2	0.2
Wave power plant	7.0	22.0	8.5	0.7	0.4
Tidal range power plant	7.0	20.0	9.5	0.3	0.4
Biogas power plant	11.0	20.0	8.6	0.3	0.3
Coal	960.0	1.0	15.6	0.5	0.9

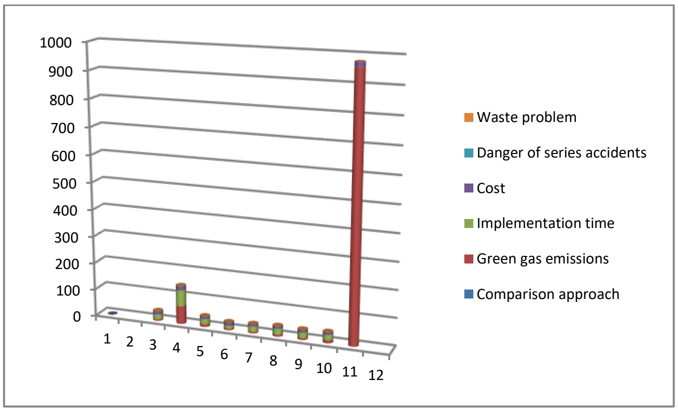

Figure 2: Explains the data of the power plants

The degree in the table 1 means, (explained in the following table2 and follows 2)

Table 2: Explains the analysis of power plants by different technique

Comparison approach	Renewable	Visual impact	Capital cost	Maintenance cost	Environmental impact
Fossil	No	Yes	Low	High	High
Nuclear power plant	No	Yes	Medium	High	High
Wind power plant	Yes	No	High	Low	Medium
Solar power plant	Yes	No	High	Low	Low
Hydro power plant	Yes	Yes	High	Low	Medium
Wave power plant	Yes	No	High	Low	Low
Tidal range power plant	Yes	Yes	High	Medium	Medium

Follows Table 2 explains the analysis of power plants by different technique

Comparison approach	Green gas emissions Gco_2e/Kwh	Implementation time	Cost Cent/Kwh	Danger of series accidents	Waste problem
Wind power plant	9-10	Minimal	8.9	Minimal	Minimal
Biogas power plant	11	Low	8.6	Low	Minimal
Solar power plant	6	Low	12.7	Low	Minimal
Coal	960-1050	High	10.6-17.3	Moderate	high
Nuclear power plant power plant	66	Very high (<10 years)	15.3	Very high	Very high

Follows Table 2 explains the analysis of power plants by different technique

Comparison approach	Hydro power plant	Thermal	Nuclear power plant power plant
Investment per Kw	High	Low	Very High
Fuel cost	Very High	Low	Very High
Maintenance cost & operation	Low	High	Very High
Energy cost	Low	High	Very High
Transmission line	Long	Short	Short
Implementation time	Long	Lower	Long
Life time	Long	Small	Medium
Job generation	High	Lower	Medium
Environmental impact	No	High	None
Green gas emissions	Lower	Very High	None
import	Low	High	Medium
Return rate	Low	High	Low

3.1 Optimal alternative for power plants by m-polar fuzzy soft set

We chose the power plants (Fossil power plant, Nuclear power plant station, Wind power plant station, Solar power plant station, Hydro power plant station, Wave power plant station, Tidal range power plant, Biogas power plant, Coal). Our aims is the examine the optimal alternative for suitability of power plants. Renewable, Visual impact, Capital cost, Maintenance cost, Environmental impact, Green gas emissions, Implementation time, Cost Cent/Kwh, Danger of series accidents and Waste problem plays the main role of state the optimal alternative for suitability of power plants. By use m-polar fuzzy soft set so.

Assume that we analyses power plants (Fossil power plant, Nuclear power plant station, Wind power plant station, Solar power plant station, Hydro power plant station, Wave power plant station, Tidal range power plant, Biogas power plant, Coal). With the following properties Renewable, Visual impact, Capital cost, Maintenance cost, Environmental impact, Green gas emissions, Implementation time, Cost Cent/Kwh, Danger of series accidents and Waste problem. Our aim how to choose the best station under this condition. So,

Let the set $X = \{x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9\}$ express about the power plants (Fossil power plant, Nuclear power plant station, Wind power plant station, Solar power plant station, Hydro power plant station, Wave power plant station, Tidal range power plant, Biogas power plant, Coal) with the parameters $I = \{i_1, i_2, i_3, i_4, i_5, i_6, i_7, i_8, i_9, i_{10}\}$ where i_1 stands for Renewable, i_2 stands for Visual impact, i_3 stands for Capital cost, i_4 stands for Maintenance cost, i_5 stands for Environmental impact, i_6 stands for Green gas emissions, i_7 stands for Implementation time, . i_8 Stands for Cost Cent/Kwh, i_9 stands for Danger of series accidents, i_{10} stands for Waste problem these parameters are important with degree. These parameters are important with degree.

Now, we will construct an algorithm for a decision making problem as indicated below.

Algorithm 1: Using 3-polar Fuzzy soft set.

Step 1. State $\mathcal{A} \in [([0,1050]^3)^I]^X$.

Step 2. Compute $p_k \circ \bar{\mathcal{A}} = 1050 \wedge \sum_{i \in I} p_k \circ \mathcal{A}(x)$ $(\forall\, x \in X)$, where $p_k\colon [0,1050]^3 \to [0,1050]$ is the k-the projection (k =1,2,3).

Step 3. Compute $\bar{\mathcal{A}} \in ([0,1050]^3)^X$.

Step 4. Put a suitable weigh vector $e^{\rightarrow} = (1.00, -10.00, -100.00)^T$. And compute the score $S(x) = \mathcal{A}(x)e^{\rightarrow}$ for each $x \in X$.

Step 5. The maximal value of $S(\tilde{x})$ state the optimal alternative for

suitability of power plants based on 3-polar Fuzzy soft set. Table 3: The important values of renewable, visual impact, Capital cost, maintenance cost, environmental impact, green gas emissions, implementation time, cost Cent/Kwh, danger of series accidents and Waste problem. (Table3 and figure 3, explained The important values of renewable, visual impact, Capital cost, maintenance cost, environmental impact, green gas emissions, implementation time, cost Cent/Kwh, danger of series accidents and Waste problem)

Table 3: The important values of renewable, visual impact, Capital cost, maintenance cost, environmental impact, green gas emissions, implementation time, cost Cent/Kwh, danger of series accidents and Waste problem.

Renewable	Visual impact	Capital cost	Maintenance cost	Environmental impact	Green gas emissions Gco2e/Kwh	Implementation time	Cost Cent/Kwh	Danger of series accidents	Waste problem
1.0	0.3	0.5	0.5	0.2	10.0	100.0	8.3	0.2	0.3

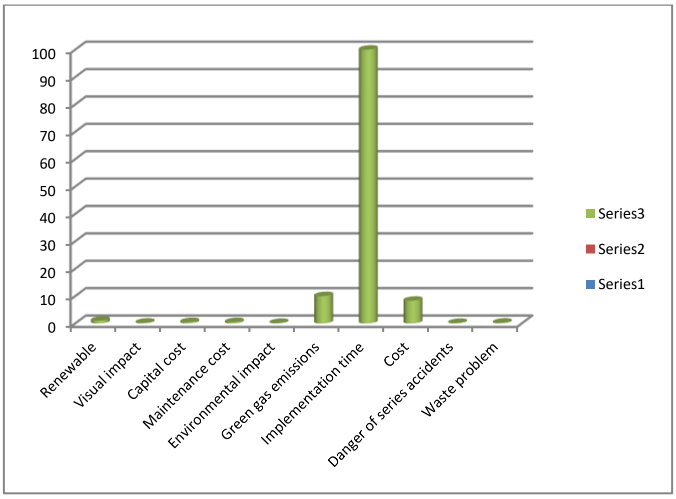

Figure 3: The important values of renewable, visual impact, Capital cost, maintenance cost, environmental impact, green gas emissions, implementation time, cost Cent/Kwh, danger of series accidents and Waste problem.

Tree of experts in power plants gives the degree of equality of the alternative $I = \{i_1, i_2, i_3, i_4, i_5, i_6, i_7, i_8, i_9, i_{10}\}$ for the power plants. And the data provided by the committee for decision-making use is the following 3-polar fuzzy soft set $\mathcal{A} \in [([0,1050]^3)^I]^X = [([0,1050]^3)^X]^I = ([0,1050]^3)^{I\times X} = ([0,1050]^3)^{X\times I}$ defined by:

$$\mathcal{A}(x_1) = \left\{ \frac{(0.0,0.0,0.0)}{i_1}, \frac{(0.8455,0.9985,0.9987)}{i_2}, \frac{(0.3771,0.4765,0.3654)}{i_3}, \frac{(0.917,0.986,0.986)}{i_4}, \frac{(0.8334,0.9672,0.8198)}{i_5}, \frac{(7.6733,7.4325,6.7325)}{i_6}, \frac{(16.6733,19.4325,18.7325)}{i_7}, \frac{(12.6733,10.4325,11.73)}{i_8}, \frac{(0.687,0.79,0.7325)}{i_9}, \frac{(0.488,0.325,0.5325)}{i_{10}} \right\}$$

$$\mathcal{A}(x_2) = \left\{ \frac{(0.0,0.0,0.0)}{i_1}, \frac{(0.8455,0.9985,0.9987)}{i_2}, \frac{(0.2771,0.4765,0.3654)}{i_3}, \frac{(0.817,0.886,0.986)}{i_4}, \frac{(0.9334,0.9672,0.9198)}{i_5}, \frac{(67.6733,70.4325,66.7325)}{i_6}, \frac{(60.6733,59.4325,58.7325)}{i_7}, \frac{(13.6733,15.4325,14.73)}{i_8}, \frac{(0.87,0.9,0.7325)}{i_9}, \frac{(0.988,0.925,0.8325)}{i_{10}} \right\}$$

$$\mathcal{A}(x_3) = \left\{ \frac{(0.934,0.932,0.964)}{i_1}, \frac{(0.145,0.095,0.077)}{i_2}, \frac{(0.8771,0.9765,0.8654)}{i_3}, \frac{(0.2917,0.3986,0.1786)}{i_4}, \frac{(0.534,0.5272,0.5198)}{i_5}, \frac{(8.07,9.2325,10.7325)}{i_6}, \frac{(19.6733,16.4325,20.7325)}{i_7}, \frac{(8.6733,8.4325,7.70)}{i_8}, \frac{(0.433,0.4325,0.325)}{i_9}, \frac{(0.2733,0.4325,0.3000)}{i_{10}} \right\}$$

$$\mathcal{A}(x_4) = \left\{ \frac{(0.9340,0.9325,0.964)}{i_1}, \frac{(0.0,0.0,0.0)}{i_2}, \frac{(0.8771,0.9765,0.8654)}{i_3}, \frac{(0.2917,0.3986,0.2786)}{i_4}, \frac{(0.334,0.272,0.3198)}{i_5}, \frac{(7.07,6.2325,6.7325)}{i_6}, \frac{(10.6733,10.4325,10.7325)}{i_7}, \frac{(12.6733,12.4325,12.70)}{i_8}, \frac{(0.333,0.3325,0.325)}{i_9}, \frac{(0.3733,0.3325,0.3000)}{i_{10}} \right\}$$

$$\mathcal{A}(x_5) = \left\{ \frac{(0.9340,0.9325,0.964)}{i_1}, \frac{(0.8771,0.9765,0.9654)}{i_2}, \frac{(0.8771,0.9765,0.8654)}{i_3}, \frac{(0.2917,0.3986,0.2786)}{i_4}, \frac{(0.534,0.572,0.5198)}{i_5}, \frac{(7.07,6.2325,6.7325)}{i_6}, \frac{(20.6733,20.4325,19.7325)}{i_7}, \frac{(7.6733,7.4325,7.702)}{i_8}, \frac{(0.233,0.2325,0.225)}{i_9}, \frac{(0.2733,0.2325,0.2000)}{i_{10}} \right\}$$

$$\mathcal{A}(x_6) = \left\{ \frac{(0.987,0.997,0.896)}{i_1}, \frac{(0.000,0.0342,0.016)}{i_2}, \frac{(0.987,0.997,0.896)}{i_3}, \frac{(0.3771,0.235,0.364)}{i_4}, \frac{(0.3876,0.3976,0.390)}{i_5}, \frac{(6.934,6.962,6.897)}{i_6}, \frac{(21.6733,22.4325,21.7325)}{i_7}, \frac{(8.673,7.432,8.725)}{i_8} \frac{(0.654,0.700,0.698)}{i_9}, \frac{(0.507,0.425,0.400)}{i_{10}} \right\}$$

$$\mathcal{A}(x_7) = \left\{ \frac{(0.987,0.997,0.896)}{i_1}, \frac{(0.997,0.990,0.996)}{i_2}, \frac{(0.987,0.997,0.896)}{i_3}, \frac{(0.5771,0.535,0.564)}{i_4}, \frac{(0.5876,0.5976,0.590)}{i_5}, \frac{(6.934,6.962,6.897)}{i_6}, \frac{(20.6733,20.4325,19.7325)}{i_7}, \frac{(9.673,7.9432,9.725)}{i_8} \frac{(0.354,0.300,0.398)}{i_9}, \frac{(0.407,0.425,0.400)}{i_{10}} \right\}$$

$$\mathcal{A}(x_8) = \left\{ \frac{(0.587,0.597,0.596)}{i_1}, \frac{(0.597,0.590,0.596)}{i_2}, \frac{(0.687,0.697,0.696)}{i_3}, \frac{(0.5771,0.535,0.564)}{i_4}, \frac{(0.4876,0.4976,0.490)}{i_5}, \frac{(11.934,10.962,10.897)}{i_6}, \frac{(20.6733,20.4325,19.7325)}{i_7}, \frac{(8.673,7.9432,9.000)}{i_8} \frac{(0.354,0.300,0.398)}{i_9}, \frac{(0.307,0.325,0.400)}{i_{10}} \right\}$$

$$\mathcal{A}(x_9) = \left\{ \frac{(0.187,0.197,0.196)}{i_1}, \frac{(0.897,0.890,0.896)}{i_2}, \frac{(0.587,0.697,0.696)}{i_3}, \frac{(0.6771,0.635,0.664)}{i_4}, \frac{(0.9876,0.976,0.990)}{i_5}, \frac{(960.934,960.962,959.897)}{i_6}, \frac{(0.1733,0.1325,0.1325)}{i_7}, \frac{(15.673,15.9432,15.600)}{i_8} \frac{(0.554,0.500,0.498)}{i_9}, \frac{(0.907,0.925,0.900)}{i_{10}} \right\}$$

Where $\mathcal{A}(x_1)(i_1) = (0.0,0.0,0.0)$ means that the renewable of power plant x_1 (Fossil power plant energy) is given by expert 1 (resp., by expert 2, by expert 3) is 0.00 (resp.,0.00, 0.00); that means that the power plant x_1 (Fossil power plant energy) is not renewable, the meanings of $\mathcal{A}(x_s)(i_t)$ can be explained by the same fashion ($s = 1,2,3,4,5,6,7,8,9$; $t = 1,2,3,4,5,6,7,8,9,10$).

To find the best choice from X, let us first compute the 3-polar fuzzy set $\bar{\mathcal{A}} \in ([0,1050]^3)^X$, defined by $p_k \circ \bar{\mathcal{A}} = 1050 \wedge \sum_{i\in I} p_k \circ \mathcal{A}(x) \quad (\forall\, x \in X)$, where $p_k: [0,1050]^3 \to [0,1050]$ is the k-the projection (k =1,2,3).

$p_1(x_1) = 1050 \wedge (0.00 + 0.8455 + 0.3771 + 0.917 + 0.8334 + 7.6733 + 16.6733 + 12.6733 + 0.687 + 0.488) = 1050 \wedge 41.1679 = 41.1679$. Similarly, Table 4and figure 3. Explain the final values of compute the 3-polar fuzzy set $\bar{\mathcal{A}} \in ([0,1050]^3)^X$, defined by $p_k \circ \bar{\mathcal{A}} = 1050 \wedge \sum_{i\in I} p_k \circ \mathcal{A}(x) \quad (\forall\, x \in X)$, where $p_k: [0,1050]^3 \to [0,1050]$ is the k-the projection (k =1, 2, and 3). (In Table 4 and figure 4: Explain the final values of compute the 3-polar fuzzy set $\bar{\mathcal{A}} \in ([0,1050]^3)^X$, defined by $p_k \circ \bar{\mathcal{A}} = 1050 \wedge \sum_{i\in I} p_k \circ \mathcal{A}(x) \quad (\forall\, x \in X)$, where $p_k: [0,1050]^3 \to [0,1050]$ is the k-the projection (k =1, 2, and 3)).

Table 4: Explain the final values of compute the 3-polar fuzzy set $\bar{\mathcal{A}} \in ([0,1050]^3)^X$, defined by $p_k \circ \bar{\mathcal{A}} = 1050 \wedge \sum_{i \in I} p_k \circ \mathcal{A}(x)$ $(\forall\, x \in X)$, where p_k: $[0,1050]^3 \rightarrow [0,1050]$ is the k-the projection (k =1, 2, and 3).									
	$\mathbf{x_1}$	$\mathbf{x_2}$	$\mathbf{x_3}$	$\mathbf{x_4}$	$\mathbf{x_5}$	$\mathbf{x_6}$	$\mathbf{x_7}$	$\mathbf{x_8}$	$\mathbf{x_9}$
p_1	41.1679	146.7509	39.9047	33.4697	39.4368	41.18	42.177	44.8776	981.577
p_2	41.8407	150.4507	37.8918	32.3421	38.4186	40.6123	40.5577	43.2583	981.8577
$\mathbf{p_3}$	**41.6299**	**145.0299**	**42.3948**	**33.2178**	**38.1852**	**41.0145**	**32.0945**	**43.6335**	**980.4695**

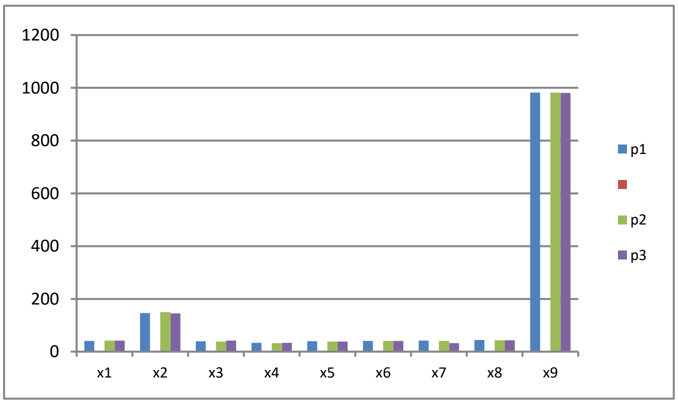

Figure 4: Explain the final values of compute the 3-polar fuzzy set $\bar{\mathcal{A}} \in ([0,1050]^3)^X$, defined by $p_k \circ \bar{\mathcal{A}} = 1050 \wedge \sum_{i \in I} p_k \circ \mathcal{A}(x)$ $(\forall\, x \in X)$, where p_k: $[0,1050]^3 \rightarrow [0,1050]$ is the k-the projection (k =1, 2, and 3).

Therfore,

$$\bar{\mathcal{A}} = \left\{ \begin{array}{l} \frac{(41.1679,41.8407,41.6299)}{x_1}, \frac{(146.7509,150.4507,145.0299)}{x_2}, \frac{(39.9047,37.8918,42.3948)}{x_3} \\ , \frac{(33.4697,32.3421,33.2178)}{x_4}, \frac{(39.4368,38.4186,38.1852)}{x_5}, \frac{(41.18,40.6123,41.0145)}{x_6}, \\ \frac{(42.177,40.5577,32.0945)}{x_7}, \frac{(44.8776,43.2583,43.6335)}{x_8}, \frac{(981.577,981.8577,980.4695)}{x_9} \end{array} \right\}$$

Based on the weigh vector $e^{\rightarrow} = (1.00, -10.00, -100\,)^T$. We compute the score $S(x) = \mathcal{A}(x)e^{\rightarrow}$ for each $x \in X$. Then:

$S(x_1) = (41.1679{,}41.8407{,}41.6299)\ e^{\rightarrow} =$ 41.1679 × 1.00 + 41.8407 × (-10.0) + 41.6299 × (-100.0) = - 4540.23

By the Model we complete to get, $S(x_2)$ = -15860.7, $S(x_3)$ = - 4578.49, $S(x_4)$ = - 3611.73, $S(x_5)$ = - 4163.27, $S(x_6)$ = - 4466.39, $S(x_7)$ = - 3572.85, $S(x_8)$ = - 4751.06, $S(x_9)$ = -106884.

As $S(x_7)$ = - 3572.85 (Tidal range power plant**)** under the values of Renewable , Visual impact, Capital cost, Maintenance cost, Environmental impact, Green gas emissions, Implementation time, Cost Cent/Kwh, Danger of series accidents and Waste problem have the highest value, the best choice by experts should be Tidal range power plant is **s**uitability of power plants based on m3-polar Fuzzy soft set. Depended on these results, we can rearrangement the power plant according to equality as:

1- Tidal range power plant 2- Solar power plant 3- Hydro power plant 4- Wave power plant 5- Fossil power plant 6- Wind power plant 7- Biogas power plant 8- Nuclear power plant 9- Coal station. Table 5 and figure 5. Explain the rearrangement the power plants according to equality. (in Table 5 and figure 5: Explain the rearrangement the power plants according to equality).

Table 5: Explain the rearrangement the power plants according to equality								
Tidal range power plant station	Solar power plant station	Hydro power plant station	Wave power plant station	Fossil station	Wind power plant station	Biogas power plant station	Nuclear power plant station	Coal station
- 3572.85	- 3611.73	- 4163.27	- 4466.39	- 4540.23	- 4578.49	- 4751.06	-15860.7	-106884

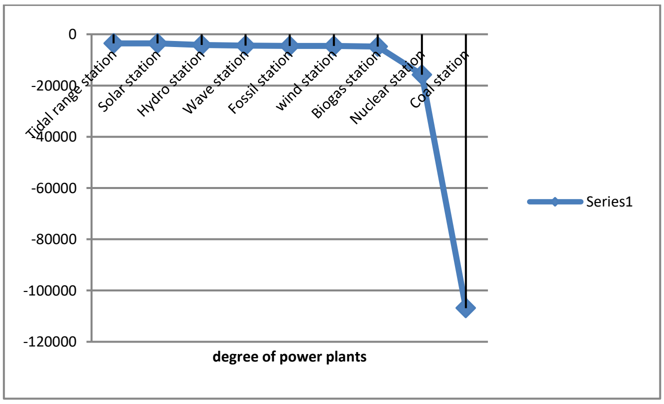

Figure 5: Explain the rearrangement the power plants according to equality

3.2 The best choice of power plants under affects the important alternatives parameters and has more impact based on 2-polar Fuzzy soft set

Here we choose the reality and important alternatives parameters (Capital cost, Environmental impact, Implementation time, Green gas emissions Gco₂e/Kwh) for the power plants. (Table 6 and figure 6. explain the important alternatives parameters and have more impact (Capital cost, Environmental impact, Implementation time, Green gas emissions Gco₂e/Kwh))

Table 6: explain the important alternatives parameters and have more impact (Capital cost, Environmental impact, Implementation time, Green gas emissions Gco₂e/Kwh)				
Comparison approach	Capital cost	Environmental impact	Implementation time	Green gas emissions
Fossil	0.3	0.9	18.0	6.0
Nuclear power plant	0.5	0.9	60.0	66.0
Wind power plant	0.9	0.5	20.0	10.0
Solar power plant	0.9	0.3	10.0	6.0
Hydro power plant	0.9	0.5	20.0	6.0
Wave power plant	0.9	0.3	22.0	7.0
Tidal range power plant	0.9	0.5	20.0	7.0
Biogas power plant	0.6	0.4	20.0	11.0
Coal	0.5	0.9	1.0	960.0-1050

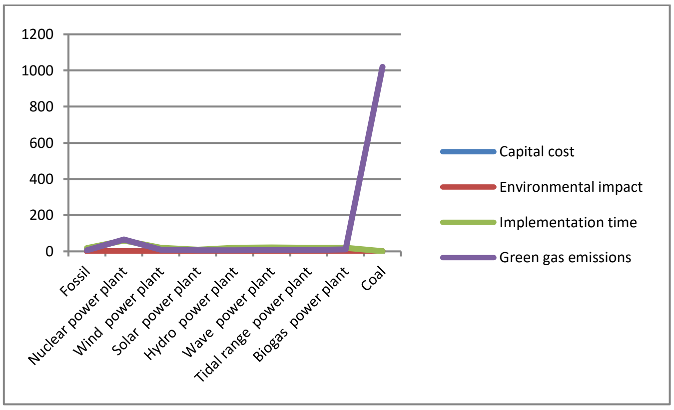

Figure 6: Explain the important alternatives parameters and have more impact (Capital cost, Environmental impact, Implementation time, Green gas emissions Gco₂e/Kwh)

So let the set $X = \{x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9\}$ express about the power plants (Fossil power plant energy , Nuclear power plant station, Wind power plant station, Solar power plant station, Hydro power plant station, Wave power plant station, Tidal range power plant, Biogas power plant, Coal) with the parameters $I = \{i_1, i_2, i_3, i_4\}$ where i_1 stands for Capital cost, i_2 stands for Environmental impact, i_3 stands for Implementation time, i_4 stands for Green gas emissions Gco₂e/Kwh, these parameters are important with degree. (0.59, 0.19, 60 and (-6.92)). Considering them own needs, the data for optimal alternative for suitability of power plants based on 2-polar Fuzzy soft set.

Motivated from the above problem, we give the following algorithm for decision- making problem (and the like):

Algorithm 2: Using 2-polar Fuzzy soft set.

Step 1. State $\mathcal{A} \in [([-1050,70]^2)^X \times ([-1050,70]^2)^X]^I = [([-1050,70]^4)^X]^I = [([-1050,70]^4)^I]^X = ([-1050,70]^4)^{X\times I}$ defined by two experts

Step 2. Compute the 2-polar fuzzy set $\bar{\mathcal{A}} \in ([-1050,1050]^2)^{X\times I}$ defined by

$$\bar{\mathcal{A}}(x,i) = 1050 \wedge \sum_{k=1}^{2}(p_k \circ p_1 \circ \mathcal{A}(x,i) \times p_k \circ p_2 \circ \mathcal{A}(x,i)) \quad \forall i \in I, \forall x \in X)$$

Where $p_k: [-1050,1050]^2 \to [-1050,1050]$ is the k-the projection (k =1,2);

Step 3. compute $m_i = \sum_{k=1}^{9}(x_k)(i)$, $x \in X$, $(i = 1,2,3,4)$ and compute $r_i = \sum_i^4 m_i - m_j$ $(j = 1,2,3,4,5,6,7,8,9)$,

Step 4. The maximal value of the score $S(x) = \max r_i$. Then, the maximum score and state the optimal alternative for suitability of power plant based on 2-polar Fuzzy soft set.

Now calculate,
$\mathcal{A} \in [([-1050,70]^2)^X \times ([-1050,70]^2)^X]^I = [([-1050,70]^4)^X]^I = [([-1050,70]^4)^I]^X = ([-1050,70]^4)^{X\times I}$. Defined by two experts to state the measure of the parameters gives us the following data, we take negative sign for the parameter Green gas emissions Gco₂e/Kwh.

$$\mathcal{A}(x_1) = \left\{\frac{\langle(0.46,0.35),(0.44,0.33)\rangle}{i_1}, \frac{\langle(0.99,0.88),(0.99,0.87)\rangle}{i_2}, \frac{\langle(19.96,17.85),(18.68,16.87)\rangle}{i_3}, \frac{\langle(-6.00,-6.11),(-6.55,-5.77)\rangle}{i_4}\right\}$$

$$\mathcal{A}(x_2) = \left\{\frac{\langle(0.76,0.55),(0.60,0.57)\rangle}{i_1}, \frac{\langle(0.95,.910),(0.99,0.920)\rangle}{i_2}, \frac{\langle(65.96,60.85),(64.68,60.87)\rangle}{i_3}, \frac{\langle(-6.16,-7.05),(-6.00,-6.87)\rangle}{i_4}\right\}$$

$$\mathcal{A}(x_3) = \left\{\frac{\langle(0.96,0.85),(1.00,0.967)\rangle}{i_1}, \frac{\langle(0.60,0.55),(0.72,0.67)\rangle}{i_2}, \frac{\langle(19.96,18.85),(25.68,20.87)\rangle}{i_3}, \frac{\langle(-9.96,-10.65),(-10.68,-11.87)\rangle}{i_4}\right\}$$

$$\mathcal{A}(x_4) = \left\{\frac{\langle(0.96,0.85),(0.99.0.87)\rangle}{i_1}, \frac{\langle(0.40,0.35),(0.56,0.37)\rangle}{i_2}, \frac{\langle(10.96,10.85),(11.68,10.87)\rangle}{i_3}, \frac{\langle(-6.06,-6.65),(-5.68,-6.87)\rangle}{i_4}\right\}$$

$$\mathcal{A}(x_5) = \left\{\frac{\langle(0.96,0.85),(0.99,0.88)\rangle}{i_1}, \frac{\langle(0.60,0.55),(0.66,0.57)\rangle}{i_2}, \frac{\langle(22.96,21.85),(22.68.21.87)\rangle}{i_3}, \frac{\langle(-6.86,-7.65),(-7.68,-8.87)\rangle}{i_4}\right\}$$

$$\mathcal{A}(x_6) = \left\{\frac{\langle(0.98,0.85),(0.90,0.80)\rangle}{i_1}, \frac{\langle(0.30,0.20),(0.36,0.27)\rangle}{i_2}, \frac{\langle(22.96,21.85),(24.68,22.87)\rangle}{i_3}, \frac{\langle(-8.96,-9.65),(-5.68,-6.87)\rangle}{i_4}\right\}$$

$$\mathcal{A}(x_7) = \left\{\frac{\langle(0.90,0.75),(0.88,0.77)\rangle}{i_1}, \frac{\langle(0.60,0.55),(0.70,0.67)\rangle}{i_2}, \frac{\langle(22.96,20.85),(23.68,22.87)\rangle}{i_3}, \frac{\langle(-8.96,-9.65),(-7.68,-8.87)\rangle}{i_4}\right\}$$

$$\mathcal{A}(x_8) = \left\{\frac{\langle(0.66,0.60),(0.50.0.67)\rangle}{i_1}, \frac{\langle(0.40,0.35),(0.56.0.47)\rangle}{i_2}, \frac{\langle(22.96,21.85),(23.68.22.87)\rangle}{i_3}, \frac{\langle(-9.96,-10.65),(-11.68.-12.87)\rangle}{i_4}\right\}$$

$$\mathcal{A}(x_9) = \left\{\frac{\langle(0.66,0.55),(0.50,0.67)\rangle}{i_1}, \frac{\langle(0.90,0.85),(0.88,0.77)\rangle}{i_2}, \frac{\langle(1.96,1.85),(1.98,1.87)\rangle}{i_3}, \frac{\langle(-1000.96,-1050.65),(-1044.68,-1050.87)\rangle}{i_4}\right\}$$

Where, $\mathcal{A}(x_1)(i_1) = \langle(0.46,0.35),(0.44.0.33)\rangle$. means that Fossil power plant energy x_1 of the parameter i_1 (Capital cost) in aspects increase take the values 0.46or decrease take the values 0.35 and by the second measure increase take the values 0.44 or decrease take the values 0.33 respectively; the meaning of $\mathcal{A}(x_s)(i_t)$ can be Explained similarly ($s = 1,2,3.4,5,6,7,8,9$; $t = 1,2,3,4$). To find the best choice from X, let us first compute the 2-polar fuzzy set $\bar{\mathcal{A}} \in ([-1050,1050]^2)^{X\times I}$ defined by $\bar{\mathcal{A}}(x,i) = 1050 \wedge \sum_{k=1}^{2}(p_k \circ p_1 \circ \mathcal{A}(x,i) \times p_k \circ p_2 \circ \mathcal{A}(x,i))$ $\forall i \in I, \forall x \in X)$

Where $p_k: [-1050,1050]^2 \to [-1050,1050]$ is the k-the projection (k =1,2);

$\bar{\mathcal{A}}(x_1)(i_1) = [(0.46 \times 0.44) + (0.35 \times 0.33)] = 0.3179$, Similarly

$$\bar{\mathcal{A}}(x_1) = \left\{\frac{0.3179}{i_1}, \frac{1.7457}{i_2}, \frac{673.9823}{i_3}, \frac{74.5\!\!5}{i_4}\right. \qquad \bar{\mathcal{A}}(x_2) = \left\{\frac{0.7695}{i_1}, \frac{1.777}{i_2}, \frac{1050}{i_3}, \frac{85.3935}{i_4}\right\}$$

$$\bar{\mathcal{A}}(x_3) = \left\{\frac{1.78195}{i_1}, \frac{1.652}{i_2}, \frac{905.9723}{i_3}, \frac{232.7}{i_4}\right. \qquad \bar{\mathcal{A}}(x_4) = \left\{\frac{1.6899}{i_1}, \frac{0.3535}{i_2}, \frac{245.9523}{i_3}, \frac{125.}{}\right.$$

$$\bar{\mathcal{A}}(x_5) = \left\{\frac{1.6984}{i_1}, \frac{0.7095}{i_2}, \frac{998.5923}{i_3}, \frac{120.6}{i}\right. \qquad \bar{\mathcal{A}}(x_6) = \left\{\frac{1.562}{i_1}, \frac{0.162}{i_2}, \frac{1050}{i_3}, \frac{117.1883}{i_4}\right\}$$

$$\bar{\mathcal{A}}(x_7) = \left\{\frac{1.3695}{i_1}, \frac{0.7885}{i_2}, \frac{1020.5323}{i_3}, \frac{154}{}\right. \qquad \bar{\mathcal{A}}(x_8) = \left\{\frac{0.732}{i_1}, \frac{0.3885}{i_2}, \frac{564.9215}{i_3}, \frac{253.3}{i_4}\right.$$

$$\bar{\mathcal{A}}(x_9) = \left\{\frac{0.6958}{i_1}, \frac{1.4465}{i_2}, \frac{7.3403}{i_3}, \frac{1050}{i_4}\right\}$$

Now, we compute $m_i = \sum_{k=1}^{9}(x_k)(i)$, $x \in X$, $(i = 1,2,3,4)$. (Table 7and figure 7, compute $m_i = \sum_{k=1}^{9}(x_k)(i)$, $x \in X$, $(i = 1,2,3,4)$)

Table 7: Compute $m_i = \sum_{k=1}^{9}(x_k)(i)$, $x \in X$, $(i = 1,2,3,4)$

X	i_1	i_2	i_3	i_4	m_i
x_1	0.3179	1.7457	673.9823	74.5547	750.6006
x_2	0.7695	1.777	1050	85.3935	1137.94
x_3	1.78195	1.652	905.9723	232.7883	1142.195
x_4	1.6899	0.3535	245.9523	125.7918	373.7875
x_5	1.6984	0.7095	998.5923	120.67035	1121.671
x_6	1.562	0.162	1050	117.1883	1168.912
x_7	1.3695	0.7885	1020.5323	154.4083	1177.099
x_8	0.732	0.3885	564.9215	253.3983	819.4403
x_9	0.6958	1.4465	7.3403	1050	1059.483

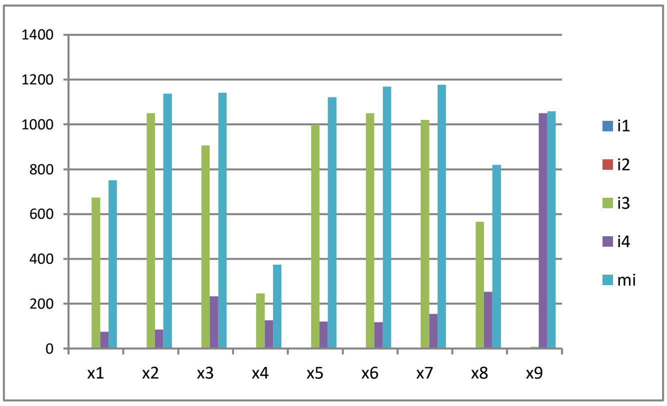

Figure 7: Compute $m_i = \sum_{k=1}^{9}(x_k)(i)$, $x \in X$, $(i = 1,2,3,4)$

Now, compute $r_i = \sum_i^4 m_i - m_j$ $(j = 1,2,3,4,5,6,7,8,9)$, then

$$r_1 = (m_1 - m_1) + (m_1 - m_2) + (m_1 - m_3) + (m_1 - m_4) + (m_1 - m_5) + (m_1 - m_6) + (m_1 - m_7) + (m_1 - m_8) + (m_1 - m_9)$$

= (750.6006 − 750.6006) + (750.6006 −1137.94)+ (750.6006−1142.195) + (750.6006−373.7875) +(750.6006 − 1121.671) + (750.6006 −1168.912)+ (750.6006−1177.099) + (750.6006−819.4403) +(750.6006−1059.483) = -1995.72, Similarly,

r_2 = 1490.332, r_3 =1528.627 , r_4 =-5387.04, r_5 =1343.911, r_6 =1769.08, r_7 =1842.763 , r_8 =-1376.17 , r_9 =784.2186. . Since the score $S(x) = \max r_i$. then, the maximum score is, r_7 =1842.763 and the optimal alternative for suitability of power plants based on 2-polar Fuzzy soft set is to select r_7 (Tidal range power plant) the same decision with the algorithm 1.

3.3 Suitability of power plants based on a two operations ($\wedge$ *and* $\vee$) 2-polar Fuzzy soft sets

In this section study the problem by use a two operations ($\wedge$ *and* $\vee$) 2-polar fuzzy soft sets. So we give power plants (Fossil power plant energy, Nuclear power plant, Wind power plant, solar power plant**)**. There are in the set $X = \{x_1, x_2, x_3, x_4\}$ with the parameters $I = \{i_1, i_2, i_3, i_4\}$ where i_1 stands for Capital cost, i_2 stands for Environmental impact, i_3 stands for Implementation time, i_4 stands for Green gas emissions Gco_2e/Kwh, these parameters are important with degree. (0.59, 0.19, 60 and (− 6.92)). Considering them own needs, the data for optimal alternative for suitability of power plants based on 2-polar fuzzy soft set .

Motivated from the above problem, we give the following algorithm for decision- making problem:

Algorithm 3: Using 3-polar Fuzzy soft set.

Step 1. State $\mathcal{A}, \mathcal{B} \in [([-70,70]^2)^X \times ([-70,70]^2)^X]^I = [([-70,70]^4)^X]^I = [([-70,70]^4)^I]^X = ([-70,70]^4)^{X \times I}$

Step 2. Compute $\mathbb{C} = \mathcal{A} \wedge \mathcal{B} \in [([-70,70]^2)^X \times ([-70,70]^2)^X]^I$

Step 3. Compute the 3-polar Fuzzy soft set $\hat{\mathbb{C}} \in ([-70,70]^{2\times3})^X$, defined by

$$\hat{\mathbb{C}}(x)(i,j) = 70 \wedge \sum_{k=1}^{3} (p_k \circ p_1 \circ \mathbb{C}(x)(i,j) \times p_k \circ p_2 \circ \mathbb{C}(x)(i,j)) \quad \forall (i,j) \in I^2, \forall x \in X)$$

Where $p_k: [-70,70]^2 \to [-70,70]$ is the k-the projection (k =1, 2, 3);

Step 4. $\mathbb{C}_M: X \to R$, by $\mathbb{C}_M(x) = \sum_{(i,j)\in I^2} \beta(x)(i,j)$, where

$$\beta(x)(i,j) = \begin{cases} \mathbb{C}(x)(i,j), & \mathbb{C}(x)(i,j) = max\{\mathbb{C}(x)(s,t) : (s,t) \in I^2\}, \\ 0 & Otherwise. \end{cases}$$

.

Step 5. The maximal value of $\mathbb{C}_M$ to state the optimal alternative for suitability of power plants based on 2-polar fuzzy soft set X Based on 3-polar Fuzzy soft set.

Now calculate,

$\mathcal{A} \in [([-70,70]^2)^X \times ([-70,70]^2)^X]^I = [([-70,70]^4)^X]^I = [([-70,70]^4)^I]^X = ([-70,70]^4)^{X\times I}$. Defined by three measures to state the measure of the parameters gives us the following data, we take negative sign for the parameter Green gas emissions Gco_2e/Kwh. From table 6,

$$\mathcal{A}(\mathrm{i}_1) = \left\{ \frac{\langle(0.4,0.3),(0.3,0.2),(0.4,0.3)\rangle}{\mathrm{x}_1}, \frac{\langle(0.9,0.8),(0.8,0.7),(0.9,0.8)\rangle}{\mathrm{x}_2}, \frac{\langle(18.6,16.5),(17.6,15.7),(17.56,17.18)\rangle}{\mathrm{x}_3}, \frac{\langle(-5.6,-6.75),(-5.76,-6.87),(-4.6,-5.88)\rangle}{\mathrm{x}_4} \right\}$$

$$\mathcal{A}(\mathrm{i}_2) = \left\{ \frac{\langle(0.5,0.3),(0.5,0.2),(0.5,0.3)\rangle}{\mathrm{x}_1}, \frac{\langle(0.9,0.8),(0.8,0.7),(0.9,0.7)\rangle}{\mathrm{x}_2}, \frac{\langle(60.6,55.5),(62.6,56.7),(65.6,60.8)\rangle}{\mathrm{x}_3}, \frac{\langle(-60.6,-66.5),(-63.6,-65.7),(-62.6,-65.8)\rangle}{\mathrm{x}_4} \right\}$$

$$\mathcal{A}(\mathrm{i}_3) = \left\{ \frac{\langle(0.9,0.8),(0.8,0.7),(0.8,0.7)\rangle}{\mathrm{x}_1}, \frac{\langle(0.5,0.4),(0.6,0.5),(0.6,0.5)\rangle}{\mathrm{x}_2}, \frac{\langle(19.6,17.5),(20.6,19.7),(20.6,18.8)\rangle}{\mathrm{i}_3}, \frac{\langle(-10.4,-10.5),(-9.6,-9.7),(-5.6,-6.8)\rangle}{\mathrm{x}_4} \right\}$$

$$\mathcal{A}(\mathrm{i}_4) = \left\{ \frac{\langle(0.9,0.8),(0.8,0.7),(0.9,0.8)\rangle}{\mathrm{x}_1}, \frac{\langle(0.3,0.2),(0.4,0.3),(0.3,0.1)\rangle}{\mathrm{x}_2}, \frac{\langle(10.6,10.5),(10.6,10.7),(10.6,10.8)\rangle}{\mathrm{x}_3}, \frac{\langle(-6.6,-7.5),(-7.6,-7.7),(-7.6,-7.8)\rangle}{\mathrm{x}_4} \right\}$$

Where $\mathcal{A}(i_1)(x_1) = (0.4,0.3),(0.3,0.2),(0.4,0.3)$ means that parameter i_1 (Capital cost) of the (Fossil power plant) x_1 increase and decrease of growth given by first measure is increase take the value 0.4 and decrease take the value, 0.3 and by the second measure increase take the value 0.3 and decrease take the value 0.2 by the third measure increase take the value 0.4 and decrease take the value 0.3 , the meaning of $\mathcal{A}(i_s)(x_t)$ can be Explained similarly (s = 1,2,3.4 ; t = 1,2,3,4). Similarly,

A subset $\mathcal{B} = \{B_i\}_i : \mathrm{I} \to ([-70,70]^{2\times3})^X$ is called also 3-polar Fuzzy soft set on X, define by $\mathcal{B}(\mathrm{i}) = B_i \ \forall i \in I$, the data for optimal alternative for suitability of power plants based on 3-polar Fuzzy soft set given by another three measures $\mathcal{B} \in [([-70,70]^{2\times3})^X]^I$ =$([-70,7]^{2\times3})^{X\times I}$ defined by

$$\mathcal{B}(\mathrm{i}_1) = \left\{ \frac{\langle(0.5,0.3),(0.4,0.2),(0.4,0.2)\rangle}{x_1}, \frac{\langle(0.8,0.7),(0.7,0.6),(0.9,0.7)\rangle}{\mathrm{x}_2}, \frac{\langle(17.6,16.5),(18.6,15.7),(18.56,17.18)\rangle}{\mathrm{x}_3}, \frac{\langle(-6.6,-6.75),(-5.76,-5.87),(-5.6,-5.88)\rangle}{\mathrm{x}_4} \right\}$$

$$\mathcal{B}(\mathrm{i}_2) = \left\{ \frac{\langle(0.4,0.3),(0.5,0.3),(0.5,0.2)\rangle}{x_1}, \frac{\langle(0.9,0.7),(0.9,0.7),(0.8,0.7)\rangle}{\mathrm{x}_2}, \frac{\langle(60.6,57.5),(60.6,57.7),(64.6,61.8)\rangle}{\mathrm{x}_3}, \frac{\langle(-63.6,-64.5),(-62.6,-64.7),(-63.6,-64.8)\rangle}{\mathrm{x}_4} \right\}$$

$$\mathcal{B}(i_3) = \left\{ \frac{\langle(0.8,0.7),(0.8,0.6),(0.8,0.6)\rangle}{x_1}, \frac{\langle(0.5,0.3),(0.6,0.4),(0.4,0.3)\rangle}{i_2}, \frac{\langle(18.6,17.5),(19.6,18.7),(21.6,19.8)\rangle}{\mathrm{x}_3}, \frac{\langle(-10.6,-10.8),(-10.9,-11.7),(-9.6,-9.8)\rangle}{\mathrm{x}_4} \right\}$$

$$\mathcal{B}(i_4) = \left\{ \frac{\langle(0.8,0.7),(0.8,0.6),(0.8,0.5)\rangle}{x_1}, \frac{\langle(0.4,0.2),(0.5,0.3),(0.5,0.1)\rangle}{x_2}, \frac{\langle(11.6,10.5),(11.6,10.7),(9.6,8.8)\rangle}{x_3}, \frac{\langle(-7.6,-8.5),(-8.6,-8.7),(-7.6,-7.8)\rangle}{x_4} \right\}$$

Now we need find the best choice from X based on $\mathbb{C} = \mathcal{A} \wedge \mathcal{B}$. SO compute $\mathbb{C}$.

$$\mathbb{C}(i_1,i_1) = \left\{ \frac{\langle(0.4,0.3),(0.3,0.2),(0.4,0.2)\rangle}{x_1}, \frac{\langle(0.8,0.7),(0.7,0.6),(0.9,0.7)\rangle}{x_2}, \frac{\langle(17.6,16.5),(17.6,15.7),(17.56,17.18)\rangle}{x_3}, \frac{\langle(-5.6,-6.75),(-5.76,-5.87),(-4.6,-5.88)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_1,i_2) = \left\{ \frac{\langle(0.4,0.3),(0.3,0.2),(0.4,0.2)\rangle}{x_1}, \frac{\langle(0.8,0.7),(0.7,0.6),(0.9,0.7)\rangle}{x_2}, \frac{\langle(17.6,16.5),(17.6,15.7),(17.56,17.18)\rangle}{x_3}, \frac{\langle(-5.6,-6.75),(-5.76,-5.87),(-4.6,-5.88)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_1,i_3) = \left\{ \frac{\langle(0.4,0.3),(0.3,0.2),(0.4,0.2)\rangle}{x_1}, \frac{\langle(0.5,0.3),(0.6,0.4),(0.4,0.3)\rangle}{x_2}, \frac{\langle(18.6,16.5),(17.6,15.7),(17.56,17.18)\rangle}{x_3}, \frac{\langle(-10.6,-10.8),(-10.9,-11.7),(-9.6,-9.8)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_1,i_4) = \left\{ \frac{\langle(0.4,0.3),(0.3,0.2),(0.4,0.2)\rangle}{x_1}, \frac{\langle(0.4,0.2),(0.5,0.3),(0.5,0.1)\rangle}{x_2}, \frac{\langle(11.6,10.5),(11.6,10.7),(9.6,8.8)\rangle}{x_3}, \frac{\langle(-7.6,-8.5),(-8.6,-8.7),(-7.6,-7.8)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_2,i_1) = \left\{ \frac{\langle(0.5,0.3),(0.4,0.2),(0.4,0.2)\rangle}{x_1}, \frac{\langle(0.8,0.7),(0.7,0.6),(0.9,0.7)\rangle}{x_2}, \frac{\langle(17.6,16.5),(18.6,15.7),(18.56,17.18)\rangle}{x_3}, \frac{\langle(-60.6,-66.5),(-63.6,-65.7),(-62.6,-65.8)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_2,i_2) = \left\{ \frac{\langle(0.4,0.3),(0.5,0.2),(0.5,0.2)\rangle}{x_1}, \frac{\langle(0.9,0.7),(0.8,0.7),(0.8,0.7)\rangle}{x_2}, \frac{\langle(60.6,55.5),(60.6,56.7),(64.6.6,60.8)\rangle}{x_3}, \frac{\langle(-60.6,-64.5),(-62.6,-64.7),(-62.6,-64.8)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_2,i_3) = \left\{ \frac{\langle(0.5,0.3),(0.5,0.2),(0.5,0.3)\rangle}{x_1}, \frac{\langle(0.5,0.3),(0.6,0.4),(0.4,0.3)\rangle}{x_2}, \frac{\langle(18.6,17.5),(19.6,18.7),(21.6,19.8)\rangle}{x_3}, \frac{\langle(-60.6,-66.5),(-63.6,-65.7),(-62.6,-65.8)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_2,i_4) = \left\{ \frac{\langle(0.5,0.3),(0.5,0.2),(0.5,0.3)\rangle}{x_1}, \frac{\langle(0.4,0.2),(0.5,0.3),(0.5,0.1)\rangle}{x_2}, \frac{\langle(11.6,10.5),(11.6,10.7),(9.6,8.8)\rangle}{x_3}, \frac{\langle(-7.6,-8.5),(-8.6,-8.7),(-7.6,-7.8)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_3,i_1) = \left\{ \frac{\langle(0.5,0.3),(0.4,0.2),(0.4,0.2)\rangle}{x_1}, \frac{\langle(0.5,0.4),(0.6,0.5),(0.6,0.5)\rangle}{x_2}, \frac{\langle(17.6,16.5),(18.6,15.7),(18.56,17.18)\rangle}{x_3}, \frac{\langle(-60.6,-66.5),(-63.6,-65.7),(-62.6,-65.8)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_3,i_2) = \left\{ \frac{\langle(0.4,0.3),(0.5,0.3),(0.5,0.2)\rangle}{x_1}, \frac{\langle(0.5,0.4),(0.6,0.5),(0.6,0.5)\rangle}{x_2}, \frac{\langle(19.6,17.5),(20.6,19.7),(20.6,18.8)\rangle}{x_3}, \frac{\langle(-63.6,-64.5),(-62.6,-64.7),(-63.6,-64.8)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_3,i_3) = \left\{ \frac{\langle(0.8,0.7),(0.8,0.6),(0.8,0.6)\rangle}{x_1}, \frac{\langle(0.5,0.3),(0.6,0.4),(0.4,0.3)\rangle}{x_2}, \frac{\langle(18.6,17.5),(19.6,18.7),(20.6,18.8)\rangle}{x_3}, \frac{\langle(-10.6,-10.8),(-10.9,-11.7),(-9.6,-9.8)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_3,i_4) = \left\{ \frac{\langle(0.8,0.7),(0.8,0.6),(0.8,0.5)\rangle}{x_1}, \frac{\langle(0.4,0.2),(0.5,0.3),(0.5,0.1)\rangle}{x_2}, \frac{\langle(11.6,10.5),(11.6,10.7),(9.6,8.8)\rangle}{x_3}, \frac{\langle(-10.4,-10.5),(-9.6,-9.7),(-7.6,-7.8)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_4,i_1) = \left\{ \frac{\langle(0.5,0.3),(0.4,0.2),(0.4,0.2)\rangle}{x_1}, \frac{\langle(0.3,0.2),(0.4,0.3),(0.3,0.1)\rangle}{x_2}, \frac{\langle(10.6,10.5),(10.6,10.7),(10.6,10.8)\rangle}{x_3}, \frac{\langle(-6.6,-7.5),(-7.6,-7.7),(-7.6,-7.8)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_4,i_2) = \left\{ \frac{\langle(0.4,0.3),(0.5,0.3),(0.5,0.2)\rangle}{x_1}, \frac{\langle(0.3,0.2),(0.4,0.3),(0.3,0.1)\rangle}{x_2}, \frac{\langle(10.6,10.5),(10.6,10.7),(10.6,10.8)\rangle}{x_3}, \frac{\langle(-63.6,-64.5),(-62.6,-64.7),(-63.6,-64.8)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_4,i_3) = \left\{ \frac{\langle(0.8,0.7),(0.8,0.6),(0.8,0.6)\rangle}{i_1}, \frac{\langle(0.3,0.2),(0.4,0.3),(0.3,0.1)\rangle}{x_2}, \frac{\langle(10.6,10.5),(10.6,10.7),(10.6,10.8)\rangle}{i_3}, \frac{\langle(-10.6,-10.8),(-10.9,-11.7),(-9.6,-9.8)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_4,i_4) = \left\{ \frac{\langle(0.8,0.7),(0.8,0.6),(0.8,0.5)\rangle}{i_1}, \frac{\langle(0.3,0.2),(0.4,0.3),(0.3,0.1)\rangle}{x_2}, \frac{\langle(10.6,10.5),(10.6,10.7),(9.6,8.8)\rangle}{i_3}, \frac{\langle(-7.6,-8.5),(-8.6,-8.7),(-7.6,-7.8)\rangle}{x_4} \right\}$$

Secondly, compute the 3-polar Fuzzy soft set $\hat{\mathbb{C}} \in ([-70,70]^{2\times3})^X$, defined by

$$\hat{\mathbb{C}}(x)(i,j) = 70 \wedge \sum_{k=1}^{3} (p_k \circ p_1 \circ \mathbb{C}(x)(i,j) \times p_k \circ p_2 \circ \mathbb{C}(x)(i,j)) \quad \forall (i,j) \in I^2, \forall x \in X)$$

Where $p_k: [-70,70]^2 \to [-70,70]$ is the k-the projection (k =1, 2, 3);

$\hat{\mathbb{C}}(x_1)(i_1,j_1) = (70) \wedge [(0.4 \times 0.3 \times 0.4) + (0.3 \times 0.2 \times 0.2)] = (70) \wedge (6096.21584) = 0.06$; Similarly; (Table 8, and figure 8 compute $\hat{\mathbb{C}}(x)(i,j) \in ([0,60]^{2\times3})^X$)

Table 8: Compute $\hat{\mathbb{C}}(x)(i,j) \in ([0,60]^{2\times3})^X$

$\hat{\mathbb{C}}$	$\hat{\mathbb{C}}(x_1)$	$\hat{\mathbb{C}}(x_2)$	$\hat{\mathbb{C}}(x_3)$	$\hat{\mathbb{C}}(x_4)$
(i_1,j_1)	0.06	0.798	70	-381.36
(i_1,j_2)	0.06	0.798	70	-381.36
(i_1,j_3)	0.06	0.158	70	-2347.5
(i_1,j_4)	0.06	0.106	70	-1073.6
(i_2,j_1)	0.092	0.798	70	-5. 2875×10^5
(i_2,j_2)	0.112	0.919	70	-5. 079×10^5
(i_2,j_3)	0.143	0.156	70	-5. 2875×10^5
(i_2,j_4)	0.143	0.126	70	-1073. 6
(i_3,j_1)	0.28	0.092	70	-528750
(i_3,j_2)	0.118	0.28	70	-523630
(i_3,j_3)	0.764	0.106	70	-2347. 5
(i_3,j_4)	0.722	0.03408	70	-1553. 2
(i_4,j_1)	0.042	0.092	70	-831. 67
(i_4,j_2)	0.018	0.042	70	-523630
(i_4,j_3)	0.764	0.042	70	-2347. 5
(i_4,j_4)	0.764	0.042	70	-1073. 6

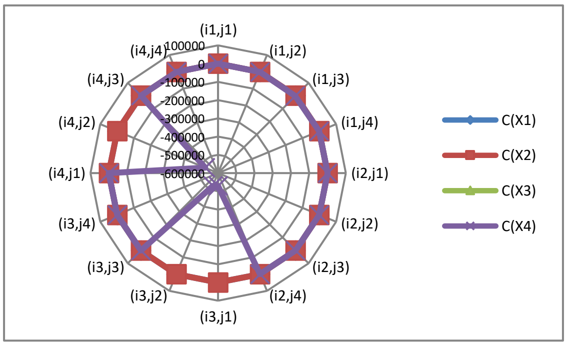

Figure 8: Compute $\hat{\mathbb{C}}(x)(i,j) \in ([0,60]^{2\times3})^X$

Therfore,

$$\hat{\mathbb{C}}(x_1) = \left\{ \begin{array}{l} \frac{0.06}{(i_1,j_1)}, \frac{0.06}{(i_1,j_2)}, \frac{0.06}{(i_1,j_3)}, \frac{0.06}{(i_1,j_4)}, \\ \frac{0.092}{(i_2,j_1)}, \frac{0.112}{(i_2,j_2)}, \frac{0.143}{(i_2,j_3)}, \frac{0.143}{(i_2,j_4)}, \\ \frac{0.28}{(i_3,j_1)}, \frac{0.118}{(i_3,j_2)}, \frac{0.764}{(i_3,j_3)}, \frac{0.722}{(i_3,j_4)}, \\ \frac{0.042}{(i_4,j_1)}, \frac{0.018}{(i_4,j_2)}, \frac{0.764}{(i_4,j_3)}, \frac{0.764}{(i_4,j_4)} \end{array} \right\}$$

$$\hat{\mathbb{C}}(x_2) = \left\{ \begin{array}{l} \frac{0.798}{(i_1,j_1)}, \frac{0.798}{(i_1,j_2)}, \frac{0.158}{(i_1,j_3)}, \frac{0.106}{(i_1,j_4)}, \\ \frac{0.798}{(i_2,j_1)}, \frac{0.919}{(i_2,j_2)}, \frac{0.156}{(i_2,j_3)}, \frac{0.126}{(i_2,j_4)}, \\ \frac{0.092}{(i_3,j_1)}, \frac{0.28}{i_3,j_2)}, \frac{0.106}{(i_3,j_3)}, \frac{0.03408}{(i_3,j_4)}, \\ \frac{0.092}{(i_4,j_1)}, \frac{0.042}{(i_4,j_2)}, \frac{0.042}{(i_4,j_3)}, \frac{0.042}{(i_4,j_4)} \end{array} \right\}$$

$$\hat{\mathbb{C}}(x_3) = \left\{ \begin{array}{l} \frac{70}{(i_1,j_1)}, \frac{70}{(i_1,j_2)}, \frac{70}{(i_1,j_3)}, \frac{70}{(i_1,j_4)}, \\ \frac{70}{(i_2,j_1)}, \frac{70}{(i_2,j_2)}, \frac{70}{(i_2,j_3)}, \frac{70}{(i_2,j_4)}, \\ \frac{70}{(i_3,j_1)}, \frac{70}{i_3,j_2)}, \frac{70}{(i_3,j_3)}, \frac{70}{(i_3,j_4)}, \\ \frac{70}{(i_4,j_1)}, \frac{70}{(i_4,j_2)}, \frac{70}{(i_4,j_3)}, \frac{70}{(i_4,j_4)} \end{array} \right\}$$

$$\hat{\mathbb{C}}(x_4) = \left\{ \begin{array}{l} \frac{-381.36}{(i_1,j_1)}, \frac{-381.36}{(i_1,j_2)}, \frac{-2347.5}{(i_1,j_3)}, \frac{-1073.6}{(i_1,j_4)}, \\ \frac{-5.2875\times 10^5}{(i_2,j_1)}, \frac{-5.079\times 10^5}{(i_2,j_2)}, \frac{-5.2875\times 10^5}{(i_2,j_3)}, \frac{-1073.6}{(i_2,j_4)}, \\ \frac{-528750}{(i_3,j_1)}, \frac{-523630}{i_3,j_2)}, \frac{-2347.5}{(i_3,j_3)}, \frac{-1553.2}{(i_3,j_4)}, \\ \frac{-831.67}{(i_4,j_1)}, \frac{-523630}{(i_4,j_2)}, \frac{-2347.5}{(i_4,j_3)}, \frac{-1073.6}{(i_4,j_4)} \end{array} \right\}$$

Now we make a decision. By two ways:

(1) First way:

Define a mapping $\mathbb{C}_M: X \to R$, by $\mathbb{C}_M(x) = \sum_{(i,j)\in I^2} \beta(x)(i,j)$, where

$$\beta(x)(i,j) = \begin{cases} \mathbb{C}(x)(i,j), & \mathbb{C}(x)(i,j) = max\{\mathbb{C}(x)(s,t) : (s,t) \in I^2\}, \\ 0 & Otherwise. \end{cases}$$

From the following table; (table 9 and figure 9 mapping $\mathbb{C}_M: X \to R$, by $\mathbb{C}_M(x) = \sum_{(i,j)\in I^2} \beta(x)(i,j)$)

Table 9: Mapping $\mathbb{C}_M: X \to R$, by $\mathbb{C}_M(x) = \sum_{(i,j)\in I^2} \beta(x)(i,j)$

$\hat{\mathbb{C}}$	$\hat{\mathbb{C}}(x_1)$	$\hat{\mathbb{C}}(x_2)$	$\hat{\mathbb{C}}(x_3)$	$\hat{\mathbb{C}}(x_4)$
(i_1,j_1)	0.06	0.798	70	-381.36
(i_1,j_2)	0.06	0.798	70	-381.36
(i_1,j_3)	0.06	0.158	70	-2347.5
(i_1,j_4)	0.06	0.106	70	-1073.6
(i_2,j_1)	0.092	0.798	70	-5.2875×10^5
(i_2,j_2)	0.112	0.919	70	-5.079×10^5
(i_2,j_3)	0.143	0.156	70	-5.2875×10^5
(i_2,j_4)	0.143	0.126	70	-1073. 6
(i_3,j_1)	0.28	0.092	70	-528750
(i_3,j_2)	0.118	0.28	70	-523630
(i_3,j_3)	0.764	0.106	70	-2347. 5
(i_3,j_4)	0.722	0.03408	70	-1553. 2
(i_4,j_1)	0.042	0.092	70	-831. 67
(i_4,j_2)	0.018	0.042	70	-523630
(i_4,j_3)	0.764	0.042	70	-2347. 5
(i_4,j_4)	0.764	0.042	70	-1073. 6
$\mathbb{C}_M$	4.202	4.58908	1120	-1580194

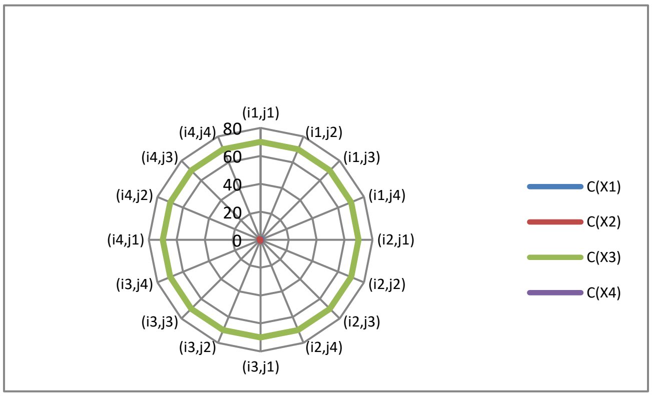

Figure 9: Mapping $\mathbb{C}_M: X \to R$, by $\mathbb{C}_M(x) = \sum_{(i,j)\in I^2} \beta(x)(i,j)$

Since $\mathbb{C}_M((x_3) = 1120 = \max \mathbb{C}_M$, then the optimal alternative for suitability of power plants based on 2-polar fuzzy soft set X Based on 3-polar Fuzzy soft set is x_3 (Wind power plant station).

(2) Second way: First give the algorithm to explain the way

Algorithm 4: Using 3-polar Fuzzy soft set.

Step 1. State $\mathcal{A},\mathcal{B} \in [([-70,70]^2)^X \times ([-70,70]^2)^X]^I = [([-70,70]^4)^X]^I = [([-70,70]^4)^I]^X = ([-70,70]^4)^{X\times I}$

Step 2. Compute $\mathbb{C} = \mathcal{A} \wedge \mathcal{B} \in [([-70,70]^2)^X \times ([-70,70]^2)^X]^I$

Step 3. Compute the 3-polar Fuzzy soft set $\hat{\mathbb{C}} \in ([-70,70]^{2\times3})^X$, defined by

$$\hat{\mathbb{C}}(x)(i,j) = 70 \wedge \sum_{k=1}^{3} (p_k{}^\circ p_1{}^\circ \mathbb{C}(x)(i,j) \times p_k{}^\circ p_2{}^\circ \mathbb{C}(x)(i,j)) \quad \forall (i,j) \in I^2, \forall x \in X)$$

Where $p_k: [-70,70]^2 \to [-70,70]$ is the k-the projection (k =1, 2, 3);

Step 4. $\mathbb{C}_M: X \to R$, by $\mathbb{C}_M(x) = \sum_{(i,j)\in I^2} \beta(x)(i,j)$, where

$$\beta(x)(i,j) = \begin{cases} \mathbb{C}(x)(i,j), & \mathbb{C}(x)(i,j) = max\{\mathbb{C}(x)(s,t) : (s,t) \in I^2\}, \\ 0 & Otherwise. \end{cases}$$

.

Step 5. Compute $m_i = \sum_{k=1}^{4} (x_k)(i,j)$, $x \in X$, $(i,j) \in (I \times I)$ and compute $r_i = \sum_{j=1}^{4} (m_i - m_j)$ $(i = 1,2,3,4)$,

Step 6. The maximal value of $r_i = \sum_{j=1}^{4} (m_i - m_j)$ $(i,j = 1,2,3,4)$ to state the optimal alternative for suitability of power plants based on 2-polar fuzzy soft set X Based on 3-polar Fuzzy soft set.
of power plants based on 2-polar fuzzy soft set X Based on 3-polar Fuzzy soft set.

The secound way, compute $m_i = \sum_{k=1}^{4} (x_k)(i,j)$, $x \in X$, $(i,j) \in (I \times I)$ and compute $r_i = \sum_{j=1}^{4} (m_i - m_j)$ $(i = 1,2,3,4)$, then , (table 10and follows table 10 Compute $m_i = \sum_{k=1}^{4} (x_k)(i,j)$, $x \in X$, $(i,j) \in (I \times I)$)

Table 10: Compute $m_i = \sum_{k=1}^{4} (x_k)(i,j)$, $x \in X$, $(i,j) \in (I \times I)$

	(i_1,j_1)	(i_1,j_2)	(i_1,j_3)	(i_1,j_4)	(i_2,j_1)	(i_2,j_2)	(i_2,j_3)	(i_2,j_4)	m_i
x_1	0.06	0.06	0.06	0.06	0.092	0.112	0.143	0.143	0.73
x_2	0.798	0.798	0.158	0.106	0.798	0.919	0.156	0.126	3.859
x_3	70	70	70	70	70	70	70	70	560
x_4	-381.36	-381.36	-2347.5	-1073.6	-5.2875×10^5	-5.079×10^5	-5.2875×10^5	-1073. 6	-4183.82

Follows table 10: Compute $m_i = \sum_{k=1}^{4}(x_k)(i,j)$, $x \in X$, $(i,j) \in (I \times I)$

	(i_3,j_1)	(i_3,j_2)	(i_3,j_3)	(i_3,j_4)	(i_4,j_1)	(i_4,j_2)	(i_4,j_3)	(i_4,j_4)	m_i
x_1	0.28	0.118	0.764	0.722	0.042	0.018	0.764	0.764	3.472
x_2	0.092	0.28	0.106	0.03408	0.092	0.042	0.042	0.042	0.73008
x_3	70	70	70	70	70	70	70	70	560
x_4	-528750	-523630	-2347. 5	-1553. 2	-831. 67	-523630	-2347. 5	-1073. 6	-1576010

From table 10 and follows 10 we obtain

$m_1 = 4.202, m_2 = 4.58908, \ m_3 = \ 1120, \ m_4 = \ -1580194$

Now, calculate,

$r_1 = (m_1 - m_1) + (m_1 - m_2) + (m_1 - m_3) + (m_1 - m_4) = (4.202 - 4.202) + (4.202 - 4.58908) + (4.202 - 1120) + (4.202 + 1580194) = 1579082$

; Similarity, $r_2 = 1579084$, $r_3 = 1583545$, $r_4 =$ -6319665

Since $r_3 = 1583545 = \max r_i$, then the optimal alternative for suitability of power plants based on 2-polar fuzzy soft set X Based on 3-polar Fuzzy soft set is x_3 (wind power plant station).

Now, find the optimal alternative for **s**uitability of power plants based on 2-polar fuzzy soft set X Based on 3-polar Fuzzy soft set by using the operator ∨,

First compute $\mathbb{C} = \mathcal{A} \vee \mathcal{B}$. SO compute $\mathbb{C}$.

$$\mathbb{C}(i_1,i_1) = \left\{ \frac{\langle(0.5,0.3),(0.4,0.2),(0.4,0.3)\rangle}{x_1}, \frac{\langle(0.9,0.8),(0.8,0.7),(0.9,0.8)\rangle}{x_2}, \frac{\langle(18.6,16.5),(18.6,15.7),(18.56,17.18)\rangle}{x_3}, \frac{\langle(-5.6,-6.75),(-5.76,-5.87),(-4.6,-5.88)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_1,i_2) = \left\{ \frac{\langle(0.4,0.3),(0.5,0.3),(0.5,0.3)\rangle}{x_1}, \frac{\langle(0.9,0.8),(0.9,0.7),(0.9,0.8)\rangle}{x_2}, \frac{\langle(60.6,57.5),(60.6,57.7),(64.6,61.8)\rangle}{x_3}, \frac{\langle(-5.6,-6.75),(-5.76,-6.87),(-4.6,-5.88)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_1,i_3) = \left\{ \frac{\langle(0.8,0.7),(0.8,0.6),(0.8,0.6)\rangle}{x_1}, \frac{\langle(0.9,0.8),(0.8,0.7),(0.9,0.8)\rangle}{x_2}, \frac{\langle(18.6,17.5),(19.6,18.7),(21.6,19.8)\rangle}{x_3}, \frac{\langle(-5.6,-6.75),(-5.76,-6.87),(-4.6,-5.88)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_1,i_4) = \left\{ \frac{\langle(0.8,0.7),(0.8,0.6),(0.8,0.5)\rangle}{x_1}, \frac{\langle(0.9,0.8),(0.8,0.7),(0.9,0.8)\rangle}{x_2}, \frac{\langle(18.6,16.5),(17.6,15.7),(17.56,17.18)\rangle}{x_3}, \frac{\langle(-5.6,-6.75),(-5.76,-6.87),(-4.6,-5.88)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_2,i_1) = \left\{ \frac{\langle(0.5,0.3),(0.5,0.2),(0.5,0.3)\rangle}{x_1}, \frac{\langle(0.9,0.8),(0.8,0.7),(0.9,0.7)\rangle}{x_2}, \frac{\langle(60.6,55.5),(62.6,56.7),(65.6,60.8)\rangle}{x_3}, \frac{\langle(-6.6,-6.75),(-5.76,-5.87),(-5.6,-5.88)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_2,i_2) = \left\{ \frac{\langle(0.5,0.3),(0.5,0.3),(0.5,0.3)\rangle}{x_1}, \frac{\langle(0.9,0.8),(0.9,0.7),(0.9,0.7)\rangle}{x_2}, \frac{\langle(60.6,57.5),(62.6,57.7),(65.6.6,61.8)\rangle}{x_3}, \frac{\langle(-60.6,-64.5),(-62.6,-64.7),(-62.6,-64.8)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_2,i_3) = \left\{ \frac{\langle(0.8,0.7),(0.8,0.6),(0.8,0.6)\rangle}{x_1}, \frac{\langle(0.9,0.8),(0.8,0.7),(0.9,0.7)\rangle}{x_2}, \frac{\langle(60.6,55.5),(62.6,56.7),(65.6,60.8)\rangle}{x_3}, \frac{\langle(-10.6,-10.8),(-10.9,-11.7),(-9.6,-9.8)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_2,i_4) = \left\{ \frac{\langle(0.8,0.7),(0.8,0.6),(0.8,0.5)\rangle}{x_1}, \frac{\langle(0.9,0.8),(0.8,0.7),(0.9,0.7)\rangle}{x_2}, \frac{\langle(60.6,55.5),(62.6,56.7),(65.6,60.8)\rangle}{x_3}, \frac{\langle(-7.6,-8.5),(-8.6,-8.7),(-7.6,-7.8)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_3,i_1) = \left\{ \frac{\langle(0.9,0.8),(0.8,0.7),(0.8,0.7)\rangle}{x_1}, \frac{\langle(0.8,0.7),(0.7,0.6),(0.9,0.7)\rangle}{x_2}, \frac{\langle(19.6,17.5),(20.6,19.7),(20.6,18.8)\rangle}{x_3}, \frac{\langle(-6.6,-6.75),(-5.76,-5.87),(-5.6,-5.88)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_3,i_2) = \left\{ \frac{\langle(0.9,0.8),(0.8,0.7),(0.8,0.7)\rangle}{x_1}, \frac{\langle(0.9,0.7),(0.9,0.7),(0.8,0.7)\rangle}{x_2}, \frac{\langle(60.6,57.5),(60.6,57.7),(64.6,61.8)\rangle}{x_3}, \frac{\langle(-10.4,-10.5),(-9.6,-9.7),(-5.6,-6.8)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_3,i_3) = \left\{ \frac{\langle(0.9,0.8),(0.8,0.7),(0.8,0.7)\rangle}{x_1}, \frac{\langle(0.5,0.4),(0.6,0.5),(0.6,0.5)\rangle}{x_2}, \frac{\langle(19.6,17.5),(20.6,19.7),(21.6,19.8)\rangle}{x_3}, \frac{\langle(-10.4,-10.5),(-9.6,-9.7),(-5.6,-6.8)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_3,i_4) = \left\{ \frac{\langle(0.9,0.8),(0.8,0.7),(0.8,0.7)\rangle}{x_1}, \frac{\langle(0.5,0.4),(0.6,0.5),(0.6,0.5)\rangle}{x_2}, \frac{\langle(19.6,17.5),(20.6,19.7),(20.6,18.8)\rangle}{x_3}, \frac{\langle(-7.6,-8.5),(-8.6,-8.7),(-5.6,-6.8)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_4,i_1) = \left\{ \frac{\langle(0.9,0.8),(0.8,0.7),(0.9,0.8)\rangle}{x_1}, \frac{\langle(0.8,0.7),(0.7,0.6),(0.9,0.7)\rangle}{x_2}, \frac{\langle(17.6,16.5),(18.6,15.7),(18.56,17.18)\rangle}{x_3}, \frac{\langle(-6.6,-6.75),(-5.76,-5.87),(-5.6,-5.88)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_4,i_2) = \left\{ \frac{\langle(0.9,0.8),(0.8,0.7),(0.9,0.8)\rangle}{x_1}, \frac{\langle(0.9,0.7),(0.9,0.7),(0.8,0.7)\rangle}{x_2}, \frac{\langle(10.6,10.5),(10.6,10.7),(10.6,10.8)\rangle}{x_3}, \frac{\langle(-6.6,-7.5),(-7.6,-7.7),(-7.6,-7.8)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_4,i_3) = \left\{ \frac{\langle(0.9,0.8),(0.8,0.7),(0.9,0.8)\rangle}{i_1}, \frac{\langle(0.5,0.3),(0.6,0.4),(0.4,0.3)\rangle}{x_2}, \frac{\langle(18.6,17.5),(19.6,18.7),(21.6,19.8)\rangle}{i_3}, \frac{\langle(-6.6,-7.5),(-7.6,-7.7),(-7.6,-7.8)\rangle}{x_4} \right\}$$

$$\mathbb{C}(i_4,i_4) = \left\{ \frac{\langle(0.9,0.8),(0.8,0.7),(0.9,0.8)\rangle}{i_1}, \frac{\langle(0.4,0.2),(0.5,0.3),(0.5,0.1)\rangle}{x_2}, \frac{\langle(11.6,10.5),(11.6,10.7),(10.6,10.8)\rangle}{i_3}, \frac{\langle(-6.6,-7.5),(-7.6,-7.7),(-7.6,-7.8)\rangle}{x_4} \right\}$$

Secondly, compute the 3-polar Fuzzy soft set $\hat{\mathbb{C}} \in ([-70,70]^{2\times3})^X$, defined by

$$\hat{\mathbb{C}}(x)(i,j) = 70 \wedge \sum_{k=1}^{3}(p_k{}^\circ p_1{}^\circ \mathbb{C}(x)(i,j) \times p_k{}^\circ p_2{}^\circ \mathbb{C}(x)(i,j)\ ) \quad \forall (i,j) \in I^2, \forall x \in X)$$

Where p_k: $[-70,70]^2 \to [-70,70]$ is the k-the projection (k =1, 2, 3);

$\hat{\mathbb{C}}(x_1)(i_1,j_1) = (70) \wedge [(0.5 \times 0.4 \times 0.4) + (0.3 \times 0.2 \times 0.3)] = (70) \wedge (0.098) = 0.098$; Similarly; (table 11 and figure 10, compute $\hat{\mathbb{C}}(x)(i,j) \in ([-70,70]^{2\times3})^X$)

Table 11: Compute $\hat{\mathbb{C}}(x)(i,j) \in ([-70,70]^{2\times3})^X$

$\hat{\mathbb{C}}$	$\hat{\mathbb{C}}(x_1)$	$\hat{\mathbb{C}}(x_2)$	$\hat{\mathbb{C}}(x_3)$	$\hat{\mathbb{C}}(x_4)$
(i_1,j_1)	0.098	1. 096	70	-381. 36
(i_1,j_2)	0.127	1. 177	70	-421. 05
(i_1,j_3)	0.764	1. 096	70	-421. 05
(i_1,j_4)	0.722	1. 096	70	-421. 05
(i_2,j_1)	0.143	1. 04	70	-445. 87
(i_2,j_2)	0.152	1. 121	70	-5.074×10^5
(i_2,j_3)	0.764	1. 04	70	-2347. 5
(i_2,j_4)	0.722	1. 04	70	-1073. 6
(i_3,j_1)	0.968	0.798	70	-445. 87
(i_3,j_2)	0.968	0.991	70	-1251. 7
(i_3,j_3)	0.968	0.28	70	-1251. 7
(i_3,j_4)	0.968	0.28	70	-868. 88
(i_4,j_1)	1. 096	0.798	70	-445. 87
(i_4,j_2)	1. 096	0.991	70	-831. 67
(i_4,j_3)	1. 096	0.156	70	-831. 67
(i_4,j_4)	1. 096	0.106	70	-831. 67

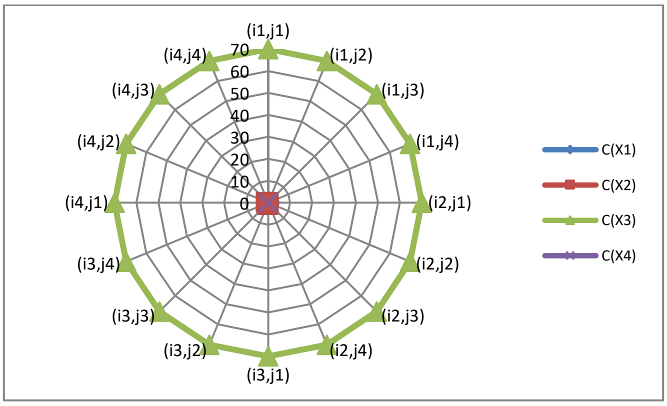

Figure 10: Compute $\hat{\mathbb{C}}(x)(i,j) \in ([-70,70]^{2\times3})^X$

Therfore,

$$\hat{\mathbb{C}}(x_1) = \left\{ \begin{array}{c} \frac{0.098}{(i_1,j_1)}, \frac{0.127}{(i_1,j_2)}, \frac{0.764}{(i_1,j_3)}, \frac{0.722}{(i_1,j_4)}, \\ \frac{0.143}{(i_2,j_1)}, \frac{0.152}{(i_2,j_2)}, \frac{0.764}{(i_2,j_3)}, \frac{0.722}{(i_2,j_4)}, \\ \frac{0.968}{(i_3,j_1)}, \frac{0.9688}{(i_3,j_2)}, \frac{0.968}{(i_3,j_3)}, \frac{0.968}{(i_3,j_4)}, \\ \frac{1.096}{(i_4,j_1)}, \frac{1.096}{(i_4,j_2)}, \frac{1.096}{(i_4,j_3)}, \frac{1.096}{(i_4,j_4)} \end{array} \right\}$$

$$\hat{\mathbb{C}}(x_2) = \left\{ \begin{array}{c} \frac{1.096}{(i_1,j_1)}, \frac{1.177}{(i_1,j_2)}, \frac{1.096}{(i_1,j_3)}, \frac{1.096}{(i_1,j_4)}, \\ \frac{1.04}{(i_2,j_1)}, \frac{1.121}{(i_2,j_2)}, \frac{1.04}{(i_2,j_3)}, \frac{1.04}{(i_2,j_4)}, \\ \frac{0.798}{(i_3,j_1)}, \frac{0.991}{i_3,j_2)}, \frac{0.28}{(i_3,j_3)}, \frac{0.28}{(i_3,j_4)}, \\ \frac{0.798}{(i_4,j_1)}, \frac{0.991}{(i_4,j_2)}, \frac{0.156}{(i_4,j_3)}, \frac{0.106}{(i_4,j_4)} \end{array} \right\}$$

$$\hat{\mathbb{C}}(x_3) = \left\{ \begin{array}{c} \frac{70}{(i_1,j_1)}, \frac{70}{(i_1,j_2)}, \frac{70}{(i_1,j_3)}, \frac{70}{(i_1,j_4)}, \\ \frac{70}{(i_2,j_1)}, \frac{70}{(i_2,j_2)}, \frac{70}{(i_2,j_3)}, \frac{70}{(i_2,j_4)}, \\ \frac{70}{(i_3,j_1)}, \frac{70}{i_3,j_2)}, \frac{70}{(i_3,j_3)}, \frac{70}{(i_3,j_4)}, \\ \frac{70}{(i_4,j_1)}, \frac{70}{(i_4,j_2)}, \frac{70}{(i_4,j_3)}, \frac{70}{(i_4,j_4)} \end{array} \right\}$$

$$\hat{\mathbb{C}}(x_4) = \left\{ \begin{array}{c} \frac{-381.36}{(i_1,j_1)}, \frac{-421.05}{(i_1,j_2)}, \frac{-421.05}{(i_1,j_3)}, \frac{-421.05}{(i_1,j_4)}, \\ \frac{-445.87}{(i_2,j_1)}, \frac{-5.074\times10^5}{(i_2,j_2)}, \frac{-5.2875\times10^5}{(i_2,j_3)}, \frac{-1073.6}{(i_2,j_4)}, \\ \frac{-445.87}{(i_3,j_1)}, \frac{-1251.7}{i_3,j_2)}, \frac{-1251.7}{(i_3,j_3)}, \frac{-868.88}{(i_3,j_4)}, \\ \frac{-445.87}{(i_4,j_1)}, \frac{-831.67}{(i_4,j_2)}, \frac{-831.67}{(i_4,j_3)}, \frac{-831.67}{(i_4,j_4)} \end{array} \right\}$$

Now we make a decision. By two ways:

(1) First way:

Define a mapping $\mathbb{C}_M: X \to R$, by $\mathbb{C}_M(x) = \sum_{(i,j)\in I^2} \beta(x)(i,j)$, where

$$\beta(x)(i,j) = \begin{cases} \mathbb{C}(x)(i,j), & \mathbb{C}(x)(i,j) = max\{\mathbb{C}(x)(s,t) : (s,t) \in I^2\}, \\ 0 & 0therwise. \end{cases}$$

From the following table; (table 12 and figure 11, mapping $\mathbb{C}_M: X \to R$, by $\mathbb{C}_M(x) = \sum_{(i,j)\in I^2} \beta(x)(i,j)$)

Table 12: mapping $\mathbb{C}_M: X \to R$, by $\mathbb{C}_M(x) = \sum_{(i,j)\in I^2} \beta(x)(i,j)$

$\hat{\mathbb{C}}$	$\hat{\mathbb{C}}(x_1)$	$\hat{\mathbb{C}}(x_2)$	$\hat{\mathbb{C}}(x_3)$	$\hat{\mathbb{C}}(x_4)$
(i_1,j_1)	0.098	1. 096	70	-381. 36
(i_1,j_2)	0.127	1. 177	70	-421. 05
(i_1,j_3)	0.764	1. 096	70	-421. 05
(i_1,j_4)	0.722	1. 096	70	-421. 05
(i_2,j_1)	0.143	1. 04	70	-445. 87
(i_2,j_2)	0.152	1. 121	70	-5.074×10^5
(i_2,j_3)	0.764	1. 04	70	-2347. 5
(i_2,j_4)	0.722	1. 04	70	-1073. 6
(i_3,j_1)	0.968	0.798	70	-445. 87
(i_3,j_2)	0.968	0.991	70	-1251. 7
(i_3,j_3)	0.968	0.28	70	-1251. 7
(i_3,j_4)	0.968	0.28	70	-868. 88
(i_4,j_1)	1. 096	0.798	70	-445. 87
(i_4,j_2)	1. 096	0.991	70	-831. 67
(i_4,j_3)	1. 096	0.156	70	-831. 67
(i_4,j_4)	1. 096	0.106	70	-831. 67
$\mathbb{C}_M$	7.266	4.4	1120	-507400

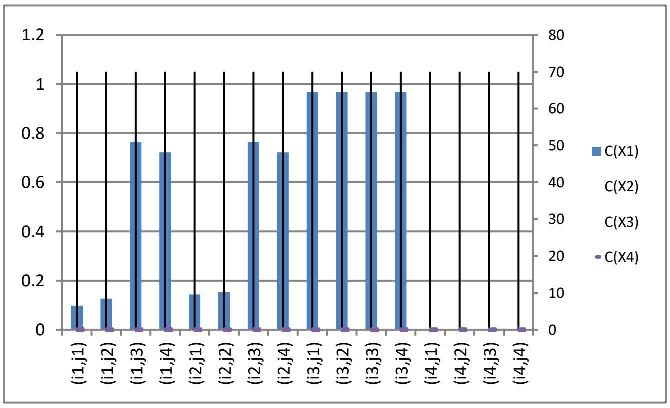

Figure 11: Mapping $\mathbb{C}_M: X \to R$, by $\mathbb{C}_M(x) = \sum_{(i,j)\in I^2} \beta(x)(i,j)$

Since $\mathbb{C}_M((x_3) = 1120 =$ max $\mathbb{C}_M$,then the optimal alternative for suitability of power plants based on 2-polar fuzzy soft set X Based on 3-polar Fuzzy soft set is x_3 (Wind power plant station).

Motivated from the above problem, we give the following algorithm for decision- making problem:

Algorithm 5: Using 3-polar Fuzzy soft set.

Step 1. State $\mathcal{A}, \mathcal{B} \in [([-70,70]^2)^X \times ([-70,70]^2)^X]^I = [([-70,70]^4)^X]^I = [([-70,70]^4)^I]^X = ([-70,70]^4)^{X\times I}$

Step 2. Compute $\mathbb{C} = \mathcal{A} \vee \mathcal{B} \in [([-70,70]^2)^X \times ([-70,70]^2)^X]^I$

Step 3. Compute the 3-polar Fuzzy soft set $\hat{\mathbb{C}} \in ([0,60]^{2\times3})^X$, defined by

$$\hat{\mathbb{C}}(x)(i,j) = 70 \wedge \sum_{k=1}^{3} (p_k{^\circ}p_1{^\circ}\mathbb{C}(x)(i,j) \times p_k{^\circ}p_2{^\circ}\mathbb{C}(x)(i,j)) \quad \forall (i,j) \in I^2, \forall x \in X)$$

Where $p_k: [-70,70]^2 \to [-70,70]$ is the k-the projection (k =1, 2, 3);

Step 4. $\mathbb{C}_M: X \to R$, by $\mathbb{C}_M(x) = \sum_{(i,j)\in I^2} \beta(x)(i,j)$, where

$$\beta(x)(i,j) = \begin{cases} \mathbb{C}(x)(i,j), & \mathbb{C}(x)(i,j) = max\{\mathbb{C}(x)(s,t) : (s,t) \in I^2\}, \\ 0 & 0therwise. \end{cases}$$

.

Step 5. The maximal value of $\mathbb{C}_M$ to state optimal alternative for suitability of power plants based on 2-polar fuzzy soft set X Based on 3-polar Fuzzy soft set

(2) Second way:

Compute $m_i = \sum_{k=1}^{4}(x_k)(i,j)$, $x \in X$, $(i,j) \in (I \times I)$ and compute $r_i = \sum_{j=1}^{4}(m_i - m_j)$ $(i = 1,2,3,4)$, then , (table 13 and follows 13 Compute $m_i = \sum_{k=1}^{4}(x_k)(i,j)$, $x \in X$, $(i,j) \in (I \times I)$)

Table 13: Compute $m_i = \sum_{k=1}^{4}(x_k)(i,j)$, $x \in X$, $(i,j) \in (I \times I)$

	(i_1,j_1)	(i_1,j_2)	(i_1,j_3)	(i_1,j_4)	(i_2,j_1)	(i_2,j_2)	(i_2,j_3)	(i_2,j_4)	m_i
x_1	0.098	0.127	0.764	0.722	0.143	0.152	0.764	0.722	3.394
x_2	1. 096	1. 177	1. 096	1. 096	1. 04	1. 121	1. 04	1. 04	8.706
x_3	70	70	70	70	70	70	70	70	560
x_4	-381. 36	-421. 05	-421. 05	-421. 05	-445. 87	-5. 074×10^5	-2347. 5	-1073. 6	-381. 37

Follows table 13: Compute $m_i = \sum_{k=1}^{4}(x_k)(i,j)$, $x \in X$, $(i,j) \in (I \times I)$

	(i_3,j_1)	(i_3,j_2)	(i_3,j_3)	(i_3,j_4)	(i_4,j_1)	(i_4,j_2)	(i_4,j_3)	(i_4,j_4)	m_i
x_1	0.968	0.968	0.968	0.968	1. 096	1. 096	1. 096	1. 096	3.872
x_2	0.798	0.991	0.28	0.28	0.798	0.991	0.156	0.106	4.4
x_3	70	70	70	70	70	70	70	70	560
x_4	-445. 87	-1251. 7	-1251. 7	-868. 88	-445. 87	-831. 67	-831. 67	-831. 67	-6759.03

From table 13 and follows 13 we obtain,

$m_1 = 7.266$, $m_2 = 13.106$, $m_3 = 1120$, $m_4 = -6759.03$

Now, calculate,

$r_1 = (m_1 - m_1) + (m_1 - m_2) + (m_1 - m_3) + (m_1 - m_4) = 0 + (7.266 - 13.106) + (7.266 - 1120) + (7.266 + 6759.03) = 5647.722$; Similarity, $r_2 = 5671.082$, $r_3 = 10098.66$

, $r_4 =$ -21417.5 Since $r_3 = 10098.66 = \max r_i$, then the optimal alternative for suitability of power plants based on 2-polar fuzzy soft set X Based on 3-polar Fuzzy soft set is x_3 (Wind power plant station).

Motivated from the above problem, we give the following algorithm for decision- making problem:

Algorithm 6: Using 3-polar Fuzzy soft set.

Step 1. State $\mathcal{A},\mathcal{B} \in [([-70,70]^2)^X \times ([-70,70]^2)^X]^I = [([-70,70]^4)^X]^I = [([-70,70]^4)^I]^X = ([-70,70]^4)^{X\times I}$

Step 2. Compute $\mathbb{C} = \mathcal{A} \wedge \mathcal{B} \in [([-70,70]^2)^X \times ([-70,70]^2)^X]^I$

Step 3. Compute the 3-polar Fuzzy soft set $\hat{\mathbb{C}} \in ([-70,70]^{2\times 3})^X$, defined by

$\hat{\mathbb{C}}(x)(i,j) = 60 \wedge \sum_{k=1}^{3}(p_k \circ p_1 \circ \mathbb{C}(x)(i,j) \times p_k \circ p_2 \circ \mathbb{C}(x)(i,j))$ $\forall (i,j) \in I^2, \forall x \in X)$

Where $p_k: [-70,70]^2 \rightarrow [-70,70]$ is the k-the projection (k =1, 2, 3);

Step 4. Compute $m_i = \sum_{k=1}^{4}(x_k)(i,j)$, $x \in X$, $(i,j) \in (I \times I)$ and compute $r_i = \sum_{j=1}^{4}(m_i - m_j)$ $(i = 1,2,3,4,5)$,

Step 5. The maximal value of $r_i = \sum_{j=1}^{4}(m_i - m_j)$ $(i,j = 1,2,3,4,5)$ to state the optimal alternative for suitability of power plants based on 2-polar fuzzy soft set X Based on 3-polar Fuzzy soft set.

4. Conclusion

The major contributions in this paper can be summarized as follows:

1. We arrives to put a standard of optimal alternative for suitability of power plants based on m-polar fuzzy soft set
2. A novel design and model of real-life applications. And explained in the Existing literature the ways to best choice of alternative for suitability of power plants
3. Studies the results of Fossil power plant station, Nuclear power plant station, Wind power plant station, Solar power plant station, Hydro power plant station, Wave power plant station, Tidal range power plant, Biogas power plant, Coal, under effective Renewable, Visual impact, Capital cost, Maintenance cost, Environmental impact, Green gas emissions, Implementation time, Cost Cent/Kwh, Danger of series accidents and Waste problem for all power plants
4. The algorithm of outcomes of these analyses is additional observed and an m-polar fuzzy soft set decision making criterion is used to decide the optimal alternative for suitability of power plants applications.

In the future, we shall apply more advanced theories into Pythagorean fuzzy set decision making based on Pythagorean fuzzy set.

Data Availability

No data were used to support this study

Conflicts of Interest

The author declares no conflicts of interest

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Authors' Contributions

All authors contributed equally

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