

Selection of a Biomass Product using a Hybrid Approach of BW-PROMETHEE

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Abstract

The selection of suitable biomass is an important stage in the generation of biofuels, which has a significant impact on the quality of biofuels. The selection of biomass is a strategic decision and, considering with the selection of the raw material for the generation of suitable biomass is influenced by various social, economic and environmental factors, it turns into a multi-criteria decision-making (MCDM) problem. By reviewing the literature in this paper, we identify the important criteria of suitable seed oil which includes 16 social, economic and environmental criteria and three options for soybean, rapeseed (colza) and cotton for the generation of biomass. Then we use a hybrid approach to determine the weight of the criteria and ranking the alternatives so we first determine the weight of the criteria using the Best-Worst (BW) method. Then we rank with PROMETHEE GAIA method the alternatives and analyze the model.

Keywords

Best-Worst Method, PROMETHEE, Biomass, MADM, Seed Oil

1. Introduction

Over the past decades, research and development of alternative fuels, including biofuels, has been increased because of reducing fossil fuels, energy security and the impact that fossil fuels have on the environment, such as greenhouse gas emissions. Biofuels are sustainable renewable energy sources that can reduce the environmental impact of fossil fuels. Biomass is the primary source of bioenergy and biofuels, bioethanol and biodiesel are among of most important biofuels. That this study focuses on biodiesel production.

After the 1970s oil crisis, many countries started planning to use more biofuels to reduce dependence on fossil fuels (Timilsina and Shrestha, 2011), for example, in Iran, according to the perspective document, by the year 2025, 20

percent of the country's energy should be supplied from renewable energy sources. According to forecasts, the fuel and energy industry will be expanding from the biomass in the next decade.

Among the renewable energy sources, biomass is the only resource that can be saved easily and used whenever needed and converted to alternative liquid fuels for the daily transportation system. Even the transportation system does not require a lot of changes, or there is no need to change at all. The selection of suitable biomass is important and one of the most important stages in the production of biofuels, which can affect the next stages. Studies show that different countries use different plants to produce biofuels (Matsumoto et al., 2009). Because of various geographic conditions and technical capabilities of countries are different, for example, bioethanol is often produced from sugarcane in Brazil. The selection of the product type for bio-based production is one of the most important decisions for the production of biofuels that have the economic, environmental and social impacts (Bueyuektahtakin and Cobuloglu, 2014). Type of product affects the selection of equipment agricultural land allocation. On the other hand, this subject affects the erosion of soil and water quality, which determines the future production in that land (Blanco-Canqui, 2010). As well as product type effects on the unemployment rate, working conditions and social welfare (Kaffka et al., 2006). In Iran, due to the increasing trend of fossil fuel consumption, in the near future, an energy exporter will become a single importer, the major driver of diesel and diesel consumption in the transportation sector (Ghobadian et al., 2009). In Iran, biofuels from agricultural materials have a lot of potential for development (Najafi et al., 2009). Biodiesel is considered as an alternative to diesel in Iran.

One of the most suitable biomass is the use of oilseeds. In this research, we are considering the different criteria and using multiple Attribute Decision making (MADM) after selecting the suitable seed oil for the production of biomass. According to studies, ideally, the production of biodiesel produced from oilseeds in Iran is covered by the 2% of diesel demand. This is the best option because there is no need to change combustion engines (Ardebili et al., 2011). Oilseeds for biodiesel production include rapeseed (colza), soybean, cotton, hazelnut, olive, sunflower seeds, almonds, corn, coconut, walnut, and so on. According to the research, the first three are the most desirable sources for biodiesel production in Iran. This study aims to prioritize these three options in Iran.

In the rest of the paper, first, in the next section, literature review and in Section 3, we will define the problem and the proposed model. Then, in Section 4, we use the combined method introduced in the previous section in the proposed problem, and in Section 5 we will analyze the sensitivity of the proposed model.

2. Literature review

MCDM has been widely used in many renewable energy issues. For example, various methods of MCDM and their combination in determining the best renewable energy source have been used extensively, which can be studied in Kabak and Dağdeviren (2014), Yazdani-Chamzini et al. (2013) and Büyüközkan and Güleriyüz (2016). Among of different methods of MCDM and their combination in the field of biofuels have been used from biomass production to the biofuels supply chain and the effectiveness of these methods has been proven in this area. Here are some biofuel studies in which MCDM methods have been used.

AHP and Monte Carlo simulation methods have been used in research to determine the proper crop system for algal species to produce bio-diesel from these. The algae are evaluated using three different culture methods. (Ubando et al., 2014). In other research with using of TOPSIS method, it is identified that fuzzy conditions of biological refineries location. This has nine criteria and 32 sub-criteria for this issue (Zhou et al., 2012). In another research, the aim is to select the best biodiesel compound for a single-cylinder engine. Fuzzy AHP is used to weigh the criteria. The combination of GRA and TOPSIS techniques is used to prioritize options (Sakthivel et al., 2014).

The purpose of this study is to select suitable biomass that has been investigated for various purposes. Several studies have used MCDM methods. In a study on the bioethanol derived from agricultural residues, authors cited the potential of various types of cellulose biomass and showed that the bioethanol production of this method covers one-third of the Austrian gasoline demand (Kahr et al., 2013). Researchers study the ratio of fiber and sucrose to the biomass derived from four types of sugarcane using a completely randomized block design (RCBD) (Santchurn et al., 2014). Researchers have developed the TOPSIS model to select suitable biomass for use in boilers. They rated three biomes under the criteria of productivity, price, and ease of use, global warming, and acidification (Saelee et al., 2014). The research of Nwokoagbara et al. (2015) aimed to select the best microalga for the generation of third-generation biodiesel. In this study, a MADM method has been used to solve this problem. In another study, researchers have used the AHP method to select biomass production under fuzzy conditions. They have defined 16 sub-criteria for the

selection of stable biomass. Their choices are cultivated products in Kansas, which prioritize options and criteria (Bueyuektahtakin and Cobuloglu, 2014). These researchers have investigated this issue by random method AHP and have shown the superiority of this method under the fuzzy condition (Cobuloglu and Büyüktaktakin, 2015). (Ardebili et al., 2011) are investigated using of statistics and forecasting future energy consumption, the opportunities and challenges of biodiesel production using oilseeds and the potential of oilseed planting in Iran and, as a result, oilseeds are a good option for biodiesel production that has been introduced in Iran.

In this research, we seek to use MADM considering different criteria with the aim of determining the importance of criteria and prioritizing the biomass from oilseeds in Iran.

3. Suggested Formulation

Several approaches are employed in the literature to evaluate alternatives, such as TOPSIS, PROMETHEE-II, DEA, and intelligent methods. Also, Simulation-based approaches are used to evaluate policies, alternatives, and scenarios. The use of MCDM methods is very suitable for evaluating and ranking subject that has different and conflicting metrics (Hamid et al., 2018b). MCDM methods are widely used in different problems such as healthcare systems optimization (Hamid et al., 2018a, Hamid et al., 2018c, Yazdanparast et al., 2018, Habibifar et al., 2019, Hamid et al., 2019, Hamid et al., 2017), safety optimization (Azadeh et al., 2016, Babajani et al., 2019), scheduling problem (Jamili et al., 2018), manufacture systems optimization (Gharoun et al., 2019), and Time, Cost and Quality Tradeoff Optimization (Mokhtari et al., 2012). On the other hand, the choice of an appropriate decision-making method is critical and requires careful consideration amongst existing methods. Different models have been proposed to choose the best method in recent years. According to our problem is biomass selection for the bio-diesel production and this issue is influenced by various social, economic, and environmental contradictions, therefore can be an effective use of MCDM. In this paper, we intend to determine the criteria weight by the Best-Worst method (BWM), which is a new method. One of the reasons for choosing this method is to reduce the computing volume in comparison with other methods, such as AHP, and the need for all of the paired-comparison matrix data. In the following, we used to rank the alternative with the PROMETHEE method because of this method has always been recognized as one of the best and most effective decision-making methods. In addition to we can use the PROMETHEE GAIA method with graphically and analyzed results capability.

3.1 Best-worst method (BWM)

The BWM method was proposed to determine the weight of criteria and rank the options of an MCDM problem by (Rezaei, 2015).

Let we have n criteria and m alternative. The decision matrix of our problem is represented in Figure 1 In which X_{mn} shows the function alternative m of criteria n , also shown as $g_{C_n}(A_m)$.

Criteria \ Alternative	$C1$	$C2$...	Cn
$A1$	X_{11}	X_{12}	...	X_{1n}
$A2$	X_{21}	X_{22}	...	X_{2n}
...
Am	X_{m1}	X_{m2}	...	X_{mn}

Figure 1. Decision matrix

BWM does not need to a decision matrix, but we need the matrix of pairwise comparisons. If we make a pairwise comparison with a scale of 9/1 to 9, the matrix A is obtained, where a_{ij} represents the relative performance of criterion i to j criterion (Eq (1)).

$$A = \begin{pmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{pmatrix} \quad (1)$$

Steps of this method;

Step 1- determining the set of criteria: At this step, we consider the criteria $C_1, C_2... C_n$ to be used in decision making.

Step 2- Identify the best criteria: (in other words, the most desirable and most important criterion) and the worst criterion (the most undesirable and the most important criterion). In this section, the decision maker outlines the best and worst criteria generally.

Step 3: Determine the performance of the best criteria against other criteria using numbers between 1 and 9.

Step 4: calculate all criteria performance against the worst criterion using numbers between 1 and 9.

Step 5: Find the optimal weights ($w_1^*, w_2^*... w_n^*$). Find the criteria weight that is proposed following model, where w_j is the j criterion weight, w_B is the best criterion weight, and w_w is the worst criterion (Eq(2)).

$$\min \max_j \left\{ \left| \frac{w_B}{w_j} - a_{Bj} \right|, \left| \frac{w_j}{w_w} - a_{jw} \right| \right\}$$

S.T;

$$\sum_j w_j = 1 \quad (2)$$

$$w_B \geq w_j \quad \forall j, B$$

$$w_j \geq w_w \quad \forall j, w$$

Which can be expressed as Eq(3):

$$\min \varepsilon$$

S.T;

$$\left| \frac{w_B}{w_j} - a_{Bj} \right| \leq \varepsilon \quad \forall j$$

$$\left| \frac{w_j}{w_w} - a_{jw} \right| \leq \varepsilon \quad \forall j$$

$$\sum_j w_j = 1 \quad (3)$$

Step 6: we obtain the optimal values of weights and ε^* by Solving the problem model in Eq. (3). Using the value of ε^* , a compatibility rate is defined(Eq.(4)):

$$\text{compatibility rate} = \frac{\varepsilon}{\text{compatibility index}} \quad (4)$$

That the value of the compatibility index(CI) is obtained according to abw from Table 1.

Table 1.CI for different values of aBW

abw	1	2	3	4	5	6	7	8	9
CI	0.00	0.44	1.00	1.63	2.30	3.00	3.73	4.47	5.23

3.2 PROMETHEE method

The PROMETHEE method was introduced to rank in the 1980s by two Belgian professors Jean Pierre Brans and Bertrand Mareschal (Mareschal et al., 1984). PROMETHEE 's disadvantage is that it does not provide an approach for weighting the criteria and leaves this to the decision maker. We also use to weigh the criteria to overcome the weakness of this method by BWM. The PROMETHEE family has six types, the PROMETHEE Type I and II articles are used in this paper. PROMETHEE I categorizes the alternatives in detail. PROMETHEE II categorizes discrete alternatives fully.

Before applying this method, the three inputs, including (w_j), weight of the criteria (g_j) and function of each option in each criterion (P_j). according to the decision maker preferred functions are determined for each criterion, according to following steps were taken:

Step 1: Calculate the overall preference index $\pi(a, b)$ for all pairs of options (a, b) Eq (5) to Eq (7):

$$d_j(a, b) = g_j(a) - g_j(b) \quad (5)$$

$$P_j(a, b) = P_j(d_j(a, b)) \quad (6)$$

$$\pi(a, b) = \frac{\sum_{j=1}^n P_j(a, b) w_j}{\sum_{j=1}^n w_j} \quad (7)$$

Brans et al. (Mareschal et al., 1984) Have proposed to facilitate the subject six types of decision-making functions, which include: Normal, U-shaped, V-shaped, Level-level, V-shaped with the Gaussian indifference and standard, which according to the type of criterion for each criterion one the function is considered by the decision maker.

Step 2: Calculate of Implicit flow Currents or Output and Input Currents. If the total number of options is m , then any alternative is competing such as a with $m-1$ option. That we can define two following implied mastering tactics for each option:

Output flow determines an alternative that is superior to other alternatives. The higher value is a better option.

$$\phi^+(a) = \frac{1}{m-1} \sum_{\substack{x \in A \\ x \neq a}} \pi(a, x) \quad (8)$$

Input flow calculates how much other alternatives are superior to option a . The smaller alternative is better. In other words, the average degree of mastering of other options is as (Eq.(9)):

$$\phi^-(a) = \frac{1}{m-1} \sum_{\substack{x \in A \\ x \neq a}} \pi(x, a) \quad (9)$$

Step 3: The fundamental difference between the PROMETHEE I and PROMETHEE II methods is this step:

In PROMETHEE I, ratings are obtained from the comparison of positive and negative superiority currents. That P , I , and R respectively represent preference, indifference and incomparable. The PROMETHEE I method is cautious in ranking because it does not decide which option is better and the choice of the choice is the responsibility of the decision maker.

Usually, the decision maker needs to be fully rated. In PROMETHEE II, the pure flow is calculated as Eq(10). The better pure flow is the better alternative.

$$\phi(a) = \phi^+(a) - \phi^-(a) \quad (10)$$

We use this method to rank the options. However, due to the use of Visual PROMETHEE software, it is not necessary to perform calculations related to the steps of this method, and it is only necessary to identify the inputs of this method, the decision matrix, the weight of the criteria, and the preferences functions correctly. The output of this software is the ranking of the options by two methods PROMETHEE I and PROMETHEE II are graphically sensitized.

3.3 BWM-PROMRTHEE

We use BWM-PROMRTHEE to select the appropriate biomass consists of four main steps: 1) aggregation of data; 2) BW calculation; 3) calculation of the PROMETHEE method; 4) decision making. In the first step, the criteria and alternative of the problem are determined. In the second step, by following the steps of the BWM already mentioned, the weight of the criteria is determined. In this step, we can use a set of experts to make a paired comparison matrix. In the third step, by performing the PROMETHEE-II step by step procedure with PROMETHEE I and the overall ranking is based on PROMETHEE II and PROMETHEE GAIA. Flowchart of the hybrid approach is shown in Figure 2

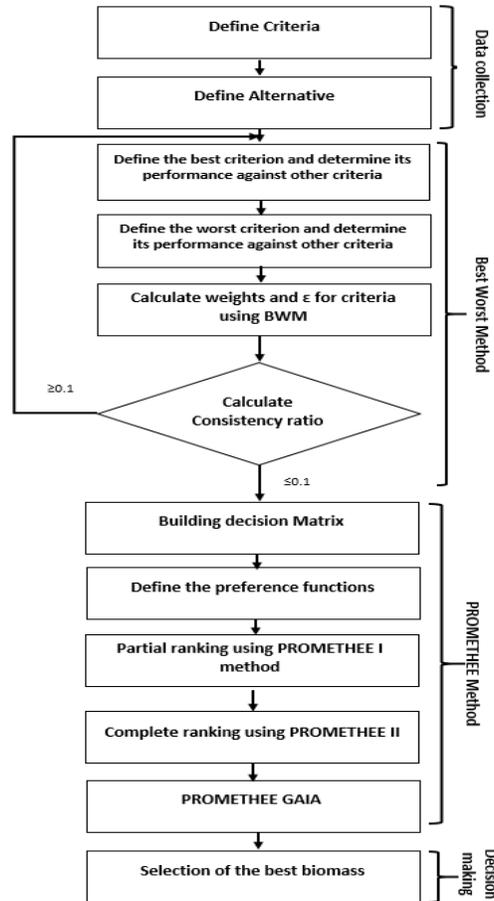


Figure 2. Hybrid approach

4. Case Study

The proposed method is used to select suitable oily seeds for the production of biomass with the objective of biodiesel production in Iran. The steps in the proposed method on this real example are described below.

4.1 Data collection and criteria Definition in the selection of appropriate biomass

In this section definition of Economic criteria, Environmental criteria and Social metrics in the selection of appropriate biomass are presented. Data set description are written as Table 2.

4.2 Best-worst method

According to the results of the study, rapeseed (colza), cotton and soybean plants can grow and grow a lot compared to other Iranian oceanic climatic conditions, so we rate these three alternative according to the criteria mentioned.

In this step, first, we calculate the best and the worst criteria. Then, we measure the performance of the best criterion against the other criteria and the performance of the criteria against the worst criterion using the range of 1/9 to 9. We consider the best criteria for the yield of the biomass (C12) and the worst criterion for technological development (C31). The result of the paired comparison is shown in Table 2. This method does not require all paired comparison matrix data to be one of the advantages of this method.

By using the resulting pair comparison, we construct Equation (3) and solve it using of GAMS with BARON solver. The obtained results are the weight of the criteria and the value of ϵ , we calculate the compatibility rate using equation (4). The weight of the criteria and the compatibility rate are shown in Table 3.

Table 2: Data set description

Economic Criteria	
<i>Planting (c11)</i>	Opening costs associated with land preparation, labor, machinery purchases, fertilizers, and pesticides.
<i>Biomass efficiency (c12)</i>	The amount of biomass produced by specific crops
<i>Production and harvest costs (c13)</i>	The costs associated with fertilization, irrigation, weed, and labor, along with the costs of specific biological disposal.
<i>Storage and transportation (c14)</i>	Transportation and storage costs associated with specific biomass.
<i>Conversion Rate (c15)</i>	The amount of produced biodiesel when particular biomass is converted.
<i>Risk Sustainability (c16)</i>	Resistance to product types against dangers such as drought, cold, price volatility and uncertainty in market demand.
<i>Equipment and knowledge (c17)</i>	Refers to the availability of equipment and the awareness of farmers regarding the cultivation of a particular product.
Environmental criteria	
<i>Effects on soil quality (c21)</i>	Assessing how much a biomass product erodes and how much soil it needs to be augmented during the planting process.
<i>Carbon emission (c22):</i>	The measurement of the total CO ₂ released and the ability to separate carbon from a particular biomass product during its production.
<i>Water quantity and quality (c23)</i>	The amount of water required in the crop of a particular biota.
<i>Preserving biodiversity and preserving wildlife (c24)</i>	Refers to the effects of specific biomass on biodiversity and wildlife, for example, the population of birds and insects.
<i>Invasion (c25)</i>	Includes the risks and costs of controlling specific biomass, such as harming the production of other products in the area.
Social metrics	
<i>Technological development (c31):</i>	Measuring of potential development about the productivity and conversion rates of biodegradable fuels. That has changed with the technological advancement of land productivity or conversion rate since last time.
<i>Need for labor (c32)</i>	A new workforce measurement that results from the cultivation of a specific biomass product
<i>Welfare and energy security (c33)</i>	Includes the potential of replacing biomass to fossil fuels rather than fossil fuels and the extent to which this biofuel production has an impact on social welfare measured by its impact on GDP.
<i>Food Competitiveness (c34)</i>	An assessment of food security that results from the allocation of arable land to the cultivation of biomass rather than human food.

Table 2. Weight of criteria and compatibility rate

Economic Criteria	C11	C12	C13	C14	C15	C16	C17
Weight (%)	9.13	15.9	5.7	7.4	9.1	3.4	2.1
	C25	C21	C22	C23	C24	C25	
Weight(%)	4	4.4	7.4	3.4	4.4	4	
	C34	C31	C32	C33			
Weight(%)	1.7	7.4	4.4	9.9			
compatibility rate	0.07						

Table 3. PROMETHEE method inputs

Scenario1	setup costs	biomass yield	Production cost	Storage Cost	Conversion r...	Risk, Robust...	knowledge a...	Soil quality	CO2 emission	Water quality	Biodiversity	Invasiveness	Technologica...	Workforce r...	energy secu...	Compete for...
Unit	Iranian toman	Ton	toman(T) per	toman per kg	Ton per year	5-point	Education	fertilization	5-point	5-point	5-point	5-point	5-point	Number	5-point	5-point
Cluster/Group																
Preferences																
Min/Max	min	max	min	min	max	max	max	min	min	min	max	max	max	max	max	min
Weight	9,00	16,00	6,00	7,00	9,00	3,00	2,00	4,00	7,00	3,00	4,00	4,00	2,00	7,00	4,00	10,00
Preference Fn.	Linear	V-shape	Linear	Linear	V-shape	V-shape	V-shape	U-shape	V-shape	V-shape	V-shape	V-shape	Usual	U-shape	V-shape	V-shape
Thresholds	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute
-Q: Indifference	toman	n/a	T 70,00	T 40,00	n/a	n/a	n/a	0,10	n/a	n/a	n/a	n/a	n/a	15,00	n/a	n/a
-P: Preference	toman	53400,00	T 210,00	T 120,00	35400,00	0,30	2,00	n/a	0,60	0,60	0,60	0,60	0,60	n/a	0,60	0,90
-S: Gaussian	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Statistics																
Minimum	toman	178818,19	T 2.300,00	T 800,00	34764,00	3,00	2,00	2,00	2,00	2,00	2,00	2,00	2,00	30,00	2,00	2,00
Maximum	toman	356890,36	T 3.000,00	T 1.200,00	142756,00	4,00	3,00	3,00	4,00	4,00	4,00	4,00	4,00	180,00	4,00	5,00
Average	toman	262991,68	T 2.600,00	T 1.000,00	80037,67	3,33	2,33	2,33	3,00	3,00	3,00	3,00	3,00	80,67	3,00	3,33
Standard Dev.	toman	75744,28	T 294,39	T 163,30	45780,68	0,47	0,47	0,47	0,82	0,82	0,82	0,82	0,82	70,24	0,82	1,25
Evaluations																
colza	toman	356890,36	T 2.500,00	T 800,00	142756,00	average	2,00	2,00	bad	average	good	average	average	32,00	good	average
cotton	toman	312966,48	T 3.000,00	T 1.200,00	62593,00	good	3,00	2,00	good	good	bad	bad	good	180,00	average	bad
soybean	toman	178818,19	T 2.300,00	T 1.000,00	34764,00	average	2,00	3,00	average	bad	average	good	bad	30,00	bad	very good

4.3 PROMRTHEE method

At this stage, we firstly formulate the decision matrix, in fact, we calculate the performance of each alternative in each criterion. In terms of qualitative criteria as well as the criteria for which access to their actual data was difficult, the comparative spectrum was used 1.5 to 5 Likert. Indeed, the options are compared at these criteria. Then, depending on the nature of each criterion, the preferred function is determined. With the weights obtained by the BWM, we begin to calculate the implicit and general dominant flows. For this, we use Visual PROMETHEE software. Firstly we create a Table 3 that contains the inputs of the PROMETHEE I and PROMETHEE II methods.

By using Visual PROMETHEE software is considered to be implicit and general currents, the result of which is shown in Table 4. And by using implicit and generalized currents, we obtain an implicit rating (PROMETHEE I) and overall rank (PROMETHEE II).

Table 4. Implicit and overall currents

action	Phi	Phi+	Phi-
1 colza	0,5218	0,7031	0,1813
2 cotton	-0,1536	0,3950	0,5485
3 soybean	-0,3682	0,2713	0,6395

As can be shown in Figure. 3.(a) and (b), in both overall and implicit ratings, the best biomass for biodiesel is ranked as colza, cotton, and soybeans, which is explained by the fact that colza in 10 criteria out of 16 minimum criteria.



Figure 3 (a). Implicit rating (PROMETHEE I). (b). Overall rating (PROMETHEE II)

It is also well-suited to other options. On the other hand, the second criterion, the biomass efficiency, which has the highest weight, is also the best and in the worst case, technological development has a moderate performance. As a result, the ranking network will be as shown in Figure. 4.

To better understand the issue of choosing the best biomass from the GAIA page, the alternatives on this page are represented by points and criteria with axes; in fact, this page is an image of alternatives and criteria in a two-dimensional space. The larger axes on this page is the more important criterion. The axis of the criteria that have the same preference is in one way, and this makes the criteria that are in conflict with each other to be easily recognizable.

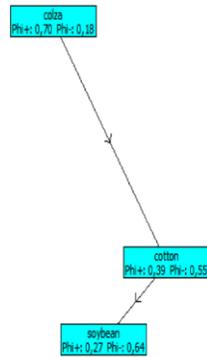


Figure 4. The network of rating alternative

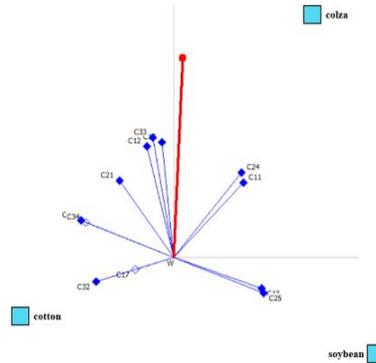


Figure 5. GAIA page for biomass selection

And as far as an option is near the criteria center, it works well on that criterion. In Figure. 5, we show the GAIA page for the biomass selection, for example, that conflicts with the water criterion and food competition, or the set-up cost and storage cost are in the same direction. It is clearly shown that rapeseed (colza) is the closest option to it, that is, in most criteria considering their weight, this option works well.

4.4 Decision-making

By combining BWM and PROMETHEE, rapeseed was considered to be the best biomass, but to make a more realistic decision, we need to analyze the sensitivity. In the next section, we analyze the sensitivity of the model.

5. Sensitive Analysis

If we change the weight of criteria or preferences, we will change the ranking of options. In this regard, we must analyze the result by analyzing the sensitivity. Note that the positioning of the alternatives and criteria in the GAIA page does not change, but the direction and length of the criteria changes. In Figure. 6, the weight of the criteria and the overall ranking given in the previous section.

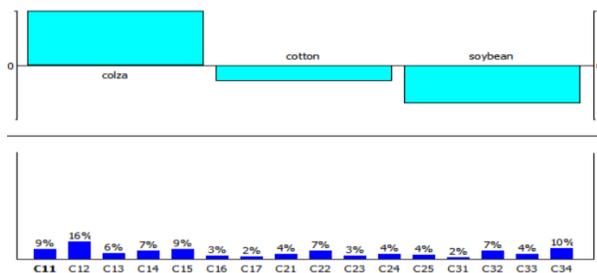


Figure 6. The weight of the criteria in normal mode with the rating alternatives

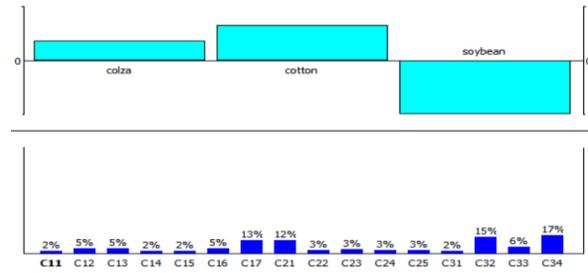


Figure 7. rating of alternatives and weight of criteria in a sensitivity analysis

We want to interpret the changes by changing the weights. For example, if we increase the weight of standards such as food competition, technological development, and knowledge and reduce the weight of startup costs, given that these three criteria are in the same way as against the cost criterion. The three criteria are good compared to other alternatives. According to the new ranking, cotton is selected as the best alternative, the results of which are shown in Figure 7.

6. Conclusion and Future Research

In this paper, we propose a hybrid approach of MADM for the biomass selection problem. We used BWM to determine the importance of criteria and the PROMTHEE-II method for ranking options. This new method decreases the disadvantages of using these methods, including reducing the weight of criteria in comparison with other methods of calculations. The advantages of using this method are the implicit rating of options and the graphical viewing of criteria and alternatives on the GAIA page that makes it easily for decision makers to understand the model. Also, we have shown in this method that by changing the weight of the criteria, the degree of importance of the alternatives varies easily, and it is possible to analyze the sensitivity of the model in this method. We applied this model to the biomass selection problem that was selected as the best biomass in early decision making of rapeseed (colza), but by changing the importance of cotton criteria, it was chosen as the best biomass. In addition, the proposed model can easily be used in other real-world. Given that deterministic numbers are used to show the performance of alternatives in the criteria, it is to suggest that fuzzy numbers be used to improve the method to obtain the evaluation matrix.

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