An Analysis of the Renewable Energy technology Selection in the Southern Region of Bangladesh Using a Hybrid Multi-Criteria Decision Making (MCDM) Method

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Abstract- Bangladesh is a country of small char lands and islands. Most of these are out of national grid coverage. Therefore, renewable energy technology (RET) is the only solution for electrification. However, proper investigation and research are needed to select the most suitable renewable energy technology. In this study, focus is given on the southern region of the country to select the best RET. Based on the currently available technology and potentiality of the renewable energy resources in the country, five types of RETs are selected for evaluation. These are solar, wind, biomass to electricity, biogas to electricity and solar-wind-battery hybrid energy system. To evaluate the best RET, Multiple-criteria decision analysis (MCDM) method is used where an integrated Entropy-EDAS (Evaluation based on Distance from Average Solution) model is proposed to identify the best RET in the study area. At first, the key criteria and sub-criteria were selected to analyse five (5) types of RETs. These criteria were categorised as economic, technical, environmental, and socio-political. Additionally, 12 sub-criteria were selected under the umbrella of four main criteria. Then, Shannon's Entropy method was deployed to find the weights of the criteria and sub-criteria. Finally, a new MCDM method, named EDAS, was applied to select the best RET in the study area. The results revealed that the Solar-Wind-Battery hybrid energy system is the best option. The outcome of this study and the decision model might be applicable to other isolated areas in the country, particularly in the southern region of Bangladesh.

Keywords- Entropy, EDAS, Renewable Energy Technology, MCDM.

1. Introduction

Bangladesh is a blessed country with enormous renewable energy resources. Therefore, the government of Bangladesh is taking initiatives to implement many large and small scale renewable energy projects. The southern zone of Bangladesh has a good opportunity for large and small scale renewable energy projects due to its off-grid nature. However, before selecting the appropriate technology, economic, technical, environmental and socio-political criteria have to be considered seriously. Most of the time in the country, economic criterion often gets priority for the technology selection than other criteria. Therefore, proper selection of appropriate renewable energy technology is often unsuccessful. A Multi-criteria decision making (MCDM) approach can solve this problem. Multi-criteria decision making (MCDM) is a discipline which deals with decisions involving the choice of the best alternative from several experts in a decision, subject to several criteria or attributes that may be concrete [1]. It is evident that most of the studies regarding the feasibility and selection of the renewable energy technologies were done based on HOMER analysis both domestically and internationally, where the application of MCDM model is almost zero. HOMER is an optimization-based software tool developed by National Renewable Energy Laboratory (NREL).

Alam et al. [2] used HOMER to analyse a hybrid energy system for the whole coastal region of Bangladesh and proved that it is possible to serve better quality electricity for 12 hours to 18 hours a day for as low as USD 0.29 – USD 0.31/kWh (kiloWatt-hour). The article suggested that depending on the location of the study area, solar-diesel generator-battery or solar-wind-diesel generator-battery could be the best option. The validation of the suggestion is high because on small islands the combination of wind power and battery storage is less favourable compared to PV-battery hybrid systems due to its uneconomic condition at low wind speeds [3]. However, the study failed to analyse environmental pollution due to the use of diesel generator. Several techno-economic studies were carried out in Saint Martin's Island which is the most popular tourist destination in the southern region of Bangladesh. Rashid et al. [4] conducted an analysis of hybrid wind/PV/diesel energy system in Saint Martin's Island which demonstrated low Cost of Energy (COE) and reasonable Net Present Cost (NPC) compared to wind-battery power systems and PV-battery system. The study also revealed that proposed hybrid system reduces GHG (greenhouse gas) emissions. However, this study didn't analyse other environmental factors. A feasibility study of a hybrid energy system conducted in Manpura Island of the southern zone of the country showed that a combination of solar-wind-biogas-diesel generator-battery system gives optimum COE and NPC [5]. However, this study didn't conduct a detailed comparative analysis of the combination of different renewable energy sources with a diesel generator. Das et al. showed that PV-Wind-Battery energy system is the optimum solution for the southern region of the country in terms of cost and environment [6]. Ruiz et al. performed some comparative studies with HOMER and other optimization techniques and concluded that the design obtained from the software is most expensive [7]. Another research claims that the utilisation of various mixtures of renewable power generations is favourable than utilising a solitary or stand-alone systems [8]. The output results of HOMER are mainly based on economic criteria which are Net Present Value (NPV) and Levelized Cost of Energy (LCOE). The software can analyse certain technical (e.g. electrical power output and battery performance) and to some extent environmental criteria (e.g. GHG emissions). But it can't analyse the complete scenario of those two criteria. Besides, this model is completely unable to analyse socio-political criteria. The main advantage of optimization tools (e.g. HOMER, Hybrid2, IHOGA etc.) is its theoretical appeal from a cost-minimisation viewpoint, which can satisfy multiple objectives concurrently with academic credibility [9]. However, this can be a problem in the rural context where the accuracy of the information is a low and often rough calculation, or speculations have to be resorted. Moreover, optimisation tools usually can't capture the conflicting issues involved in the decision-making process. A multi-criteria decision tool can provide an efficient framework to capture all five dimensions of the system. It can consider the conflicting objectives which try to find the best compromise (not the optimal solution) and also consider the qualitative factors that optimisation tools cannot solve [9]. Also, multi-criteria decision tool has strong academic credibility.

Rahman et al. [10] conducted a study to select an appropriate waste-to-energy conversion technology for Dhaka City, Bangladesh by Analytic Hierarchy Process (AHP) which is a very popular MCDM technique. However, the study focused only on technology selection of a particular type of renewable energy. It is evident that during the literature review, articles related with MCDM models and renewable energy technology selection based on Bangladesh context was not found. Regarding the types of MCDM models, the application of Fuzzy Sets methods were mostly used (25%) to evaluate power generation technologies followed by AHP, ANP (Analytic Network Process) (19.64%) method and lastly, MULTI MOORA method (3.57%) [11]. This research also demonstrated that the Evaluation based on Distance from Average Solution (EDAS) was not used to evaluate power generation technologies. EDAS modelling approach is a very recent MCDM technique. This method was first introduced in 2015 which is well consistent and stable than other MCDM techniques e.g. VIKOR, TOPSIS, SAW and COPRAS [12]. Entropy method is a type of objective method which calculates weights by solving mathematical equations without any consideration of the expert's decision. Thus, this method can be considered as non-bias approach. Decision-making process with human knowledge extraction techniques is important [13]. AHP is a subjective method and determined by the expert's choice. Therefore, sometimes this method could be biased and can affect the decision making process. It is evident that lot of works were done based on AHP than Entropy. However, to the best of our knowledge none of the researchers used integrated Entropy-EDAS model to evaluate renewable energy technology selection. Moreover, the application of the proposed decision model for the study area is a novel idea. The main objectives of this study are given below.

- To construct a decision model based on integrated Entropy-EDAS model.
- To establish the sub-criteria of the economic, technical, environmental and socio-political criteria.
- To develop a decision matrix based on experts' rating.
- To calculate the weights of the criteria and sub-criteria by using Entropy method and integrate it with EDAS method to obtain the final ranking of the renewable energy technologies.

2. Synopsis of the Study Area

In this study, off-grid locations in the southern region of the country are prioritized. Barisal is the southern division of the country and thus it is chosen as a study area which is very near to the Bay of Bengal. In 2018 a list of off-grid villages was documented by the government of Bangladesh. Among them 5 districts are from Barisal division and according to the number of off-grid villages, Patuakhali district is ahead of districts. The district has total 158 off-grid villages [14]. Among them Patar Char village is selected for the study which is under Dashmina upazila and Rangopaldi union of the Patuakhali district. The village is surrounded by the Tetulia River. The study area is a low-lying area. Agriculture is the most common occupation in this area. However, fishing is another competent occupation through which people conduct their life in this way. Boat is the only way of transportation for communication between the village and upazila. Climate of the study area is tropical. The inhabitants of the village have to travel at least 4-5 miles to a faraway town in order to serve their purpose. Very few households use stand-alone solar system and rest of them uses kerosene, candles for lighting, fuel-wood, and cow-dung for cooking purposes. Most of the villagers live under poverty and thus, the purchasing capacity of the local people is meagre. The average income per household is around $70. The location of the study area is displayed in Fig 1.

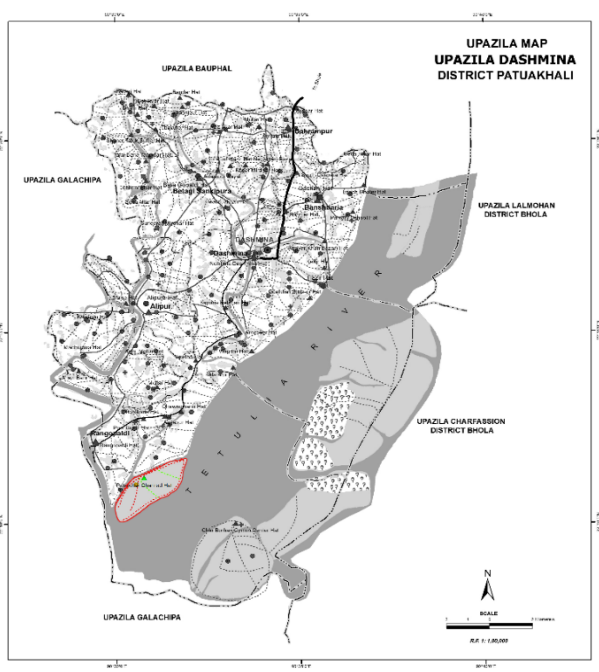

Figure 1. Study area

3. Decision Model

The proposed decision model is shown in Fig. 2. At first, different renewable energy technologies were selected based on the available technology in Bangladesh. Then, criteria and sub-criteria were selected after the literature survey. The detail of the criteria and sub-criteria are shown in Table 1. To form the decision matrix, ten experts were selected from different government and non-government organizations who are involved in policymaking regarding power and energy sector. While selecting the experts it was ensured that they have minimum 10 years' experience in the relevant field. The survey was carried out by face to face interview. A five (5) point Likert Scale was used to conduct the survey. The linguistic terms were used in the survey along with the numerical values which are displayed in Table 2. After obtaining the decision matrix an Entropy-EDAS integrated Matlab program was formulated to analyse decision model. Then, decision matrix and types of criteria were used as input value. For the non-beneficial criteria and beneficial criteria, 0 and 1 were used as input, respectively. After the simulation of the program ranking order of different renewable energy technologies were obtained.

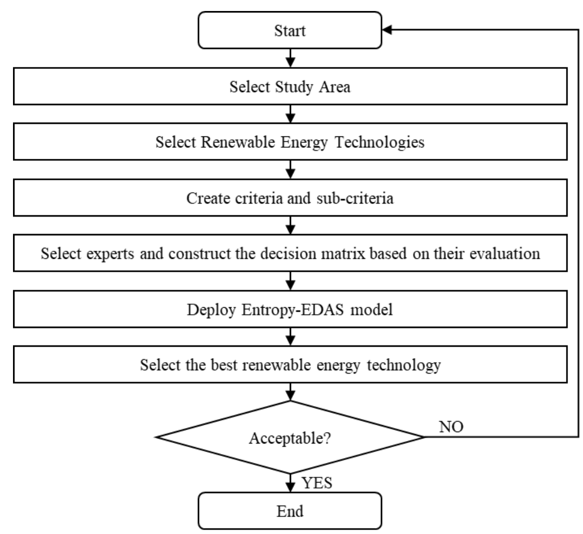

Figure 2. Decision Model

Table 1. Details of Criteria and Sub-Criteria

Criteria	Sub-Criteria	Types of Criteria
Economic (EC)	Operation and Maintenance Cost (EC_1)	Non-Beneficial
	Levelised Cost of Energy (EC_2)	Non-Beneficial
	Capital Cost (EC_3)	Non-Beneficial
Technical (TC)	Technology Maturity (TC_1)	Beneficial
	Reliability (TC_2)	Beneficial
	Efficiency (TC_3)	Beneficial
Environmental (EC)	Land Requirement ($ENVC_1$)	Non-Beneficial

	Ecological Impact ($ENVC_2$)	Non-Beneficial
	Noise ($ENVC_3$)	Non-Beneficial
Socio-Political (SPC)	Political Goodwill (SPC_1)	Beneficial
	Social Benefit (SPC_2)	Beneficial
	Social Acceptance (SPC_3)	Beneficial

Table 2. Details of Likert scale

Linguistic Term	Alphabetic order of expert comments	Numerical number of expert comments
Very Low	VL	1
Below Average	BA	2
Average	A	3
Above Average	AA	4
Very High	VH	5

Table 3. Computing procedure of Entropy-EDAS Integrated Matlab Program

Step 1: Estimate Normalized Matrix	R(i,j)=X(i,j)/sum(X(:,j));

Step 2: Calculate Entropy	Re(i,j)=R(i,j).*log(R(i,j));
	h=1/log(Xval);
	e(j)=-h.*sum(Re(:,j));
	d(j)=1-e(j);

Step 3: Calculate Weights	W(j)=d(j)/sum(d); Entropy_Weights= num2str ([W])
Step 4: Solve using EDAS	Y = zeros([Xval,length(W)]);
Step 5: Estimate AV	Xavg(1,j)= mean(X(:,j)); Average Solution = num2str([Xavg])
Step 6: Estimate PDA and NDA	NDA(i,j)= max(0,(X(i,j) Xavg(j)))/Xavg(j); PDA(i,j)= max(0,(Xavg(j)-X(i,j)))/Xavg(j); NDA(i,j)= max(0,(Xavg(j)-X(i,j)))/Xavg(j); PDA(i,j)= max(0,(X(i,j)-Xavg(j)))/Xavg(j); Positive_Distance_from_Average = num2str([PDA]) Negative_Distance_from_Average = num2str([NDA])
Step 7: Estimate SP, SN, NSP and NSN	SP(i,1)= sum(W(j)*PDA(i,:)); SN(i,1)= sum(W(j)*NDA(i,:)); weighted_Sum_of_PDA =num2str([SP]) weighted_Sum_of_NDA =num2str([SN]) NSP(i,1)= SP(i)/max(SP); NSN(i,1)= 1-(SN(i)/max(SN));
Step 8: Estimate AS	AS(i,1)= 0.5*(NSP(i)+NSN(i)); AS = num2str([AS])

3.1. Calculation Method of Shannon's Entropy

A step by step systematic procedure was followed to calculate Shannon's Entropy. The following steps were followed to estimate the criteria weights using Shannon's Entropy model [15].

Step 1: Normalize the decision matrix.

$$r_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}}, j = 1,2,3,\dots,m \tag{1}$$

Where, m is the number of alternatives.

The primary data are normalized to remove variances with different measurement units. This procedure converts different scales and units among diverse criteria into common measurable units. Thus, it allowed comparing different criteria. However, in this research all data are ordinal.

Step 2: Calculate the entropy value.

$$e_j = -h \sum_{i=1}^{m} r_{ij} \ ln \ r_{ij}, j = 1,2,3,\dots\dots,n \tag{2}$$

Where, h is the entropy constant and expressed as, $h = \frac{1}{\ln(m)}$ and $ln \ r_{ij}$ is defined as 0 if r_{ij}=0.

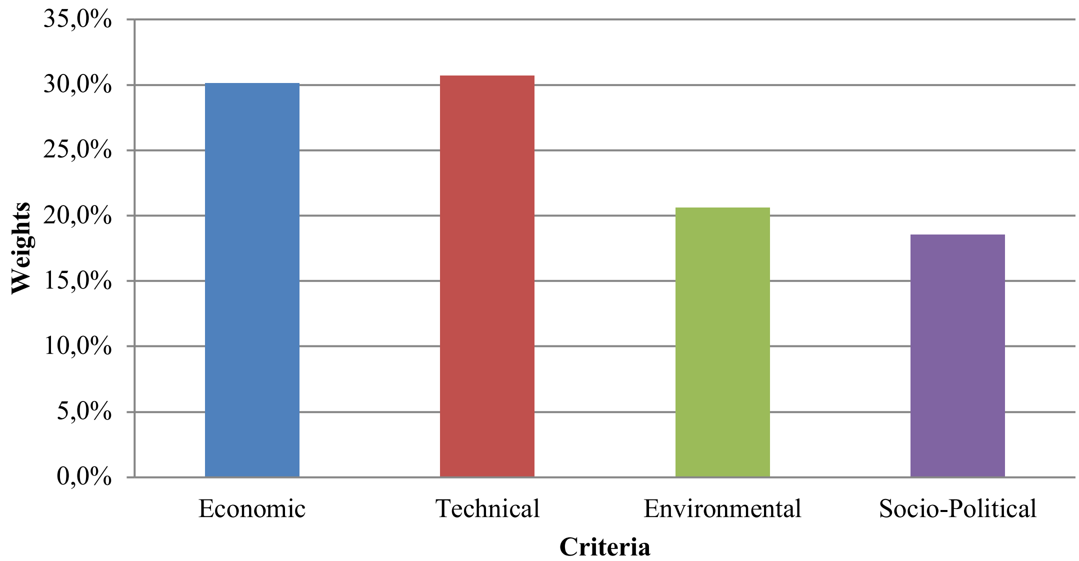

Figure 3. Weights of the criteria

Step 3: Compute the weight.

$$W_j = \frac{e_j}{\sum_{j=1}^{n}(1-e_j)} \quad (3)$$

Where, d_j is the degree of diversification and expressed as $d_j = 1 - e_j$.

3.2. Calculation Method of EDAS

The following calculation procedure was followed to find the ranking of alternative renewable energy systems [12].

Step 1: Formulate the decision matrix.

$$X_{ij} = \begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1n} \\ X_{21} & X_{22} & \cdots & X_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ X_{m1} & X_{m2} & \cdots & X_{mn} \end{bmatrix} \quad (4)$$

Here, X_{ij} represents the ith alternative on the jth criterion.

Step 2: Estimate the average solution (AV_j).

$$AV_j = \frac{\sum_{i=1}^{N} X_{ij}}{n} \quad (5)$$

Step 3: Calculate the Positive Distance from Average (PDA) and the Negative Distance from Average (NDA) based on beneficial and non-beneficial criteria.

If jth criteria are beneficial then the below equations were formed.

$$PDA_{ij} = \frac{max\left(0, \left(X_{ij} - AV_j\right)\right)}{AV_j} \quad (6)$$

$$NDA_{ij} = \frac{max\left(0, \left(AV_j - X_{ij}\right)\right)}{AV_j} \quad (7)$$

On the other hand, if jth criteria are non-beneficial then the following equations were formed.

$$PDA_{ij} = \frac{max\left(0, \left(AV_j - X_{ij}\right)\right)}{AV_j} \quad (8)$$

$$NDA_{ij} = \frac{max\left(0, \left(X_{ij} - AV_j\right)\right)}{AV_j} \quad (9)$$

Step 4: Calculate the weighted sum of PDA (SP) and NDA (SN) for all the alternatives.

$$SP_i = \sum_{j=1}^{m} W_j PDA_{ij} \quad (10)$$

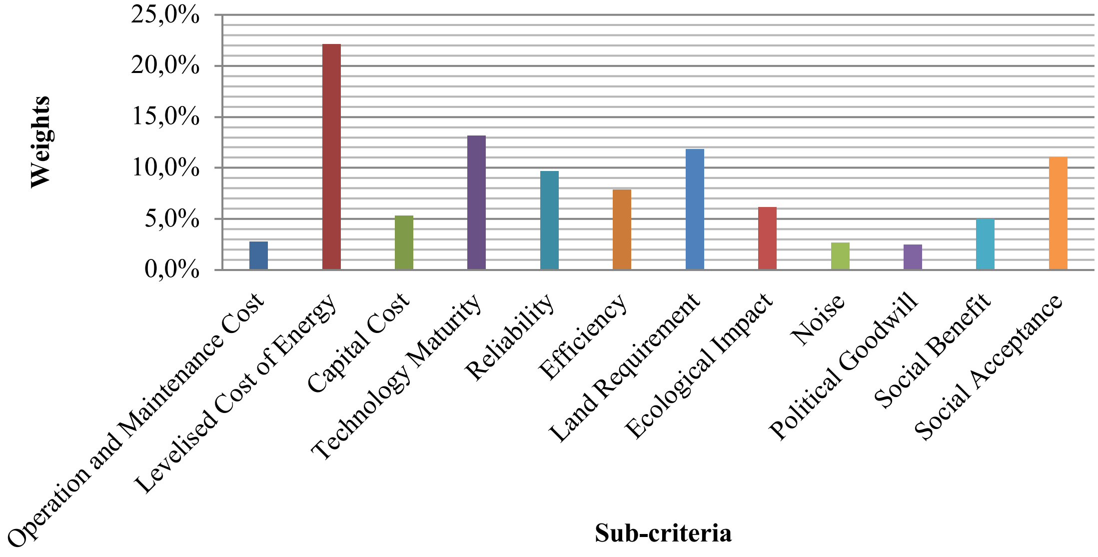

Figure 4. Weights of the sub-criteria

$$SN_i = \sum_{j=1}^{m} W_j NDA_{ij} \tag{11}$$

Where W_j is the weight of jth criterion.

Step 5: Normalize the values of SP_i and SN_i for all the alternatives.

$$NSP_i = \frac{SP_i}{max_i(SP_i)} \tag{12}$$

$$NSN_i = 1 - \frac{SN_i}{max_i(SN_i)} \tag{13}$$

Step 6: Calculate the Appraisal Score (AS) for all alternatives. According to the decreasing values of AS all the alternatives

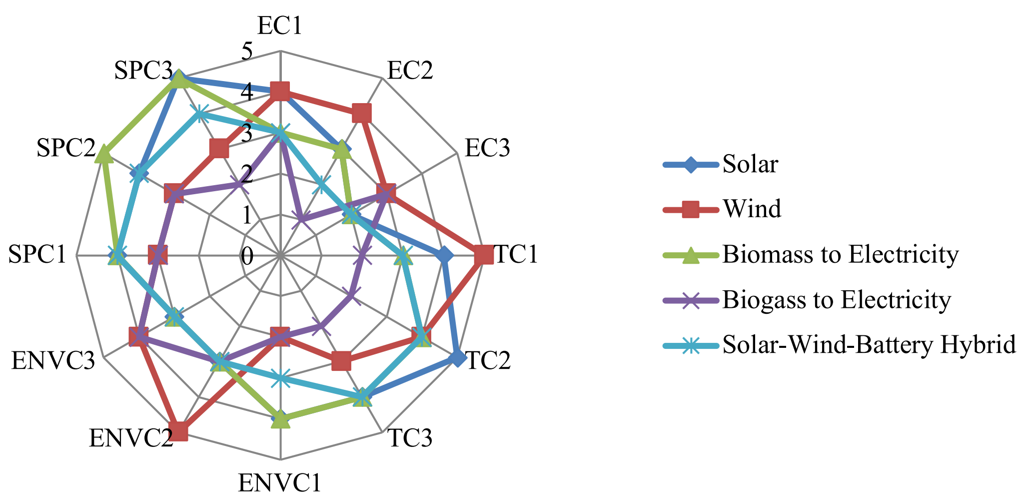

Figure 5. Decision matrix

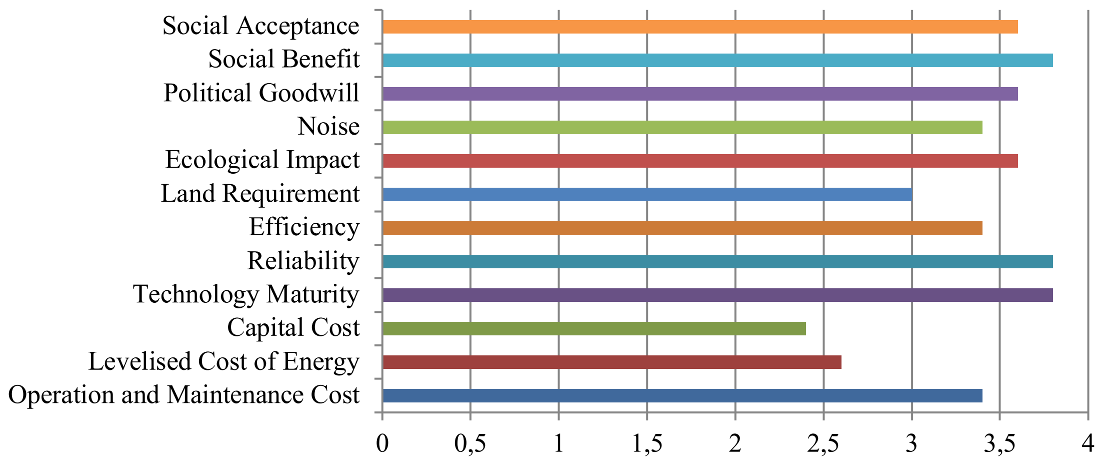

Figure 6. Average solution of each criterion

were ranked. The alternative with the uppermost AS was the paramount choice among the alternatives.

$$AS_i = \frac{1}{2}(NSP_i + NSN_i) \tag{14}$$

4. Results and Discussion

After the simulation of Entropy-EDAS Matlab program, weights of the criteria and sub-criteria have obtained. The program also provides the final ranking of renewable energy technologies. The results and discussion section have been divided into two sub-sections. One is Weights of the Criteria and Sub-Criteria, and another is ranking.

4.1. Weights of the Criteria and Sub-Criteria

Fig. 3 and Fig.4 demonstrate the criteria and sub-criteria weights obtained from the entropy model which was calculated by equation 1-3. From Fig. 3 it found that Technical criteria ranked one (30.7%), followed by Economic (30.1%), Environmental (21.6%) and Socio-Political (18.5%) criteria. Similarly, from Fig. 4, it is evident that LCOE ranked one (22.1%), followed by Technology Maturity (13.1%), Land Requirement (11.8%), Social Acceptance (11.1%), Reliability (9.7%), Efficiency (7.9%), Ecological Impact (6.1%), Capital Cost (5.3%), Social Benefit (5%), Operation and Maintenance Cost (2.8%), Noise (2.7%) and finally, Political Goodwill (2.5%).

Technology Maturity is the most important sub-criteria under the Technical criteria. The sub-criteria has a direct

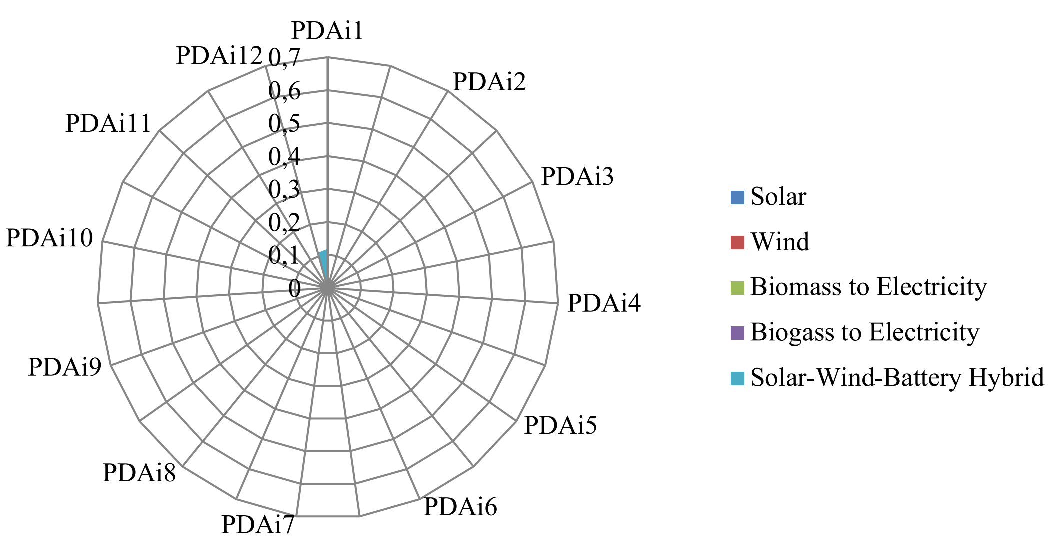

Figure 7. Positive distance from average (PDA)

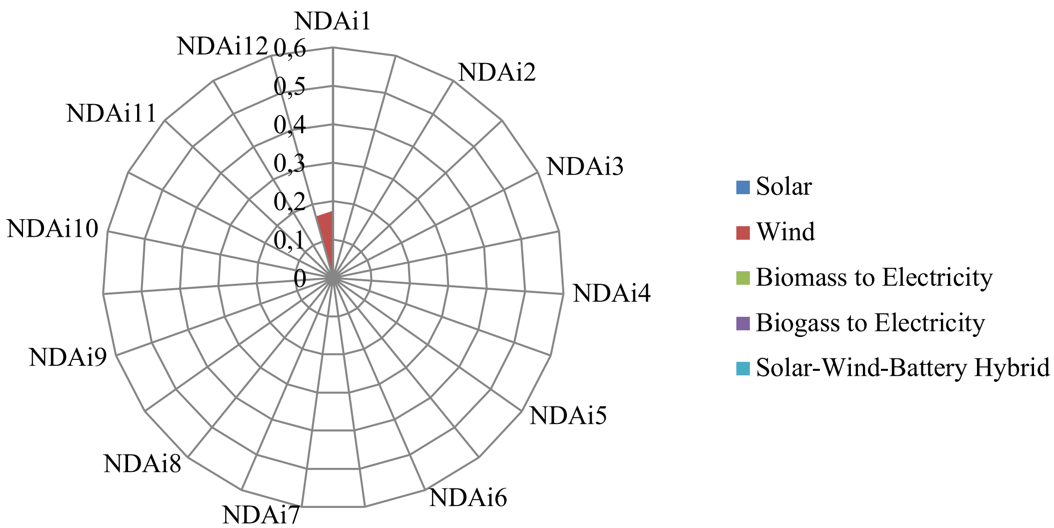

Figure 8. Negative distance from average (NDA)

relationship with cost reduction during the renewable energy market development process [16]. The study also revealed that if technology maturity is achieved, then the economic barrier will be reduced. Besides, Reliability and Efficiency are also significant technical criteria.

About the economic criterion, the entropy model prioritized the sub-criteria LCOE. The calculation of the LCOE includes capital costs, operations and maintenance (O&M) costs, performance, and fuel costs [17]. As it is evident that capital and O&M costs are included in the LCOE, the weights of these two criteria are not significant. Particularly, the weight of Operation and Maintenance Cost is the lowest as renewable power plants need much lesser O&M cost than conventional power plants.

Land requirement obtained the highest weight in Environmental criterion. For any kind of renewable energy technology selection, it is highly important to select land. A recent study showed that in United States of America (USA), electricity sources Coal, Natural Gas, Nuclear, Solar, Wind and Hydro need 12.21, 12.41, 12.71, 43.50, 70.64 and 315.22 acres of land to produce 1MW electricity, respectively [18]. The article showed a new insight that renewable energy development projects are more land consuming than conventional energy projects. The country already has good experience regarding solar energy projects. According to different organizations and local energy experts, 3.5-4 acres of land is required for a 1 MW solar power project. Bangladesh is a small country with limited land resources and the study area is an isolated small area. Already the country faced difficulties to implement some solar power projects due to land acquisition problem. Therefore, the land requirement should be taken seriously before the technology selection and need to use latest design and methods to optimize the land as much as possible. The sub-criteria Ecological Impact obtained the second highest weight in the Environmental criteria. The conventional power generation system has a negative impact on the ecosystem. However, renewable energy technology is also responsible for it even in lesser amount. Particularly, negative impact of ecosystem during construction and operation phase of renewable energy project development is critical. Emission of electromagnetic fields from the renewable energy power system could cause serious damage to coastal species [19]. Finally, Noise obtained the lowest weight in the Environmental sub-criteria. Renewable energy technologies produce extremely less noise except wind turbine. However, due to recent technological advancement, wind turbines produce almost zero noise. It is to be noted that the noise in the study area may not affect the locality because the distance from the energy generation location to the community is expected to be far enough.

Social Acceptance ranked top in the Socio-Political criterion and finally, Political Goodwill ranked last among all the twelve (12) sub-criteria. Government of Bangladesh has taken lot of small and large renewable energy development projects which shows strong Political Goodwill. However, nowadays, worldwide Social Acceptance is strongly emphasised and considered as a strong criterion than Political Goodwill as it is influenced by both the awareness of climate change and its impacts, and the knowledge of the renewable energy technology in question [20].

4.2. Ranking

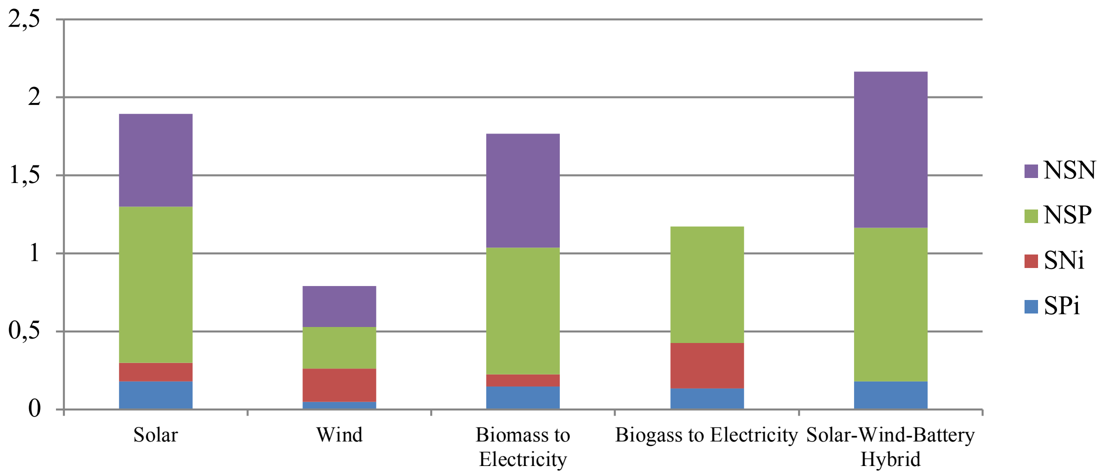

Figure 9. Values of SP_i, SN_i, NSP and NSN of renewable energy technologies

A step by step calculation is performed to obtain the rank of renewable energy technologies. At first equation 4 was used to construct the decision matrix considering experts' rating. The matrix is shown in Fig. 5. Then using equation 5, the AV of each criterion is estimated which is demonstrated in Fig 6.

By using equation 6 and 8 the values of PDA are estimated. Similarly, using equation 7 and 9 the parameters of NDA are calculated. It is also found from the calculation that when PDA = 0 then NDA>0 [12]. The results of PDA and NDA are demonstrated in Fig.6 and Fig.7, respectively. It is seen from Fig.7 that Solar-Wind-Battery Hybrid energy system has PDA values which is optimum considering all criteria. At the same time, Fig. 8 demonstrates that Wind energy has NDA values, which is the worst alternative considering criteria. In order to find out the ranking of other two alternatives, the values of AS of all the alternatives need to be estimated.

Next, using equation 10-13 the values of SP_i, SN_i, NSP, NSN of each renewable energy technology is estimated. The results are shown in Fig.9.

Finally, using equation 14 the AS of the renewable energy technologies is obtained. The results obtained from the equation are shown in Fig. 10. Based on the highest to lowest values the ranking order of each renewable energy technology is determined.

From the AS it is seen that Solar-Wind-Battery Hybrid Energy technology scored the highest value, which is 0.992, followed by Solar (0.798), Biomass to Electricity (0.772), Biogas to Electricity (0.375), and Wind energy (0.266) technologies. Therefore, it can be said that Solar-Wind-Battery Hybrid Energy technology is the best choice and Wind energy

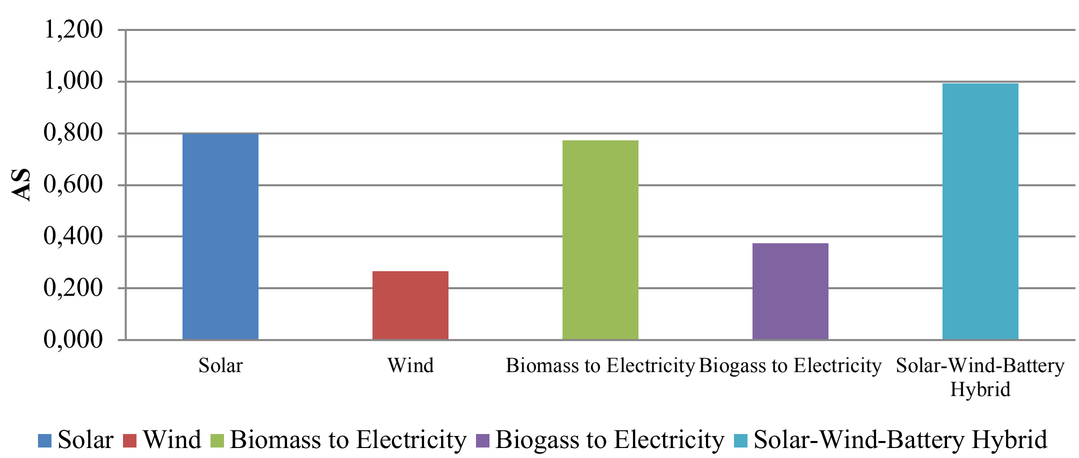

Figure 10. AS of Renewable Energy Technologies

is the worst choice for the study area. The ASs of Biomass to Electricity and Biogas to Electricity are not varied significantly.

In Bangladesh solar, wind, biomass and biogas energy technologies are the established renewable energy technologies. However, none of these technologies is ranked one by the proposed decision model. The model justifies the Solar-Wind-Battery Hybrid energy technology as the top priority. Podder et. Al [21] argued that off-grid solar-wind-battery hybrid technology can be economically and environmentally feasible than diesel generator and other stand-alone energy systems in the Chittagong district of Bangladesh. The author used HOMER software to analyse the system. The result of this study is agreed with the author. However, the proposed decision model in this research, additionally, considered technical and socio-political criteria. Moreover, the model considers experts' opinion to analyse the system. Overall, the proposed model gives more accurate result and justifies that Solar-Wind-Battery Hybrid energy technology is the best option for the study area. It is also evident that hybrid energy systems could be more consistent and economic than single-source energy systems [22]. Although, solar energy is the most commonly used renewable energy in Bangladesh, but it takes huge amount of land and sometimes the capital cost is high. Recently, a prominent Bangladeshi energy researcher Dr. Badrul Imam pointed out two drawbacks which are the barriers of the development of solar energy technology in Bangladesh. According to him, these drawbacks are the difficulty of acquiring land and lack of governmental incentive [23]. These two factors might affect if solar energy is chosen in the study area. The results of this study also recommend solar energy technology as the second option which could be an alternative solution of the hybrid energy technology. Although Biomass plant requires large amount of land, but the study area has plenty of biomass fuel which could be a good potential for electricity generation. Therefore, it could be considered as the third alternative option. It is to be noted that there is high possibility of flooding in the area due to its geographical location. It is estimated that minimum 210 biogas plants stopped functioning due to flooding and approximately 2000 biogas plants are under serious threat [24]. Therefore, it might be better to keep the biogas plant as the fourth option where the decision model also justified about it. However, small scale Biomass Energy technology could be installed in the study area on experimental basis. The study area is near the coastline. Therefore, force majeure risk due to the cyclone is a common phenomenon in the study area which could harm the wind turbine severely. Noise is also an important phenomenon which occurs mostly from wind turbine. Birds could be also harmed by the turbines and effect the ecosystem. It is also notable that Bangladesh generates small scale electricity from wind energy. However, still now this technology is not economic and socio-politically acceptable in the country, particularly in the study area. Therefore, the proposed model shows wind energy as the last option.

5. Conclusion

This study gives new insight into the field of appropriate renewable energy technology selection method. The study will contribute to low-income rural communities in Bangladesh, particularly off-grid areas in the southern region. Previously, investigations about off-grid energy systems in the rural community mainly was focused on techno-economic feasibility studies using HOMER model. Therefore, MCDM model plays a vital role to cover the deficiency of HOMER. A novel decision model is developed using an integrated Entropy-EDAS model which gives a complete scenario to understand the feasibility of different kind of renewable energy technologies. Furthermore, the proposed model can be used by different researchers, consultants and policy makers.

After the analysis, it is found that Solar-Wind-Battery hybrid energy system ranked one, followed by solar, biomass to electricity, biogas to electricity and wind hydro energy systems. The policy regarding hybrid energy system in Bangladesh needs to be improved. The "Renewable Energy Policies of Bangladesh (2008)" does not explain the detail policy of the hybrid energy system [25]. However, in 2017 India established national policy of solar-wind hybrid energy system [26]. In this regard, Bangladesh could also make a separate national policy of solar-wind hybrid energy system ensuring the definition and implementation strategy of the system, incentives, regulatory requirements, standard and quality. Renewable Energy action plan/ policy is not only a government plan, but also involvement of public and private sectors to achieve the target of the plan [27]. At the same time research and development need to be focused seriously.

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