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Analysis of green energy-oriented sustainable development goals for emerging economies

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ABSTRACT

Countries should focus on the improvements to achieve sustainable development goals. However, taking these actions create some operational costs. Thus, it is appropriate for rising nations to prioritize sustainable development objectives. Due to this condition, more critical sustainable development goals should be identified. Accordingly, this study evaluates green energy-oriented sustainable development goals for emerging economies. Within this context, a model is generated by considering the golden cut and bipolar q-rung orthopair fuzzy sets (q-ROFSs). The novelty of this study is to identify key green energy-oriented sustainable development goals for the improvement of emerging economies by an original model based on the golden cut and bipolar q-ROF decision making approach. All results are similar, indicating the proposed model's validity and coherency. It is concluded that increasing renewable energy is the most significant target with a weight of 0.235 regarding green energy-oriented sustainable development. Cooperation and efficiency are other significant issues for this condition, with weights of 0.198 and 0.196. It is also identified that Turkey and Mexico are the most successful countries in reaching green energy-oriented sustainable development goals. Increasing the share of renewable energy in total energy production and consumption is important for emerging countries. For this situation, governments should provide subsidies for renewable energy investors to provide a cost advantage. In this context, issues such as tax cuts and loans with low-interest rates can increase the motivation of clean energy investors.

1. Introduction

The Sustainable Development Goals (SDGs) consist of 17 global goals adopted by the United Nations in 2015. These goals are aimed to be achieved by 2030. The SDGs cover social, economic and environmental dimensions, and each targets a specific area (Regona et al., 2024). The most fundamental goals in the development of these goals are to end poverty, achieve a healthy and quality life, have access to clean water, create sustainable cities and ensure responsible production and consumption. In this context, the importance of accessible and clean energy is emphasized in the 7th goal (SDG 7) (Mishra et al., 2024). The main purpose of this goal is to ensure that everyone has access to affordable, reliable and sustainable energy. Green energy is directly related to many sustainable development goals, especially SDG 7. Thanks to the use of green energy, environmental sustainability can be achieved, and air pollution can be significantly reduced. Therefore, the expansion of renewable energy sources plays a critical role in achieving sustainable development goals (Leonidou et al., 2024). Therefore, investments in renewable energy should be increased.

Green energy-focused sustainable development goals should be prioritized especially for developing countries. Developing countries focus on industrial production to grow their economies (Abbasi et al., 2024). As a result, the energy needs of these countries are increasing significantly. In this context, these countries need to be able to produce their own energy in order not to be affected by energy price volatilities

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Nomenclature

ELECTRE	the elimination and choice translating reality
IFSs	intuitionistic fuzzy sets
MCDM	Multi-criteria decision making
M-SWARA	multi stepwise weight assessment ratio analysis
NSD	new service development
PERT	Project Evaluation and Review Technique
PFSs	Pythagorean fuzzy sets
q-ROFSs	q-rung orthopair fuzzy sets
SDG	sustainable development goals
SWARA	stepwise weight assessment ratio analysis

(Vakulchuk and Overland, 2024). Green energy sources also contribute significantly to countries achieving this goal. Otherwise, countries may face some financial and technical difficulties (Fernandez-Pinto et al., 2024). For example, if strategies are determined for less important targets, countries will not be able to use their resources effectively (Mustafa et al., 2024). This situation negatively affects the budget balances of the countries as it will cause inefficiency. As a result of examining similar studies in the literature, it is often emphasized that green energy-focused sustainable development goals are very important for developing countries. On the other hand, there are very few studies highlighting which goals are more important for these countries. This situation is considered as an important gap in the literature on this subject.

Accordingly, in this paper, an analysis of green energy-focused sustainable development goals for emerging economies is made. The golden cut and bipolar q-ROFSs are taken into account in order to develop a model for this purpose. The targets for the sustainable development goals focused on green energy are weighted in the first stage. The United Nations has created and modified five distinct targets for the sustainable development goals focused on green energy. The M-SWARA approach is used to investigate these variables. The ranking of sustainable development goals focused on green energy is part of the generated model's second step. The ELECTRE method is used in this framework to examine the E7 economies. The main motivation of this study is the necessity for a comprehensive evaluation to understand the most critical green energy-focused sustainable development goals for emerging economies. Decision making methodology can be taken into consideration to reach this objective. However, management of the uncertainties is the key problem for these models. Therefore, for the purpose of making effective evaluations, the criticisms related to this analysis should be taken into consideration.

The main contribution of this study is the generation of the most appropriate strategies for the emerging economies by establishing an original decision making model. Hence, this study has both theoretical and methodological contributions to the literature. (i) The main theoretical contribution is the generation of the most critical strategies for emerging economies with respect to the critical green energy-focused sustainable development goals. Identifying priority targets helps countries clarify their energy policies and strategies. In this way, countries can make more effective and comprehensive long-term energy plans. Similarly, by determining the priority targets, states can clarify the content of the investment incentives they will develop for these projects. This situation contributes significantly to the increase of these projects. In addition to them, it is possible to ensure energy security by determining more important targets. In other words, the negative effects of possible energy crises will be much less affected. (ii) According to the methodological contribution, the superiorities of the proposed are given below. M-SWARA, an extension of the SWARA approach, is used in this work to weight the criteria. It is possible to establish a causal connection between the things. The causal directions between the items cannot be identified by using SHP methodology. The originality of the suggested model is increasingly impacted by these two key changes. In comparison to IFSs and PFSs, q-ROFSs also concentrate on a larger area during the analysis process (Bhuiyan et al., 2022). This problem enables a thorough assessment to be performed (Farid and Donyatalab, 2021). IFSs and PFSs are also used in the calculations. This circumstance offers a chance to do a comparative analysis to check the model's dependability. There are many different SDGs and these items can have an impact on each other. Therefore, to identify the most critical goals, causal directions between them should be considered. Hence, using M-SWARA technique to weight the items can have a powerful contribution to reach these purposes. In addition to this situation, this study's innovation is its use of an original model based on the golden cut and a bipolar q-ROF decision making approach to identify important green energy-oriented sustainable development goals for the betterment of emerging economies. This study can be used to pinpoint more significant objectives. The circumstance is helping to increase the use of green energy. When compared to other decision making models, the suggested approach also offers some advantages. For more accurate computations, the degrees of the q-ROFSs are estimated in this model using a golden cut. The main problem in fuzzy decision making models is the uncertainty in the analysis process. Therefore, to handle this uncertainty, q-ROFSs and golden cut are integrated into the proposed model.

The literature on this topic is explained in the section that follows. The final section demonstrates the process. The fourth portion of the analysis includes results. Discussions, conclusions and policy suggestions are offered at the end.

2. Background

This section of the study includes summaries of previous studies on the subject. In this context, the Web of Science platform is used in the selection process of relevant studies. In this way, it is possible to access more qualified studies. In the selection process of similar studies from this platform, care is taken to obtain studies from the last 4 years. In this way, the current literature on the subject has been examined. After the selection of these studies, they are clustered according to the variables they emphasize the priority importance. In this context, four different variables such as price, cooperation, technological improvement and accessibility are determined. The studies are grouped into four groups according to these variables. In this section, studies emphasizing the importance of these variables are summarized in each paragraph. After these, the basic missing part in this literature review is emphasized. On the other hand, how this missing part will be satisfied with this study is also explained.

Green energy projects have an important role in sustainable development goals. For these projects to be developed, the *price* offered to the customers should be reasonable (Olabi et al., 2022). The most important prerequisite for offering a reasonable price is the reduction of costs (Xue et al., 2022). An important issue for renewable energy projects is storage costs (Simpson et al., 2020; Michalak and Wolniak, 2023). Due to climate differences in clean energy projects, the amount of energy produced cannot be predicted in advance (Razmjoo et al., 2021; Zhu et al., 2020; Meher et al., 2023). The excess energy produced must be stored. In this way, efficiency in energy production will be increased (Cheng et al., 2020; Andriyani et al., 2024). Investments in energy storage technologies will help reduce the cost of this process (Qiao et al., 2021; Parmentola et al., 2022). This innovative solution will contribute to offering reasonable prices to customers (Wiroonrath et al., 2024; Nguyen et al., 2024). Chen et al. (2021) examined the performance of renewable energy investments. They determined that the effectiveness of energy storage investments has an important impact on the cost reduction of these projects. Meng et al. (2021) also identified that necessary investments should be made in improving energy storage technologies to provide a reasonable price to customers.

Cooperation is crucial to achieving sustainable development goals based on green energy projects. For green energy projects to become affordable, costs must be reduced (Viana et al., 2022). Within the scope of the microgeneration management system, the clean energy system can be evaluated within a group (Solaymani, 2021; Zakari et al., 2022; Wiroonrath et al., 2024). Since energy costs can be shared within this group, the cost per unit can be reduced. A single storage system will serve many parties within the group (Zhao et al., 2021; Xydis et al., 2020; Kilani et al., 2023). The negative impact of climatic conditions on renewable energies will be efficiently minimized (Ogunmakinde et al., 2022; Lacerda et al., 2020). This innovative system also allows energy exchange between different segments (Gajdzik et al., 2024; Jayabalan et al., 2024; Wu et al., 2021). Thanks to the cooperation, green energy-based development goals will be achieved more easily (Streimikiene et al., 2020; Voola et al., 2022). Aquila et al. (2021) made risk evaluations for microgeneration systems in Brazil. They concluded that the microgeneration system plays a key role in the cost efficiency of clean energy projects. Ehsan et al. (2021) also stated that cooperation with the microgeneration system has a powerful contribution to effective clean energy projects.

For green energy projects to help achieve sustainable development goals, this energy must be *accessible* to people and companies. For this, clean energy projects should be expanded throughout the country (Adjakloe et al., 2021; Qadir et al., 2021; An and Mikhaylov, 2024). On the other hand, it may not be possible to design all clean energy projects in every region (Jeong and González-Gómez, 2020; Shaik et al., 2023). A comprehensive analysis should be made, and the regions where clean energy projects will be established should be determined (Andoni et al., 2021; Kutlu Gündoğdu, and Kahraman 2020). Both the effectiveness of these projects will be increased, and it will be much easier for people and companies to reach clean energy projects (Khare et al., 2021; Elattar and Elsayed, 2020). Zoungrana and Çakmakci (2021) studied how to increase the performance of clean energy projects. They discussed that clean energy projects should be accessible to everyone and companies.

Investing in clean energy *technologies* is important to achieve sustainable development goals. Thanks to these technologies, it will be easy to quickly integrate current applications into projects (Xie et al., 2021; Yuping et al., 2021). Technological innovations within this scope will reduce project costs (Østergaard et al. 2020; Li et al., 2021; Phonthanukitithaworn et al., 2024). On the other hand, it will be possible to increase the efficiency of projects with applications such as more efficient energy storage processes (Liu et al., 2021; Raza et al., 2020; Gazi et al., 2024). By prioritizing research activities, it will be possible to manage the main weaknesses in clean energy projects more effectively (Elia et al., 2021; Siksnelyte-Butkiene et al., 2020; Veríssimo et al., 2024). Ahmed et al. (2021) evaluated energy investments and concluded that renewable energy technology investments should be increased. Dhirasasna and Sahin (2021) also claimed that for cost reductions, investments in clean energy technologies should be prioritized.

The literature review results show the importance of clean energies in sustainable economic development. Targets for clean energy projects should be determined and implemented efficiently. Despite this situation, it is quite difficult for the countries to achieve all these goals in a short time because the actions for this issue involve high costs. It would be appropriate to make a priority analysis among sustainable development goals. With the help of this condition, transferring the available opportunities to more important targets will increase the efficiency of this process. This situation also has a powerful impact on improving the use of clean energy. There are lots of studies in the literature that focused on the significance of the green energy oriented sustainable development goals. However, the number of studies indicating which of these variables are more important is quite low. This situation is determined as a very important gap in the sustainable development literature. In this study, an evaluation is made to analyze green energy-oriented sustainable development goals for emerging economies. A model is created by considering the golden cut and bipolar q-ROFSs. With the help of these actions, it is aimed to fill this gap in the literature.

3. Methodology

This section provides explanations for bipolar q-ROFSs, SWARA, and ELECTRE. The appendix section of the manuscript contains information about the equations in detail.

3.1. Bipolar q-ROFSs with golden cut

IFSs were first established by Atanassov (1999), who also offered degrees (μ_I, n_I) for membership (MHP) and non-membership (NHP). Eqs. (1) and (2) display the specifics of these sets and the requirement. Yager (2013) produced PFSs using the degrees (μ_p, n_p). The necessary issues are covered in Eqs. (3) and (4). Furthermore, Yager (2016) created q-ROFSs with new degrees (μ_q, n_q). The specifics and conditions are described in Eqs. (5) and (6). Zhang (1994) developed BFSs to manage uncertainties more effectively. Eq. (7), in which $\mu_B{}^{+}$ stands for the level of satisfaction and $\mu_B{}^{-}$for the degree of satisfaction for the same element, describes them. Eqs. (8) through (13) illustrate how BPSs and q-ROFSs, PFSs, and IFSs are integrated. Eqs. (14)–(17) show the bipolar q-ROFS calculation specifics. Defuzzification is described in Eqs. (18) through (20), where S stands for the scoring function. To calculate these degrees, this study uses a golden cut (φ). The specifics are shown in Eqs. (21) through (23) where a and b denote the large and small values, respectively (Hu et al., 2021). The integration of this ratio to bipolar q-ROFSs is explained by Eqs. (24)–(26).

3.2. M-SWARA method with bipolar q-ROFSs

Keršuliene et al. (2010) created SWARA to determine the importance of the factors. There aren't many comparisons that can be made with this method, which increases process effectiveness. Eq. (27) shows a relation matrix developed using professional assessments. The next step is to develop bipolar q-ROFSs and determine the scoring functions. In Eqs. (28)–(30), the values of k_j (coefficient), q_j (recalculated weight), s_j (comparative importance rate), and w_j (weights) are calculated. It is possible to get stable values by taking the limit and transposing the matrix by the power of 2 t+1.

3.3. ELECTRE with bipolar q-ROFSs

ELECTRE was created by Benayoun et al. in 1966 to rank the things and this method is integrated with bipolar q-ROFSs in this paper. The decision matrix created by the decision makers' evaluations is included in Eq. (31). Eq. (32) is used to compute the normalized values. Eq. (33), which weights the values, is used. The creation of interval matrices for concordance and discordance is covered in Eqs. (34) through (39). Eqs. (40) through (47) are considered while calculating the concordance E, discordance F, and aggregated G index matrices. The sets of concordance, discordance, and aggregation index matrices are shown with e_{ab}, f_{ab}, *and* g_{ab}. The letters $\bar{c}$ and $\bar{d}$also clarify the key values. The net superior c_a, inferior d_a and overall values used in the ranking procedure are represented by Eqs. (48) to (50).

4. Analysis results

A new model detailed in Fig. 1 is generated in this study to evaluate green energy-oriented sustainable development goals for emerging economies using golden cut and bipolar q-ROF decision making approach.

The weighting of the targets for the sustainable development goals focused on green energy is the first stage. With respect to the variable construction, the details of the sustainable development goals are analyzed. In addition to this issue, current literature in this subject is also reviewed. With the help of these two steps, targets for the sustainable development goals focused on green energy can be identified. As a

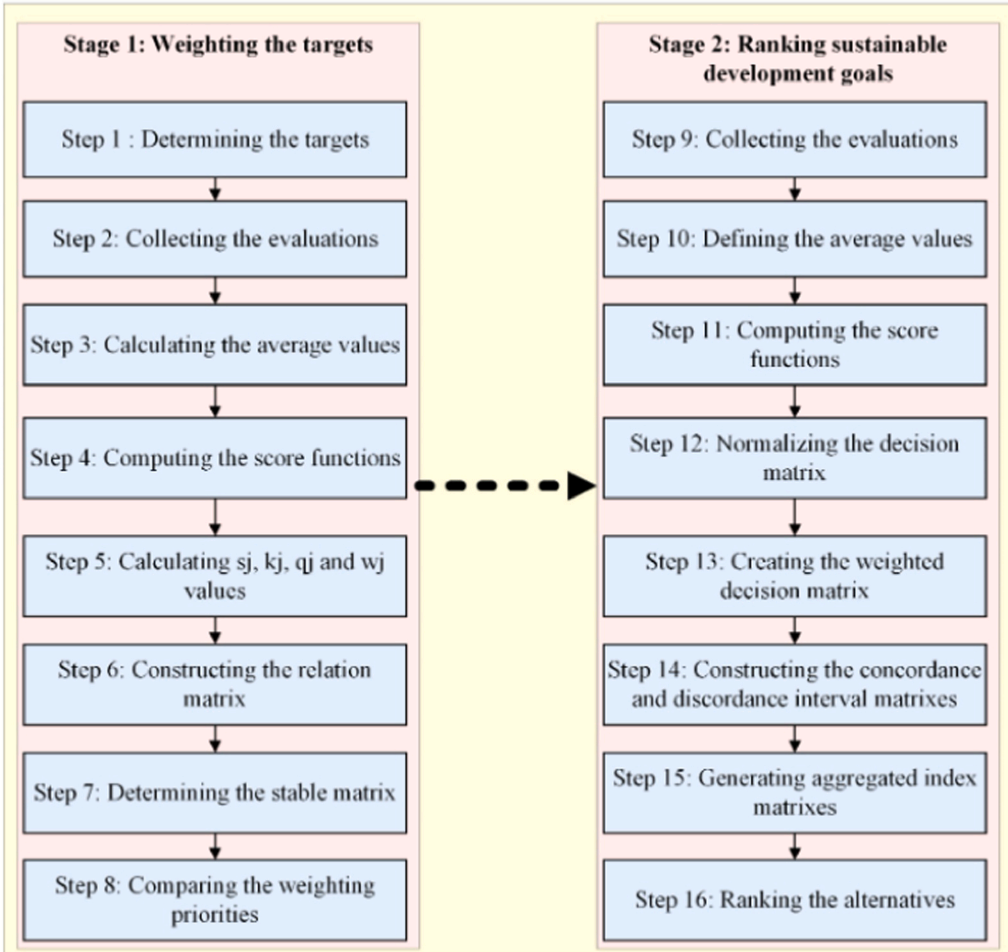

Fig. 1. Proposed model.

result of this process, five distinct targets of this situation are defined. The details of these selected items as shown in Table 1.

Affordability (AFF) gives information about universal access to services (Jiglau et al., 2024). Moreover, renewables (RWS) explain the improvement of the share of renewable energy (Namahoro et al., 2024). In addition to this situation, efficiency (EFC) identifies producing high energy with optimal costs (Xu et al., 2024). Furthermore, cooperation (CPN) refers to enhancing international cooperation to access clean energy (Carayannis et al., 2024). Finally, infrastructure (ISR) defines modern technology for supplying sustainable energy services (Klimek et al., 2024). The criteria for determining the most accurate green energy-oriented investment strategies are determined in line with sustainable development goals. This contributes to achieving more accurate and effective results for developing countries. The criteria determined in line with these goals also increase the environmental sustainability of the projects. This increases the social acceptance of the projects. On the other hand, there are some issues in the sustainable development goals to increase energy supply security. Therefore, using these targets in the criteria in the analyses to be carried out allows more accurate strategies to be determined. Table 2 displays the degrees and scales that were applied during the test, with POV and NEV standing for positive and negative degrees, respectively.

After that, questions are created by comparing the criteria with each other. In this context, the causal effect of each criterion on the others is asked. For example, to understand the impact of criterion 1 on criterion 2, the question "evaluate the impact of affordability on renewables in the context of green energy-oriented sustainable development goals" is created. In the manuscript’s appendix section (Table A1), evaluations for the objectives are listed. Within this framework, the data set of this study consists of the evaluations from the expert team. There are three different people in this team. The first decision maker is the academician that has significant publications related to the sustainable development

Table 1
Targets for green energy-oriented sustainable development goals.

Targets	Codes
Affordability (AFF)	AFF
Renewables (RWS)	RWS
Efficiency (EFC)	EFC
Cooperation (CPN)	CPN
Infrastructure (ISR)	ISR

Source: Adapted from the United Nations, Department of Economic and Social Affairs, https://sdgs.un.org/goals/goal7

Table 2
Degrees and scales.

Scales		POV		NEV	
Targets	Economies	MHP	NHP	MHP	NHP
No (n)	Weakest (w)	.40	.25	−.60	−.37
some (s)	Poor (p)	.45	.28	−.55	−.34
medium (m)	Fair (f)	.50	.31	−.50	−.31
high (h)	Good (g)	.55	.34	−.45	−.28
very high (vh)	Best (b)	.60	.37	−.40	−.25

Source: Authors Compilation*

and green energy investments. Moreover, other two decision makers work as a general manager in the international energy investment companies. They have been involved in comprehensive projects aimed at green energy and sustainable development. In the process of taking the evaluations, online meetings are conducted with each expert. The objectives' average values are listed in Table A2. Table A3 shows the scoring function values for the targets. The values of the sj, kj, qj, and wj are described in Table A4. The creation of the relation matrix is connected to Table A5. Table A6 creates a stable matrix. IFSs and PFSs are also considered in the evaluations. The summary of all results is indicated in Table 3.

Increasing renewable energy is the most significant target regarding green energy-oriented sustainable development. Cooperation and efficiency are also other important sustainable development goals.

Goals for sustainable development that are focused on green energy are ranked in the second stage of the model that is developed. Seven emerging economies—Russia (RSA), Brazil (BZL), India (IDA), China (CNA), Turkey (TKY), Indonesia (IES), and Mexico (MCO)—are referred to as alternatives in this context. Table A7 provides evaluations. In Table A8, average economic values are shown. Table A9 provides information on the values of the score function. Table A10 includes a normalization of this matrix. A11 in Table contains the weighted matrix. Table A12 displays the matrices C and D. These matrices are described in Table A13. In Table A14, the rankings of the economies' net superior, net inferior, and overall values are shown. In Table 4, the rising economies are ranked for each fuzzy set.

Turkey and Mexico are the most successful countries in reaching green energy-oriented sustainable development goals. Also, Indonesia and Brazil have the lowest performance.

5. Discussions

Clean energy access is essential for nations to meet their objectives for sustainable development. For developing nations, it is crucial to increase the proportion of renewable energy in overall energy production and consumption. Many nations have begun to take measures to expand their investments in renewable energy in order to accomplish this aim. In comparison to polluting fossil fuels, renewable energy initiatives are relatively expensive. In this situation, emerging nations must likewise take action to overcome this disadvantage. The cost disadvantage of renewable energy projects might be lessened with the use of state subsidies. In this context, factors like tax reductions and loans with low interest rates may motivate clean energy investors more.

Investments in technologies for renewable energy are also necessary. It will be able to lower the high costs in this method. The fact that the amount of energy produced is unstable owing to climatic circumstances is a significant weakness of renewable energy initiatives. However, energy storage technologies can raise the price of renewable energy initiatives. The cost advantage of clean energy projects over those using fossil fuels is drastically reduced by this circumstance (Lutfi et al., 2023; Alshurideh et al., 2023). This issue can be reduced with the use of an efficient energy storage system. Energy storage technical advancements, according to Smolenski et al. (2022), Costa and Kenisarin (2022), and Zheng et al. (2022), contribute to raise the effectiveness of renewable energy investments. Taking into account the data from these studies, countries should prioritize research and development projects. Energy storage techniques will be put into use in this way at a cheaper cost.

Table 3
Weighting priorities.

	Bipolar IFSs	Bipolar PFSs	Bipolar q-ROFSs
AFF	4	4	4
RWS	1	1	1
EFC	3	3	3
CPN	2	2	2
ISR	5	5	5

Source: Authors Compilation*

Table 4
Comparative ranking results for the economies.

Economies	SWARA-ELECTRE Multi-Q-ROF Bipolar	SWARA-ELECTRE Bipolar PF Multi	SWARA-ELECTRE Bipolar IF Multi
RSA	4	4	4
BZL	7	7	7
IDA	5	5	6
CNA	3	3	3
TKY	1	1	1
IES	6	6	5
MCO	2	2	2

Source: Authors Compilation*

Government backing is another factor that contributes to the cost advantage of renewable energy projects. States can support the growth of sustainable energy projects by putting certain procedures into place. For instance, tax rebates may be offered for initiatives involving renewable energy. The projects' cost-effectiveness could rise as a result. Governments may also offer low-interest loans to sustainable energy investors (Somwethee et al., 2023). With a fairly high initial expenditure, this application will considerably improve the efficiency of clean energy projects (Al Kurdi et al., 2023; Kwilinski et al., 2024). Additionally, it was noted by Dinçer et al. (2022), Jamali and Rasti-Barzoki (2022), and others that government backing is essential for enhancing clean energy investments.

Cooperation is extremely important in achieving sustainable development goals. These goals deal with multidimensional problems such as combating climate change and improving the quality of education. This situation makes it very difficult to achieve the goals. Cooperation is very necessary to combat this problem more effectively. According to Lafont-Torio et al. (2024), Saleem et al. (2024) and Brodny and Tutak (2024), more innovative solutions can be found for these problems when different countries and organizations work together for the same purpose. Another issue required to achieve sustainable development goals is accessing sufficient financial resources. Leal Filho et al. (2024) identified that access to these resources may not be easy, especially in developing countries. Thanks to international cooperation, it is more possible for these countries to receive financial support. In this way, it becomes easier for projects to be implemented in a healthy way. Leonidou et al. (2024) and Sorooshian (2024) discussed that thanks to cooperation between countries, it is also possible to ensure technology transfer. Thus, energy technology transfer is carried out especially from developed countries to developing countries. As a result, it is possible to achieve energy savings in developing countries.

6. Conclusion

The evaluation of green energy-focused sustainable development objectives in emerging economies is done. The bipolar q-ROFSs and the golden cut are taken into account while building a model within this framework. The targets for the sustainable development goals focused on green energy are weighted in the first stage. Within this scope, the United Nations defines and adapts five different targets of the green energy-oriented sustainable development goals. M-SWARA methodology is considered to examine these items. The generated model's second stage includes ranking the emerging economies' green energy-oriented sustainable development goals. For this purpose, E7 economies are analyzed by using the ELECTRE technique. As a result of this evaluation, it can be possible to reach some important conclusions. (i) It is concluded that increasing renewable energy is the most significant target with a weight of 0.235 regarding green energy-oriented sustainable development. (ii) Cooperation and efficiency are other significant issues for this condition, with weights of 0.198 and 0.196. (iii) In terms of achieving sustainable development targets focused on green energy, Turkey and Mexico stand out as the two best-performing nations. The lowest performance, however, is found in Brazil and Indonesia.

The novelty of this study is to identify key green energy-oriented sustainable development goals for the improvement of emerging economies by an original model based on the golden cut and bipolar q-ROF decision making approach. The main theoretical limitation of this study is that emerging economies are only evaluated. However, the subject of this study is also quite essential for other countries. Therefore, this study can be performed for developed economies. The analysis results can pave the way to generate appropriate strategies to provide green energy-oriented sustainable development. Furthermore, a country-specific evaluation can be done. On the other side, the proposed model has some limitations. In this context, average values of the evaluations of the experts are used to create a decision matrix. In other words, the importance of all experts is assumed as equal. Nevertheless, these people can have different demographical issues. Because of this situation, in the following models, artificial intelligence methodology can be adopted to the decision making methodology to compute the weights of the experts.

7. Policy suggestions

By considering the analysis results, it is understood that renewable energy investments should be increased. In this process, necessary actions should be taken into consideration to achieve this purpose. In this context, the development of technological innovation is of critical importance. It is possible to increase the efficiency of projects by investing in innovative technologies. The costs of investments may decrease with the use of new technologies. In this process, financial incentives also contribute to reducing the costs of projects. Increasing the effectiveness of renewable energy projects is directly related to the United Nations' Sustainable Development Goals. For example, SDG 7 emphasizes accessible and clean energy. Thanks to the development of renewable energy projects, it is possible to reduce the costs of energy use. This enables everyone to have access to clean energy. Similarly, the issue of sustainable cities is highlighted in SDG 11. Thanks to renewable energy projects, the carbon emission problem is significantly reduced. Thus, achieving the goal of sustainable cities can be much easier.

To develop renewable energy projects, the problem of high costs must be solved. In this context, state supports such as tax reductions and interest-free loans must be provided. Thus, cost advantages can be provided, and more investors can focus on this area. Public and private sector collaborations must be supported for the development of renewable energy infrastructure. Thanks to this situation, it is possible to solve the financing of large-scale investments more easily. In addition to them, the transfer of clean energy technologies from developed countries to developing countries must also be ensured. In this context, the necessary supports must be provided especially for large-scale renewable energy companies to make investments in countries. Moreover, the implementation of a carbon tax is another policy proposal that allows for the development of renewable energy investments. Thanks to this tax, the use of fossil fuels becomes more costly. Therefore, these projects will lose a significant competitive advantage as a result of the increase in the costs of energy types that harm the environment. Thus, investors will be more willing to invest in clean energy projects.

Energy efficiency is determined as a determining factor in green energy-focused sustainable development goals for emerging economies. It is possible to present policy and strategy recommendations regarding this result. In this context, countries should develop actions to reduce energy consumption. To achieve this goal, energy efficiency can be increased by creating comprehensive legal regulations. On the other hand, government incentives for energy efficiency projects should be increased. In this context, low-interest loans and tax deductions may be taken into consideration. In this way, cost efficiency of businesses will be achieved, which supports the increase of energy efficiency projects. One of the most important issues in ensuring energy efficiency is increasing social awareness. In this context, regular training should be provided to increase people's knowledge on the subject. Thus, it is possible to reduce unnecessary energy consumption. The development of energy storage technologies contributes significantly to energy efficiency. Thanks to the development of energy storage systems, excess energy produced can be stored and used when demand increases or production stops. Therefore, they play a critical role in achieving energy efficiency targets.

CRediT authorship contribution statement

Khalid M Kisswani: Writing – review & editing, Supervision, Resources, Investigation, Funding acquisition. **Hasan Dincer:** Writing – review & editing, Methodology, Investigation, Formal analysis, Data curation. **Serhat Yüksel:** Validation, Software, Resources, Methodology, Formal analysis. **Mohammed Imran Khan:** Validation, Supervision, Investigation. **Mohammad Alsharif:** Writing – review & editing, Software, Resources. **Md Shabbir AIam:** Writing – original draft, Conceptualization.

Ethical statement

This research project does not involve the use of animal or human subjects.

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Declaration of Competing Interest

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Appendix

A) **The Details of the Equations**

$$I = \{\langle \vartheta, \mu_I(\vartheta), n_I(\vartheta) \rangle / \vartheta \epsilon U\} \quad (1)$$

$$0 \le \mu_I(\vartheta) + n_I(\vartheta) \le 1 \quad (2)$$

$$P = \{\langle \vartheta, \mu_P(\vartheta), n_P(\vartheta) \rangle / \vartheta \epsilon U\} \quad (3)$$

$$0 \le (\mu_P(\vartheta))^2 + (n_P(\vartheta))^2 \le 1 \quad (4)$$

$$Q = \left\{ \left\langle \vartheta, \mu_Q(\vartheta), n_Q(\vartheta) \right\rangle / \vartheta \epsilon U \right\} \tag{5}$$

$$0 \leq \left(\mu_Q(\vartheta)\right)^q + \left(n_Q(\vartheta)\right)^q \leq 1 \quad , \quad q \geq 1 \tag{6}$$

$$B = \{\langle \vartheta, \quad {\mu_B}^+(\vartheta), {\mu_B}^-(\vartheta)\rangle / \vartheta \epsilon U\} \tag{7}$$

$$B_I = \left\{ \left\langle \vartheta, \quad {\mu_{B_I}}^+(\vartheta), {n_{B_I}}^+(\vartheta), {\mu_{B_I}}^-(\vartheta), {n_{B_I}}^-(\vartheta) \right\rangle / \vartheta \epsilon U \right\} \tag{8}$$

$$B_P = \left\{ \left\langle \vartheta, \quad {\mu_{B_P}}^+(\vartheta), {n_{B_P}}^+(\vartheta), {\mu_{B_P}}^-(\vartheta), {n_{B_P}}^-(\vartheta) \right\rangle / \vartheta \epsilon U \right\} \tag{9}$$

$$B_Q = \left\{ \left\langle \vartheta, \quad {\mu_{B_Q}}^+(\vartheta), {n_{B_Q}}^+(\vartheta), {\mu_{B_Q}}^-(\vartheta), {n_{B_Q}}^-(\vartheta) \right\rangle / \vartheta \epsilon U \right\} \tag{10}$$

$$0 \leq \left({\mu_{B_I}}^+(\vartheta) \right) + \left({n_{B_I}}^+(\vartheta) \right) \leq 1 \quad , \quad -1 \leq \left({\mu_{B_I}}^-(\vartheta) \right) + \left({n_{B_I}}^-(\vartheta) \right) \leq 0 \tag{11}$$

$$0 \leq \left({\mu_{B_P}}^+(\vartheta) \right)^2 + \left({n_{B_P}}^+(\vartheta) \right)^2 \leq 1, \quad 0 \leq \left({\mu_{B_P}}^-(\vartheta) \right)^2 + \left({n_{B_P}}^-(\vartheta) \right)^2 \leq 1 \tag{12}$$

$$0 \leq \left({\mu_{B_Q}}^+(\vartheta) \right)^q + \left({n_{B_Q}}^+(\vartheta) \right)^q \leq 1 \quad , \quad -1 \leq \left({\mu_{B_Q}}^-(\vartheta) \right)^q + \left({n_{B_Q}}^-(\vartheta) \right)^q \leq 0 \tag{13}$$

$$B_{Q1} = \left\{ \frac{\left\langle \vartheta, \ {\mu_{B_{Q1}}}^+(\vartheta), {n_{B_{Q1}}}^+(\vartheta), {\mu_{B_{Q1}}}^-(\vartheta), {n_{B_{Q1}}}^-(\vartheta) \right\rangle}{\vartheta \epsilon U} \right\}$$

and.

$$B_{Q2} = \left\{ \left\langle \vartheta, \ {\mu_{B_{Q2}}}^+(\vartheta), {n_{B_{Q2}}}^+(\vartheta), {\mu_{B_{Q2}}}^-(\vartheta), {n_{B_{Q2}}}^-(\vartheta) \right\rangle / \vartheta \epsilon U \right\}$$

$$B_{Q1} \oplus B_{Q2} = \left(\left(\left({\mu_{B_{Q1}}}^+\right)^q + \left({\mu_{B_{Q2}}}^+\right)^q - \left({\mu_{B_{Q1}}}^+\right)^q . \left({\mu_{B_{Q2}}}^+\right)^q \right)^{\frac{1}{q}}, \ \left({n_{B_{Q1}}}^+ . {n_{B_{Q2}}}^+\right), -\left({\mu_{B_{Q1}}}^- . {\mu_{B_{Q2}}}^-\right), -\left(\left({n_{B_{Q1}}}^-\right)^q + \left({n_{B_{Q2}}}^-\right)^q - \left({n_{B_{Q1}}}^-\right)^q . \left({n_{B_{Q2}}}^-\right)^q \right)^{\frac{1}{q}} \right) \tag{14}$$

$$B_{Q1} \otimes B_{Q2} = \left(\left({\mu_{B_{Q1}}}^+ . {\mu_{B_{Q2}}}^+\right), \ \left(\left({n_{B_{Q1}}}^+\right)^q + \left({n_{B_{Q2}}}^+\right)^q - \left({n_{B_{Q1}}}^+\right)^q . \left({n_{B_{Q2}}}^+\right)^q \right)^{\frac{1}{q}}, \ -\left(\left({\mu_{B_{Q1}}}^-\right)^q + \left({\mu_{B_{Q2}}}^-\right)^q - \left({\mu_{B_{Q1}}}^-\right)^q . \left({\mu_{B_{Q2}}}^-\right)^q \right)^{\frac{1}{q}}, \ -\left({n_{B_{Q1}}}^- . {n_{B_{Q2}}}^-\right) \right) \tag{15}$$

$$\lambda B_{Q1} = \left(\left(1 - \left(1 - \left({\mu_{B_{Q1}}}^+\right)^q \right)^\lambda \right)^{1/q}, \ \left({n_{B_{Q1}}}^+\right)^\lambda, \ -\left(-{\mu_{B_{Q1}}}^-\right)^\lambda, -\left(1 - \left(1 - \left(-{n_{B_{Q1}}}^-\right)^q \right)^\lambda \right)^{1/q} \right), \lambda > 0 \tag{16}$$

$${B_{Q1}}^\lambda = \left(\left({\mu_{B_{Q1}}}^+\right)^\lambda, \ \left(1 - \left(1 - \left({n_{B_{Q1}}}^+\right)^q \right)^\lambda \right)^{1/q}, -\left(1 - \left(1 - \left(-{\mu_{B_{Q1}}}^-\right)^q \right)^\lambda \right)^{\frac{1}{q}}, \ -\left(-{n_{B_{Q1}}}^-\right)^\lambda \right), \lambda > 0 \tag{17}$$

$$S(\vartheta)_{B_I} = \left(\left({\mu_{B_I}}^+(\vartheta)\right) - \left({n_{B_I}}^+(\vartheta)\right) \right) - \left(\left({\mu_{B_I}}^-(\vartheta)\right) - \left({n_{B_I}}^-(\vartheta)\right) \right) \tag{18}$$

$$S(\vartheta)_{B_P} = \left(\left({\mu_{B_P}}^+(\vartheta)\right)^2 - \left({n_{B_P}}^+(\vartheta)\right)^2 \right) + \left(\left({\mu_{B_P}}^-(\vartheta)\right)^2 - \left({n_{B_P}}^-(\vartheta)\right)^2 \right) \tag{19}$$

$$S(\vartheta)_{B_Q} = \left(\left({\mu_{B_Q}}^+(\vartheta)\right)^q - \left({n_{B_Q}}^+(\vartheta)\right)^q \right) - \left(\left({\mu_{B_Q}}^-(\vartheta)\right)^q - \left({n_{B_Q}}^-(\vartheta)\right)^q \right) \tag{20}$$

$$\varphi = \frac{a}{b} \tag{21}$$

$$\varphi = \frac{1 + \sqrt{5}}{2} = 1.618\ldots \tag{22}$$

$$\varphi = \frac{\mu_{G_{B_Q}}}{n_{G_{B_Q}}} \tag{23}$$

$$G_{B_Q} = \left\{ \left\langle \vartheta, \quad {\mu_{G_{B_Q}}}^+(\vartheta), {n_{G_{B_Q}}}^+(\vartheta), {\mu_{G_{B_Q}}}^-(\vartheta), {n_{G_{B_Q}}}^-(\vartheta) \right\rangle / \vartheta \epsilon U \right\} \tag{24}$$

$$0 \leq \left({\mu_{G_{B_Q}}}^+(\vartheta) \right)^q + \left({n_{G_{B_Q}}}^+(\vartheta) \right)^q \leq 1 \quad , \quad -1 \leq \left({\mu_{G_{B_Q}}}^-(\vartheta) \right)^q + \left({n_{G_{B_Q}}}^-(\vartheta) \right)^q \leq 0 \tag{25}$$

$$0 \leq \left(\mu_{G_{B_Q}}{}^{+}(\vartheta) \right)^{2q} + \left(n_{G_{B_Q}}{}^{+}(\vartheta) \right)^{2q} \leq 1, \quad 0 \leq \left(\mu_{G_{B_Q}}{}^{-}(\vartheta) \right)^{2q} + \left(n_{G_{B_Q}}{}^{-}(\vartheta) \right)^{2q} \leq 1 \quad q \geq 1 \tag{26}$$

$$Q_k = \begin{bmatrix} 0 & Q_{12} & \cdots & \cdots & Q_{1n} \\ Q_{21} & 0 & \cdots & \cdots & Q_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ Q_{n1} & Q_{n2} & \cdots & \cdots & 0 \end{bmatrix} \tag{27}$$

$$k_j = \begin{cases} 1 & j = 1 \\ s_j + 1 & j > 1 \end{cases} \tag{28}$$

$$q_j = \begin{cases} 1 & j = 1 \\ \dfrac{q_{j-1}}{k_j} & j > 1 \end{cases} \tag{29}$$

$$If s_{j-1} = s_j, \quad q_{j-1} = q_j; If s_j = 0, \quad k_{j-1} = k_j$$

$$w_j = \frac{q_j}{\sum_{k=1}^{n} q_k} \tag{30}$$

$$X_k = \begin{bmatrix} 0 & X_{12} & \cdots & \cdots & X_{1m} \\ X_{21} & 0 & \cdots & \cdots & X_{2m} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ X_{n1} & X_{n2} & \cdots & \cdots & 0 \end{bmatrix} \tag{31}$$

$$r_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{m} X_{ij}^2}} \tag{32}$$

$$v_{ij} = w_{ij} \times r_{ij} \tag{33}$$

$$C = \begin{bmatrix} - & c_{12} & \cdots & \cdots & c_{1n} \\ c_{21} & - & \cdots & \cdots & c_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ c_{n1} & c_{n2} & \cdots & \cdots & - \end{bmatrix} \tag{34}$$

$$D = \begin{bmatrix} - & d_{12} & \cdots & \cdots & d_{1n} \\ d_{21} & - & \cdots & \cdots & d_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ d_{n1} & d_{n2} & \cdots & \cdots & - \end{bmatrix} \tag{35}$$

$$c_{ab} = \{ j | v_{aj} \geq v_{bj} \} \tag{36}$$

$$d_{ab} = \{ j | v_{aj} < v_{bj} \} \tag{37}$$

$$c_{ab} = \sum_{j \in c_{ab}} w_j \tag{38}$$

$$d_{ab} = \frac{\max_{j \in d_{ab}} |v_{aj} - v_{bj}|}{\max_j |v_{mj} - v_{nj}|} \tag{39}$$

$$E = \begin{bmatrix} - & e_{12} & \cdots & \cdots & e_{1n} \\ e_{21} & - & \cdots & \cdots & e_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ e_{n1} & e_{n2} & \cdots & \cdots & - \end{bmatrix} \tag{40}$$

$$F = \begin{bmatrix} - & f_{12} & \cdots & \cdots & f_{1n} \\ f_{21} & - & \cdots & \cdots & f_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ f_{n1} & f_{n2} & \cdots & \cdots & - \end{bmatrix} \tag{41}$$

$$G = \begin{bmatrix} - & g_{12} & \cdots & \cdots & g_{1n} \\ g_{21} & - & \cdots & \cdots & g_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ g_{n1} & g_{n2} & \cdots & \cdots & - \end{bmatrix} \tag{42}$$

$$\begin{cases} e_{ab} = 1 if c_{ab} \geq \overline{c} \\ e_{ab} = 0 if c_{ab} < \overline{c} \end{cases} \tag{43}$$

$$\overline{c} = \sum_{a=1}^{n} \sum_{b}^{n} c_{ab} / n(n-1) \tag{44}$$

$$\begin{cases} f_{ab} = 1 if d_{ab} \leq \overline{d} \\ f_{ab} = 0 if d_{ab} > \overline{d} \end{cases} \tag{45}$$

$$\overline{d} = \sum_{a=1}^{n} \sum_{b}^{n} d_{ab} / n(n-1) \tag{46}$$

$$g_{ab} = e_{ab} \times f_{ab} \tag{47}$$

$$c_a = \sum_{b=1}^{n} c_{ab} - \sum_{b=1}^{n} c_{ba} \tag{48}$$

$$d_a = \sum_{b=1}^{n} d_{ab} - \sum_{b=1}^{n} d_{ba} \tag{49}$$

$$o_a = c_a - d_a \tag{50}$$

B) The Details of the Tables

Table A1
Evaluations for the targets

	AFF		RWS		EFC		CPN		ISR	
Decision Maker 1										
	POV	**NEV**	**POV**	**NEV**	**POV**	**NEV**	**POV**	**NEV**	**POV**	**NEV**
AFF			S	S	S	M	S	N	M	VH
RWS	VH	S			S	VH	M	N	S	H
EFC	M	VH	H	S			S	M	S	S
CPN	VH	N	VH	M	VH	N			H	M
ISR	VH	M	VH	M	H	H	S	N		
Decision Maker 2										
	AFF		**RWS**		**EFC**		**CPN**		**ISR**	
	POV	**NEV**	**POV**	**NEV**	**POV**	**NEV**	**POV**	**NEV**	**POV**	**NEV**
AFF			M	S	S	M	S	N	M	VH
RWS	H	S			M	VH	H	N	M	H
EFC	M	N	H	H			S	M	H	S
CPN	M	M	VH	N	VH	N			H	M
ISR	M	M	H	N	H	M	S	N		
Decision Maker 3										
	AFF		**RWS**		**EFC**		**CPN**		**ISR**	
	POV	**NEV**	**POV**	**NEV**	**POV**	**NEV**	**POV**	**NEV**	**POV**	**NEV**
AFF			H	S	M	M	S	H	M	M
RWS	H	S			S	M	M	N	S	H
EFC	M	M	H	S			S	M	S	S
CPN	VH	H	H	M	S	N			H	M
ISR	H	M	S	M	H	H	S	H		

Table A2
Average values of the targets

	AFF				RWS				EFC				CPN				ISR			
	POV		NEV		POV		NEV		POV		NEV		POV		NEV		POV		NEV	
	μ	n	μ	n	μ	n	μ	n	μ	n	μ	n	μ	n	μ	n	μ	n	μ	n
AFF					.50	.31	−.55	−.34	.47	.29	−.50	−.31	.45	.28	−.55	−.34	.50	.31	−.43	−.27
RWS	.57	.35	−.55	−.34					.47	.29	−.43	−.27	.52	.32	−.60	−.37	.47	.29	−.45	−.28
EFC	.50	.31	−.50	−.31	.55	.34	−.52	−.32					.45	.28	−.50	−.31	.48	.30	−.55	−.34
CPN	.57	.35	−.52	−.32	.58	.36	−.53	−.33	.55	.34	−.60	−.37					.55	.34	−.50	−.31
ISR	.55	.34	−.50	−.31	.53	.33	−.53	−.33	.55	.34	−.47	−.29	.45	.28	−.55	−.34				

Table A3
Score function values of the targets

	AFF	RWS	EFC	CPN	ISR
AFF	.000	.223	.173	.197	.158
RWS	.266	.000	.140	.270	.147
EFC	.191	.232	.000	.165	.213
CPN	.244	.268	.292	.000	.223
ISR	.223	.232	.205	.197	.000

Table A4
Sj, kj, qj, and wj values

AFF	Sj	Kj	qj	wj	RWS	Sj	kj	qj	Wj
RWS	.223	1.000	1.000	.316	CPN	.270	1.000	1.000	.324
CPN	.197	1.197	.836	.264	AFF	.266	1.266	.790	.256
EFC	.173	1.173	.712	.225	ISR	.147	1.147	.688	.223
ISR	.158	1.158	.615	.195	EFC	.140	1.140	.604	.196
EFC	**Sj**	**Kj**	**qj**	**wj**	**CPN**	**Sj**	**kj**	**qj**	**Wj**
RWS	.232	1.000	1.000	.322	EFC	.292	1.000	1.000	.340
ISR	.213	1.213	.824	.265	RWS	.268	1.268	.789	.268
AFF	.191	1.191	.692	.223	AFF	.244	1.244	.634	.216
CPN	.165	1.165	.594	.191	ISR	.223	1.223	.519	.176
CPN	**Sj**	**Kj**	**qj**	**Wj**					
RWS	.232	1.000	1.000	.326					
AFF	.223	1.223	.818	.267					
EFC	.205	1.205	.679	.222					
CPN	.197	1.197	.567	.185					

Table A5
Relation matrix

	AFF	RWS	EFC	CPN	ISR
AFF		.316	.225	.264	.195
RWS	.256		.196	.324	.223
EFC	.223	.322		.191	.265
CPN	.216	.268	.340		.176
ISR	.267	.326	.222	.185	

Table A6
Stable matrix

	AFF	RWS	EFC	CPN	ISR
AFF	.194	.194	.194	.194	.194
RWS	.235	.235	.235	.235	.235
EFC	.196	.196	.196	.196	.196
CPN	.198	.198	.198	.198	.198
ISR	.177	.177	.177	.177	.177

Table A7
Evaluations for economies

	AFF		RWS		EFC		CPN		ISR	
Decision Maker 1										
	AFF		**RWS**		**EFC**		**CPN**		**ISR**	
	POV	**NEV**	**POV**	**NEV**	**POV**	**NEV**	**POV**	**NEV**	**POV**	**NEV**
RSA	P	P	G	F	F	W	G	G	F	B
BZL	P	P	F	F	B	G	P	B	P	W
IDA	F	P	G	P	G	F	G	G	F	B
CNA	B	F	P	W	G	G	B	W	P	B
TKY	G	G	G	W	P	W	G	G	B	F
IES	B	G	P	F	B	G	G	F	G	F
MCO	P	P	G	F	G	F	G	G	B	G
Decision Maker 2										
	AFF		**RWS**		**EFC**		**CPN**		**ISR**	
	POV	**NEV**	**POV**	**NEV**	**POV**	**POV**	**NEV**	**POV**	**NEV**	**POV**
RSA	B	P	P	F	B	F	P	W	F	G
BZL	B	P	P	F	B	G	P	G	P	B
IDA	F	P	G	F	G	F	P	G	G	B
CNA	G	W	G	G	G	G	B	W	P	B
TKY	G	G	G	G	P	W	G	W	B	B
IES	B	G	P	F	G	G	P	F	G	F
MCO	P	F	G	G	P	F	G	F	B	F
Decision Maker 3										
	AFF		**RWS**		**EFC**		**CPN**		**ISR**	
	POV	**NEV**	**POV**	**NEV**	**POV**	**POV**	**NEV**	**POV**	**NEV**	**POV**
RSA	G	P	G	F	F	F	G	F	B	F
BZL	P	F	G	F	G	G	B	W	P	G
IDA	F	P	G	W	G	B	G	B	F	B
CNA	G	F	G	F	G	G	B	W	P	G
TKY	G	G	G	W	B	B	G	B	B	F
IES	B	F	G	G	G	G	G	F	G	F
MCO	G	W	B	G	G	F	B	W	B	G

Table A8
Average values of the economies

	AFF				RWS				EFC				CPN				ISR			
	POV		NEV		POV		NEV		POV		POV		NEV		POV		NEV		POV	
	μ	n	μ	n	μ	n	μ	n	μ	n	μ	n	μ	n	μ	n	μ	n	μ	n
RSA	.53	.33	−.55	−.34	.52	.32	−.50	−.31	.53	.33	−.53	−.33	.52	.32	−.52	−.32	.53	.33	−.45	−.28
BZL	.50	.31	−.53	−.33	.50	.31	−.50	−.31	.58	.36	−.45	−.28	.50	.31	−.48	−.30	.45	.28	−.48	−.30
IDA	.50	.31	−.55	−.34	.55	.34	−.55	−.34	.55	.34	−.47	−.29	.52	.32	−.43	−.27	.52	.32	−.40	−.25
CNA	.57	.35	−.53	−.33	.52	.32	−.52	−.32	.55	.34	−.45	−.28	.60	.37	−.60	−.37	.45	.28	−.42	−.26
TKY	.55	.34	−.45	−.28	.55	.34	−.55	−.34	.50	.31	−.53	−.33	.55	.34	−.48	−.30	.60	.37	−.47	−.29
IES	.60	.37	−.47	−.29	.48	.30	−.48	−.30	.57	.35	−.45	−.28	.52	.32	−.50	−.31	.55	.34	−.50	−.31
MCO	.48	.30	−.55	−.34	.57	.35	−.47	−.29	.52	.32	−.50	−.31	.57	.35	−.52	−.32	.60	.37	−.47	−.29

Table A9
Score function values of the economies

	AFF	RWS	EFC	CPN	ISR
RSA	.243	.201	.232	.211	.186
BZL	.211	.191	.221	.182	.156
IDA	.223	.254	.205	.168	.154
CNA	.255	.211	.197	.330	.125
TKY	.197	.254	.211	.213	.243
IES	.243	.173	.209	.201	.223
MCO	.213	.217	.201	.244	.243

Table A10
Normalized matrix

	AFF	RWS	EFC	CPN	ISR
RSA	.404	.351	.415	.351	.360
BZL	.352	.334	.396	.303	.303
IDA	.370	.444	.367	.279	.299
CNA	.424	.368	.352	.550	.242
TKY	.327	.444	.379	.356	.471
IES	.404	.302	.374	.335	.432
MCO	.355	.379	.360	.407	.471

Table A11
Weighted matrix

	AFF	RWS	EFC	CPN	ISR
RSA	.078	.083	.081	.069	.064
BZL	.068	.079	.078	.060	.054
IDA	.072	.105	.072	.055	.053
CNA	.082	.087	.069	.109	.043
TKY	.063	.105	.074	.070	.083
IES	.078	.071	.073	.066	.077
MCO	.069	.089	.071	.081	.083

Table A12
C and D matrixes

	C							D						
	RSA	BZL	IDA	CAN	TKY	IES	MCO	RSA	BZL	IDA	CAN	TKY	IES	MCO
RSA	.000	1.000	.765	.373	.390	.823	.390	.000	.000	1.000	1.000	1.000	1.000	1.000
BZL	.000	.000	.571	.373	.390	.431	.196	1.000	.000	1.000	1.000	1.000	1.000	1.000
IDA	.235	.429	.000	.608	.429	.235	.625	.649	.223	.000	1.000	1.000	.699	1.000
CNA	.627	.627	.392	.000	.392	.627	.392	.530	.218	.334	.000	1.000	.789	1.000
TKY	.610	.610	.806	.610	.000	.806	.608	.896	.159	.275	.950	.000	.441	.662
IES	.177	.569	.765	.373	.194	.000	.390	.914	.331	1.000	1.000	1.000	.000	1.000
MCO	.610	.804	.375	.608	.569	.610	.000	.553	.240	.508	.697	1.000	.520	.000

Table A13
D, E and F matrixes

	D							E							F						
	RSA	BZL	IDA	CAN	TKY	IES	MCO	RSA	BZL	IDA	CAN	TKY	IES	MCO	RSA	BZL	IDA	CAN	TKY	IES	MCO
RSA	0	1	1	0	0	1	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0
BZL	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
IDA	0	0	0	1	0	0	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0
CNA	1	1	0	0	0	1	0	1	1	1	1	0	0	0	1	1	0	0	0	0	0
TKY	1	1	1	1	0	1	1	0	1	1	0	1	1	1	0	1	1	0	0	1	1
IES	0	1	1	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0
MCO	1	1	0	1	1	1	0	1	1	1	1	0	1	1	1	1	0	1	0	1	0

Table A14
Net superior, inferior, and overall values of the economies

Economies	Net superior values	Net Inferior values	Overall values
RSA	1.482	.458	1.024
BZL	−2.076	4.829	−6.905
IDA	−1.111	.455	−1.567
CNA	.108	−1.776	1.885
TKY	1.688	−2.618	4.306
IES	−1.065	.795	−1.860
MCO	.974	−2.143	3.117

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