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Evaluation of Countries Environmental Efficiency Using Data Envelopment Analysis

Mina Moshfegh[1] and Mohsen Rostamy-Malkhalifeh[2*]

[1] Islamic Azad University,Science and Research Branch,Tehran,Iran
[*2] Islamic Azad University, Science and Research Branch

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Abstract

Over the last few decades, there has been a dramatic increase in public attention to environmental issues. As a consequence of the growing concerns about environmental quality, climate change, and pollutant emission, which are key elements of sustainable development, one of the main challenges is measuring environmental efficiency. The main purpose of this study is to evaluate the ecological efficiency of countries and rank countries based on data envelopment analysis (DEA) method, considering the favorable and unfavorable outputs (7 inputs and 7 outputs) affecting climate change in 2020 in 176 countries. The units were evaluated by CCR model and Also AP model in order to ranking both efficient units and inefficient units. The results show that the environmental efficiency of the selected countries is 80.60% on average, of which Iran ranks 140th with an efficiency of 0.58 and Iceland, Singapore and Lesotho have the highest environmental efficiency, respectively, as well as Sierra Leon, the Philippines, and Pakistan have the lowest environmental performance, respectively.

Keywords:
Data envelopment analysis
Environmental efficiency
Anderson Peterson model

***Correspondence E-mail**: mohsen_rostamy@yahoo.com

INTRODUCTION

Recently, environmental conservation is one of the most important issues in the world. From an ecological point of view, environmental pollution is important owing to its adverse effects. Attention to environmental issues began in the 1960s, and their main focus was on industrial pollution. This issue was directly related to industrial development and economic growth [1]. The process of industrial development of countries and industrialization and the set of governing policies lead to the problems of environmental degradation. With increasing concerns about irreversible harmful effects on the environment, environmental issues have been addressed from a variety of perspectives. Therefore, it is necessary to pay attention to the destructive effects and environmental pollutants caused by economic activities in assessing the efficiency of units at the micro level, meso level and macro levels.

The United Nations Conference on Environment and Development (UNCED), known as the Earth Summit, was held in Rio de Janeiro, Brazil (1992) to coordinate global economic development with environmental protection. The Earth Summit was the largest gathering of world leaders since 1992, attended by 117 heads of state and representatives from 178 countries. Recognizing the importance of the issue of environment, environmental management within the framework of development, and drafting of international environmental laws, as well as a new concept called sustainable development should be considered the most important achievement of this meeting. Using treaties and other documents signed at the conference, most of the world’s nations nominally committed themselves to on the track economic development in ways that would protect the Earth’s environment and nonrenewable resources [2].

Industrial activities that are carried out in order to the economic growth of developing and developing countries and the increasing population have consequences such as the emission of pollutants, waste, improper use of resources, mines, and forests. These results cause global warming. Global warming itself causes problems such as fires and deforestation. The consequences and problems have led to environmental indicators considered in economic policy targeting. Measuring efficiency can modify policy makers' plans to improve efficiency, energy efficiency, reduce environmental pollutants, and economic development, leading to the implementation of macro-level sustainable environmental development policies. Therefore, considering the growing problem of environmental issues and overhead costs that various activities create on the quality of the environment, it is necessary to study efficiency models despite the combined production of desirable and undesirable outputs. Therefore, in this study, the environmental performance of 176 countries is evaluated and the countries are ranked, regardless of the rate of development.

LITERATURE REVIEW

Brundtland Report, also called Our Common Future, a publication released in 1987 by the World Commission on Environment and Development (WCED) that introduced the concept of sustainable development and described how it could be achieved.
"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." In other words, the sustainable development of a comprehensive approach that promotes development in ways that do not enter the environment or not naturally resorting natural resources, which is available in the future. The report adds that these conditions change not only environmental policies, but also economic and social policies [3].

Environmental pollution has become one of the most substantial global concerns in recent years. The formation of numerous international forums and conferences on the environment and the formulation of various environmental treaties and agreements between countries show the growing global attention to the consequences of environmental pollution and the emphasis on economic growth with the protection of environmental resources or sustainable development. The problems of environmental pollution in Iran have also become one of the main challenges facing policymakers, governments, and the people. In particular, the closure of government offices and organizations due to the high volume of air pollution has imposed hefty costs on society. In Iran, as in most developing countries, there are many harmful pollutants due to the incomplete combustion of fossil fuels. Consumption of more fossil fuels (such as coal and gas) instead of using clean energy, has led to the increasing growth of environmental pollutants by releasing large amounts of carbon dioxide, a greenhouse gas, into the air. [4].

In recent years, there has been a growing interest in measuring the environmental efficiency of different regions, countries, and/or nations. This has led to the development of various methods for evaluating environmental performance, such as data envelopment analysis (DEA). This method, which is supported by numerous studies, makes it possible to measure the relative efficiency of the environment and has been presented as a very reliable method for measuring the effectiveness of environmental policies in a specific geographical area [5]. Typically, efficiency is related to how the firm allocates scarce resources optimally to achieve production goals. In general, when it comes to the efficiency of a firm, it usually means the success of that firm in achieving maximum output with a certain level of inputs [6].

Data Envelopment Analysis (DEA) is a non-parametric method for defining the relative efficiency of a group of decision units (DMU) [18, 19]. In 1957, the original idea for data envelopment analysis (DEA) was proposed by Farrel [7, 17], and later its theory and calculations were used by Abraham Charnes, William Cooper, and Edward Rhodes, so it is possible to use several variables as inputs and outputs which were produced in data envelopment analysis (DEA) [17, 19]. The analysis approach in the form of mathematical-based programming in environmental management and industrial productivity was suggested by Haynes in 1994 as an alternative to decision-making methods and monitoring of pollutant reduction. In 1996, Färe et al. applied the DEA method to measure pollution and productivity indices, using US data of fossil fuels burned to generate electricity.

Data envelopment analysis method is one of the most widely used non-parametric methods in measuring efficiency, in which efficiency is calculated by performing a series of optimizations separately for each decision-making unit (DMUs). In this method, the measurement of production factors and products can be done with different units.DEA models can be output-oriented or input-oriented. On output-oriented models, the goal is to maximize production, according to a certain number of inputs, but in the input-oriented method, the goal is to use minimum inputs according to a certain level of product. These models can also be constant or variable returns to scale. With increasing concerns about environmental quality, it seems necessary to consider the adverse effects of economic activities in evaluating the efficiency and productivity of decision-making units at different levels. Therefore, to measures the economic performance of countries, indicators that have environmental dimensions are needed. To address this issue, a new type of efficiency called environmental efficiency was introduced, which also includes undesirable output. In fact, environmental efficiency focuses on input with negative environmental consequences, by reducing the level of pollutant inputs, affects technical and environmental efficiency [8].

DEA method has been widely used to energy, power, water, mining, insurance, health services, transportation, tourism, education, ... [19]. DEA also has many applications for Productivity interpretation has complex economic and engineering systems [20].

In recent years, several studies have been conducted to measure environmental efficiency and influential indices of environmental performance, some of which have been done in the environmental efficiency of countries as follows:

Ohadi et al. (2009) conducted a study entitled "Assessing the environmental efficiency of carbon with inaccurate data using fuzzy data envelopment analysis (Case study: Iran and oil-rich countries)". In the present study, fuzzy data envelopment analysis method was used. The results of the study showed that the average range of environmental carbon efficiency during the study period for the countries under study is 75% - 90%. Also, compared to other countries under study, Iran is not in a Satisfactory position and has a low environmental carbon efficiency with an average environmental carbon efficiency of 74% - 61%, for the upper and lower limits of efficiency, respectively. In this study, in order to increase the environmental efficiency of carbon, the correct and optimal use of production inputs and less use of resources was recommended [1].

Houshangi and Emami Meibodi (2009) conducted a study entitled "Measuring Technical Efficiency, Environmental Efficiency and Energy Efficiency in Desalination Plant by Data Envelopment Analysis". In this study, the technical efficiency and environmental efficiency of the desalination plant by reverse osmosis method located in the South Pars Special Economic Zone from 2008 to 2016, has been measured by DEA method. The results show that the average technical efficiency of the study unit under the assumption of constant and variable returns to scale was 90.8 and 98.4%, respectively. Also, scale inefficiency has the most considerable impact on technical inefficiency under the CRS hypothesis, which indicates the inefficiency of optimal scale production for the target firm. Also, in calculating the environmental efficiency, the efficiency of the studied desalination plant for the whole period of its activity has been a figure equal to 90%. In addition, using the energy efficiency index of all factors, the average energy efficiency is estimated at 91%. According to the results, the increasing temperature in hot seasons caused a significant decrease in energy efficiency [9].

Mamipour and Najafzadeh (2016) conducted a study entitled "Three-Stage Environmental Efficiency Evaluation of Iran's Power Industry: Network Data Envelopment Analysis Approach". In this research, using the combination of the nonradial SBM model and three-part network structure, the environmental efficiency of 15 regional electricity companies in Iran in the period 2010-2014 has been evaluated. The electricity network in the country consists of three sections of production, transmission, and distribution, which are interconnected using two intermediaries of electricity generated and electricity transmitted, and the overall efficiency of electricity is determined by them. The results show that the production sector affects the overall efficiency more than the other two sectors and significantly reduces the efficiency scores of companies. Khuzestan Company had the highest efficiency and Gharb Company had the worst performance in the entire electricity network. The results of this study can lead to a better understanding of the general position of electricity companies and provide appropriate policies to improve their performance [10].

Rasekhi et al. (2016) conducted a study entitled "The relationship between economic efficiency and environmental efficiency: new evidence for developing and developed countries." In this study, the relationship between environmental and economic efficiencies has been examined. To do this, first using the data envelopment analysis method, the environmental and economic efficiencies of 50 selected developed and developing countries, including Iran during the period 2002-2002, are estimated and then, using the Granger causality test and The formation of a system of simultaneous equations, the relationship between environmental and economic efficiencies has been investigated. The results of performance calculations show that developed countries have higher environmental and economic efficiencies than developing countries. In this regard, Iran's average environmental and economic efficiencies are 0.570 and 0.379, respectively, which is lower than the average of the countries under study. Also, the results of the Granger causality test show that there is a two-way causality relationship between environmental and economic efficiencies. Based on the results of estimating the two-stage least squares model, there is a positive two-way relationship between economic efficiency and environmental efficiency in selected countries. Thus, upgrading one of these two efficiencies will increase the other efficiencies [11].

Fathi et al. (2021) in their research entitled "Energy, environmental, and economic efficiency in fossil fuel exporting countries: A modified data envelopment analysis approach" state that due to increasing concerns about high energy consumption and heating Land, energy efficiency and the environment has been the focus of researchers and policymakers. The purpose of this study is to investigate energy, environmental and economic (E3) efficiency in fossil fuel exporting countries from 2015 to 2017, using traditional data envelopment analysis (DEA) and a DEA efficiency bargaining approach. According to the results, the average energy, economic and environmental efficiency are 0.77, 0.8, and 0.26, respectively. The results of the DEA approach show that efficiency performance is different in each country and it is not possible to accurately determine the equilibrium points according to all three criteria. Therefore, the efficient performance of E3 is examined by an integrated model of the DEA game by bargaining. By obtaining a bargaining chip product, countries are ranked in terms of efficient performance. Countries such as China, Oman, Bahrain, Romania, and Poland have the top five rankings, respectively. The bottom five countries are Gabon, Saudi Arabia, Albania, Algeria, and Georgia, respectively. Comparison of the results of DEA method and Nash bargaining game - DEA model shows that the second model is more suitable for ranking due to its unique solution [12].

Orzáez et al. (2020) calculated the environmental performance of 28 European Union (EU) member states using the DEA method. They used data from previous years that contained valid comparative data. They studied the results of environmental policies implemented in different countries to be able to compare countries and classify them based on environmental efficiency. Two different of calculations were analyzed within the DEA method to evaluate in a contrasted way the results of environmental efficiency for the 28 countries of the European Union (EU).

Using this new method as the newest DEA method, which is called Advanced Analysis Method (MAN) and to aggregate and evaluate more objectively, applies the results of two DEA methods. The results show that 14 out of 28 countries have high relative environmental efficiency. However, they also have countries with poor environmental performance that need to be enhanced in the coming years [5].

Wang et al. (2020) in their study entitled "Environmental efficiency evaluation of China's iron and steel industry: A process-level data envelopment analysis" state that to address the growing energy and environmental pressures, assess the environmental performance of China's iron and steel industry It is essential to identify an accurate route of energy conservation and emission reduction. However, current studies focus only on performance appraisal at the national, regional, or organizational levels and lack analysis of various processes. Therefore, the purpose of this study is to apply data envelopment analysis (DEA) to evaluate the environmental efficiency of China's iron and steel industry. Totally, 54 enterprises are included, as the input-output structure of 5 processes: sintering, coking, ironmaking, steelmaking, and steel rolling are set specifically in this study. In addition, to compare the effects to the efficiency results of different DEA methods, Banker, Charnes & Cooper (BCC) model, Slack-based Measure (SBM) model, and Bootstrap-DEA methods are adopted. Finally, a regression model is used to study key environmental protection strategies that influence environmental performance. The results show that: (1) Within different methods, the average efficiency scores from SBM model are lower than the ones from BCC model, and the Bootstrap-DEA method also has a negative modification. 2) There is a difference in regional efficiency as companies in South China perform best in sintering and coking processes but have the lowest overall efficiency scores. (3) Most enterprises have one or more short board processes. 12 companies are companies with an individual process of low environmental efficiency, whereas the other 25 are companies with unbalanced environmental performance. (4) The coefficient factor between environmental protection, investment and the efficiency scores are positive, but the factors of proportion of environmental protection staffs, and whether the enterprise has environmental protection research are negative. [13].

Wang et al. (2013) used the Envelopment Analysis Model of modified data containing adverse outputs to examine environmental and energy efficiency for 29 regions of China during the period 2002-2008 [14].

In addition to research on micro and macro scales and measurement of environmental performance, in recent years several studies have been conducted on indicators affecting environmental performance, for example: examining the relationship between economic growth and environmental impact leading to the Kuznes hypothesis that Various studies have rejected or confirmed this theory. In addition, other studies have examined the relationship between GDP and the environment [15, 16].

RESEARCH FINDINGS

This research is based on an applied purpose. The approach of the method is data envelopment analysis. The time frame of this research is 2020 and the spatial scope of this research is 176 countries. After a computer search, accurate and reliable statistical sources were used in this field. Due to the nature of the problem, the Anderson-Peterson model was used for ranking. By studying previous researches in the field of environmental efficiency and variables affecting the performance of the environment, the input and output variables have been selected. Variables are according to Tables (1, 2).

Table 1: Inputs

Row	Inputs	Description
1	population	In terms of people
2	area	In terms of square kilometers
3	Population density	p/km^2
4	Annual rainfall	In millimeters per year
5	Consumption of crude oil	Number of barrels consumed per day
6	Water consumption	In terms of million cubic meters per year
7	Vegetation	Percentage of vegetation

Table 2: Outputs

Row	Output	Description
1	Carbon dioxide emissions	In millions of tons per year **Because this output is considered undesirable, .it entered the model in reverse
2	Regional warming since 1960	The degree of global warming per century **Because this output is considered undesirable, .it entered the model in reverse

3	water quality	Use WQI index and score from 100
4	PM 2.5	The amount of suspended particles less than 2.5 microns in air in terms of micrograms per cubic meter. **Because this output is considered undesirable, .it entered the model in reverse
5	Annual death due to air pollution	In terms of people **Because this output is considered undesirable, .it entered the model in reverse
6	GDP	In US dollars
7	Production of plastic waste	Per capita plastic waste per kilogram per day **Because this output is considered undesirable, it entered the model in reverse

Data analysis

Efficiency measurement methods are classified into parametric and non-parametric according to their characteristics. The most obvious model proposed in the parametric method is the stochastic frontier analysis (SFA) and in the "nonparametric method" the most prominent is the "data envelopment analysis" (DEA), which is a linear programming technique. Due to the nature of the data, the second technique is used**.**

CCR model

The CCR model is the first data envelopment analysis model consisting of the initials of its creators (Charans, Cooper, Rhodes).
The CCR ratio model calculates an overall efficiency for the unit where it’s pure technical efficiency and scale efficiency are aggregated into one value. there are constant returns to scale (CRS).

Input and output-oriented in CCR models

In DEA models, the way to improve inefficient units is to reach the efficiency threshold. The efficiency limit consists of units with an efficiency size of 1. In general, there are two types of strategies to improve inefficient units and reach the efficiency limit:
A DEA model can be input or output oriented:

- In an input orientation, DEA minimizes input for a given level of output; in other words, it indicates how much a firm can decrease its input for a given level of output. - In an output orientation, DEA maximizes output for a given level of input; in other words, it indicates how much a firm can increase its output for a given level of input.

CCR output-oriented model (multiplier form)

$$Min\ Z_0 = \sum_{i=1}^{m} v_i x_{i0}$$

St:

$$\sum_{r=1}^{s} u_r y_{r0} = 1$$

(1)

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \le 0$$

$$u_r, v_i \ge 0 \quad (j = 1,2,\ldots,n)$$

(1)

CCR otput-oriented model (envelopment form)

$$Max\ Y_0 = \theta$$

St:

$$\sum_{j=1}^{n} \lambda_j y_{rj} \ge \theta y_{r0} \qquad (r = 1,2,\ldots,s)$$

(2)

$$\sum_{j=1}^{n} \lambda_j x_{ij} \le x_{i0} \qquad (i = 1,2,\ldots,m)$$

$\lambda_j \geq 0 \qquad (j=1,2,\ldots,n)$

θ is unrestricted in sign

m: number of inputs;

n: number of units;

s: number of outputs

(2)

Anderson-Peterson DEA model (AP)

The basic models divide the units under study into two groups of efficient units and inefficient units, and it is impossible to rank the efficient units in these models because the work units are determined by a numerical value of one. The Anderson-Peterson model is used to solve this problem. In this model, efficient units with a value of more than one is assigned.

Anderson-Peterson super-efficiency DEA model (multiplier form)

$$\text{Max } Z_k = \sum_{r=1}^{s} u_r y_{rk}$$

St:

$$\sum_{i=1}^{m} v_i x_{ik} = 1$$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0 \qquad (j=1,2,\ldots,n), \quad j \neq k$$

$$u_r, v_i \geq \varepsilon$$

K: a unit under evaluation

(3)

Anderson-Peterson super-efficiency DEA model (envelopment form)

$$\text{Min } Y_0 = \theta - \left(\sum_{r=1}^{s} \varepsilon s_r^+ + \sum_{i=1}^{m} \varepsilon s_i^- \right)$$

St:

$$\sum_{\substack{j=1 \\ j \neq k}}^{n} \lambda_j x_{rj} + s_i^- = \theta x_{ik} \qquad (i=1,2,\ldots,m)$$

$$\sum_{\substack{j=1 \\ j \neq k}}^{n} \lambda_j x_{rj} - s_r^+ = y_{rk} \qquad (r=1,2,\ldots,s)$$

$$\lambda_j, s_r^+, s_i^- \geq 0$$

θ is unrestricted in sign (4)

In the BCC model, the $\sum_{i=1}^{n} \lambda_j = 1$ constraint is added to the above constraints

Deal with unfavorable outputs in output-oriented DEA models

Envelopment analysis method of output-driven data with undesirable output

There are common methods for data envelopment analysis models that have undesirable outputs. In this study, by considering the undesirable output quantities inversely, their negative effects on environmental efficiency are calculated.

CASE STUDY

In this study, 176 decision-making units with respect to 7 inputs and 7 outputs were examined with the output-oriented CCR model. Then, the Anderson-Peterson (AP) method was used to rank the efficient units. The data used in this study is the latest valid data available in the previous year (2020).

Table 3: Results and ranking of countries based on CCR and AP models.

row	country	CCR-efficiency	AP-efficiency	rank
1	Afghanistan	1	1.123	73
2	Albania	0.671107	0.671	121

3	Algeria	1	1.516	55
4	Angola	0.407903	0.408	170
5	Antigua and Barbuda	1	2.586	22
6	Argentina	0.71146	0.711	113
7	Armenia	0.809603	0.81	98
8	Australia	1	1.891	35
9	Austria	0.807846	0.808	99
10	Azerbaijan	0.559443	0.559	142
11	Bahamas	1	2.345	26
12	Bahrain	1	4.246	14
13	Bangladesh	1	1.094	76
14	Barbados	1	2.442	25
15	Belarus	0.66233	0.662	123
16	Belgium	0.843213	0.843	92
17	Belize	1	2.502	23
18	Benin	0.431736	0.432	167
19	Bhutan	1	2.095	30
20	Bolivia	1	1.005	80
21	Bosnia and Herzegovina	0.803865	0.804	100
22	Botswana	1	1.432	58
23	Brazil	0.490005	0.49	157
24	Bulgaria	0.795398	0.795	102
25	Burkina Faso	0.665277	0.665	122
26	Burundi	0.731347	0.731	107
27	Cabo Verde	1	2.687	20
28	Cambodia	0.59388	0.594	138
29	Cameroon	0.525822	0.526	149
30	Canada	0.995302	0.995	83
31	Central African Republic	1	1.675	47
32	Chad	1	2.322	27
33	Chile	0.850975	0.851	91
34	China	1	1.008	79
35	Colombia	0.445209	0.445	165
36	Comoros	1	5.142	8
37	Congo (Congo-Brazzaville)	1	1.445	57
38	Costa Rica	0.723	0.723	110
39	Croatia	0.73013	0.73	108
40	Cuba	0.55341	0.553	144

41	Cyprus	1	1.694	45
42	Czechia (Czech Republic)	0.710521	0.711	114
43	Democratic Republic of the Congo	1	1.243	63
44	Denmark	1	1.205	67
45	Djibouti	1	2.751	19
46	Dominica	1	4.251	13
47	Dominican Republic	0.466118	0.466	161
48	Ecuador	0.48575	0.486	159
49	Egypt	1	6.018	5
50	El Salvador	0.645176	0.645	126
51	Equatorial Guinea	1	2.598	21
52	Eritrea	1	1.138	72
53	Estonia	1	2.474	24
54	Ethiopia	0.76743	0.767	104
55	Fiji	1	1.585	52
56	Finland	1	1.587	51
57	France	1	1.111	74
58	Gabon	1	1.1	75
59	Gambia	0.684425	0.684	120
60	Georgia	0.831867	0.832	94
61	Germany	1	1.678	46
62	Ghana	0.448548	0.449	164
63	Greece	0.916005	0.916	88
64	Grenada	1	1.89	36
65	Guatemala	0.473124	0.473	160
66	Guinea	0.644685	0.645	127
67	Guinea-Bissau	0.608126	0.608	135
68	Guyana	1	3.583	17
69	Haiti	0.49478	0.495	155
70	Honduras	0.46148	0.461	162
71	Hungary	0.702502	0.703	115
72	Iceland	1	14.534	1
73	India	0.404161	0.404	171
74	Indonesia	0.409393	0.409	169
75	Iran	0.588121	0.588	140
76	Iraq	0.7141	0.714	112
77	Ireland	1	1.829	39
78	Italy	0.832206	0.832	95

79	Jamaica	0.690584	0.691	119
80	Japan	1	1.224	65
81	Jordan	1	1.948	34
82	Kazakhstan	1	1.563	53
83	Kenya	0.745587	0.746	106
84	Kuwait	1	3.916	15
85	Kyrgyzstan	1	1.005	81
86	Laos	1	1.729	43
87	Latvia	1	1.224	66
88	Lebanon	0.70204	0.702	116
89	Lesotho	1	7.633	3
90	Liberia	0.818273	0.818	96
91	Libya	1	5.778	6
92	Lithuania	0.85619	0.856	90
93	Luxembourg	1	3.478	18
94	Madagascar	0.513203	0.513	152
95	Malawi	0.457892	0.458	163
96	Malaysia	1	2.312	28
97	Maldives	1	6.851	4
98	Mali	1	1.071	77
99	Malta	1	4.7	11
100	Mauritania	1	4.342	12
101	Mauritius	0.634817	0.635	130
102	Mexico	0.500223	0.5	153
103	Moldova	1	1.201	68
104	Mongolia	1	2.278	29
105	Montenegro	1	1.672	48
106	Morocco	0.528447	0.528	148
107	Mozambique	0.515413	0.515	151
108	Myanmar (formerly Burma)	0.635355	0.635	131
109	Namibia	1	1.715	44
110	Nepal	0.59496	0.595	137
111	Netherlands	1	1.595	50
112	New Zealand	1	1.4	59
113	Nicaragua	0.533327	0.533	147
114	Niger	1	1.734	41
115	Nigeria	0.542773	0.543	146
116	North Korea	0.76203	0.762	105
117	North Macedonia	0.980623	0.981	84

118	Norway	1	1.175	70
119	Oman	1	2.026	31
120	Pakistan	0.360071	0.36	174
121	Panama	0.604651	0.605	136
122	Papua New Guinea	0.617885	0.618	132
123	Paraguay	0.974796	0.975	85
124	Pelastine	1	1.286	62
125	Peru	0.55593	0.556	143
126	Philippines	0.352558	0.353	175
127	Poland	0.592993	0.593	139
128	Portugal	0.801796	0.802	101
129	Qatar	1	4.757	10
130	Romania	0.64456	0.645	128
131	Russia	0.648024	0.648	125
132	Rwanda	0.692221	0.692	118
133	Saint Lucia	1	1.35	60
134	Saint Vincent and the Grenadines	1	1.788	40
135	Sao Tome and Principe	1	1.521	54
136	Saudi Arabia	1	1.982	32
137	Senegal	0.492613	0.493	156
138	Serbia	0.643947	0.644	129
139	Seychelles	1	1.325	61
140	Sierra Leone	0.329398	0.329	176
141	Singapore	1	9.594	2
142	Slovakia	1	1.07	78
143	Slovenia	0.940464	0.94	86
144	Somalia	1	1.861	37
145	South Africa	0.841976	0.842	93
146	South Korea	0.937644	0.938	87
147	South Sudan	0.496135	0.496	154
148	Spain	0.866675	0.867	89
149	Sri Lanka	0.444136	0.444	166
150	Sudan	0.550254	0.55	145
151	Suriname	1	1.16	71
152	Sweden	1	1.857	38
153	Switzerland	1	1.731	42
154	Syria	0.816749	0.817	97
155	Tajikistan	0.614008	0.614	133

156	Tanzania	0.487036	0.487	158
157	Thailand	0.525256	0.525	150
158	Timor-Leste	1	1.493	56
159	Togo	0.393825	0.394	172
160	Tonga	1	3.897	16
161	Trinidad and Tobago	0.71691	0.717	111
162	Tunisia	0.996561	0.997	82
163	Turkey	0.612482	0.612	134
164	Turkmenistan	1	5.327	7
165	Uganda	0.655662	0.656	124
166	Ukraine	0.702397	0.702	117
167	United Arab Emirates	1	1.606	49
168	United Kingdom	1	1.972	33
169	United States of America	1	4.765	9
170	Uruguay	1	1.176	69
171	Uzbekistan	0.725066	0.725	109
172	Venezuela	0.415754	0.416	168
173	Vietnam	0.360728	0.361	173
174	Yemen	1	1.228	64
175	Zambia	0.56023	0.56	141
176	Zimbabwe	0.788035	0.788	103

CONCLUSION

Since the protection of the environment is one of the most important issues in the world. One of the important issues in this regard is measuring environmental efficiency. Therefore, in this study, environmental efficiency was measured for Iran and 175 other countries. Since the classical model of data envelopment analysis cannot distinguish between efficient units, the Anderson-Peterson model was used to rank the DMUs. So, all countries were prioritized. The results of the study showed that Iran, with an efficiency of 0.58 and a rank of 140 among the 176 countries under study, does not have a favorable position in comparison with other countries. Iceland, Singapore, and Lesotho have the highest environmental performance, respectively. Sierra Leone, the Philippines, and Pakistan also have the lowest environmental performance, respectively. The reason for Iran's low environmental efficiency can be considered as related to the factors explaining environmental performance. In Iran, the amount of crude oil burning and water consumption is higher than the average of the countries under study. On the other hand, Iran's green zone is much lower than the average of the studied countries, which can undermine Iran's environmental efficiency. The average environmental efficiency of the studied countries was estimated at 80%. The following suggestions are recommended as results of this study: Due to the fact that in the present study, variables such as carbon dioxide emissions, global warming since 1960, PM 2.5, annual death caused by air pollution, and plastic waste production are uncertain and inaccurate unfavorable outputs. Recommended that by extending to fuzzy numbers-based model, make stronger DEA approach. Owing to the low environmental efficiency of Iran in comparison with other countries, it is suggested that by setting a comprehensive plan, efficiency can be increased in such a way that both existing resources are preserved and the environment is not damaged. Using the experiences of countries with high environmental efficiency can be useful for other low-efficiency countries.

In this research, accurate data has been used. It is better to use fuzzy data for review and re-evaluation. In addition, it is necessary to re-research in determining the variables affecting the environment, because the low average environmental efficiency leads to catastrophic short-term problems.

In future research, it is suggested that by adding hypothetical influencing factors, suggestions be made to control the adverse effects and improve the global situation and find the optimal solution to save the environment.

Due to the low performance on a general scale, it is better to study each climate separately and more closely. Finally, the impact of environmental inefficiencies and finding the most important connections between countries are essential as complementary research**.**

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