International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2019): 7.583

Country Evaluation of Islamic Economic Criteria: An Application Using Entropy Weight and TOPSIS Methodologies

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Abstract: ***While Islamic economy is growing in all sectors, Halal compliance is carried out by more countries worldwide. The purpose of this paper is toestablish a methodology based on MCDM methods in order to create an accurate ranking of countries according to the basis of the Halal standards, which can be used by public and private institutions. Although Islamic economy is evaluated globally by different institutions every year, those reports are based on indicators which are equally weighted. In this paper, weights of the six Islamic economy criteria are determined by the EWM (Entropy Weight Method) and theTechnique for Order Preference by Similarity to Ideal Solution (TOPSIS) has been used to create a ranking of countries in terms of the Halalprinciples.***

Keywords: Halal, MCDM, TOPSIS, Entropy, Islamic economy

1. Introduction

Islamic economy and Muslim consumers play a critical role in the global economy. In this context, several countries around the world are adapting their economies to the Halal principles in order to attract new Muslim consumers from all around the world [1]. According to [2], it is estimated that Muslims spent US$2.2 trillion in 2018 across the food, pharmaceutical and lifestyle sectors which are impacted by Islamic faith inspired ethical consumption needs. This spending reflects a healthy 5.2% year-on-year growth and it is forecasted to reach US$3.2 trillion by 2024.

In this paper, evaluation criteria system of global Islamic economy is established on the basis of the Halal principles. Weights of criteria are determined by the Entropy Weight Method in order to weight the criteria according to the registered information. Those criteria of the Islamic economy in seventy countries are applied using TOPSIS method, which was firstly introduced by [3] in 1981.

Furthermore, results are compared with other evaluation methodologies and the case study reports that the method is clear and the results are reliable. So the methodology could be promoted in several fields for evaluating and ranking.

This study is focused on the measurement of the strengths of seventy countries in order to analyze their ecosystems in terms of the Islamic economy. Analyzing the Islamic economy is important in order to have a comprehensive picture of those countries in order to determinate which ones are better positioned to face this multi-trillion global opportunity.

Although this has been measured since 2013when the report was firstly published [4], in this research a more accurate methodology is applied and the results show some differences in the terms of the final ranking of the countries involved because the methodology is not simply based on equally weighted methods.

As in previous reports, results show that leading countries such as UAE and Malaysia are maintaining the first positions but in different order. When talking about fast growing countries such as, Turkey or Indonesia, results are also different in terms of final ranking positions.

2. Materials and Methods

2.1 Criteria's selection

On the basis of [2] and as it is shown in table 1.six indicators have been identified as criteria to be used in this research. These criteria focus on the four pillars of Islamic economy, that is to say, consumers, business, governments and investors.

Table 1: List of criteria

Criteria	Symbol
IslamicFinance	C_1
Halal Food	C_2
Halal Travel	C_3
ModestFashion	C_4
Halal Media and Recreation	C_5
Halal Pharmaceuticals and Cosmetics	C_6

2.2 Weights of the criteria

Determining weights of criteria can be a done using subjective methods such as the Analytic Hierarchy Process Method (AHP) introduced by[5] in the 70s,but they could involve deviations because of subjective factors.In this case,Entropy Weight Method (EWM) is applied as an objective fixed weights method in order to determine the weights of the criteria based on the amount of inherent information, so the man-made disturbances are eliminated. Entropy weight method has been applied as follows.

2.2.1 Standardization of criteria

Supposing there are m countries and n criteria, x_{ij} is the j^{th} criteria value in the i^{th} country. In order to eliminate the influence of criteria on incommensurability,it is necessary to standardize criteria using the equations of relative optimum membership degree. For the benefit criteria, the attribute value of the j^{th} criterion in the i^{th} country can be transformed by (1)

$$r'_{ij} = \frac{x_{ij}}{\max\limits_{j} x_{ij}}, (i = 1, \dots, m; j = 1. \dots, n) \quad (1)$$

For the cost criteria, the attribute value of the j^{th}criterion in the i^{th}country can be transformed by (2)

$$r'_{ij} = \frac{\min\limits_{j} x_{ij}}{x_{ij}}, \min\limits_{j} x_{ij} \neq 0, (i = 1, \dots, m; j = 1. \dots, n) \quad (2)$$

2.2.2 Calculation of the index's entropy

Entropy of the j^{th} index is determined by (3) and (4)

$$H_j = -\frac{\sum_{i=1}^{m} f_{ij} \ln f_{ij}}{\ln m}, (i = 1, \dots, m; j = 1. \dots, n) \quad (3)$$

Where:

$$f_{ij} = -\frac{r'_{ij}}{\sum_{i=1}^{m} r_{ij}}, (i = 1, \dots, m; j = 1, \dots, n) \quad (4)$$

2.2.3 Calculation of the criteria's entropy weight as in (5)

$$w_j = \frac{1 - H_j}{n - \sum_{j=1}^{n} H_j}, \sum_{j=1}^{n} w_j = 1, (j = 1. \dots, n) \quad (5)$$

Therefore, the bigger the entropy weight is, the more important the criteria are. Therefore, as is shown in the case study, pharmaceutical and halal food are considered the most important criteria.

2.3 Applying TOPSIS method

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) has been used in several applications,like [6]in logistics or [7] for a warehouse's location selection problem, and the basic thought is to find the ideal positive and negative solution for decision making problems first.

Then, the main aim consists offinding a feasible solution and ranking a set of alternatives (countries) according to the closeness between the feasible solution and the ideal solution, which is made the nearest to the ideal solution and farthest from the negative ideal solution. The method has been used as follows.

2.3.1 Structure of the decision matrix

Criteria set is $C=(C_1.C_2.\dots,C_n)$, the j^{th}value index in the i^{th} country is x_{ij}, then the decision matrix is $X=[x_{ij}]m\times n$.

2.3.2 Normalization of the decision matrix

In order to eliminate the influence of index dimension and its variation range on evaluation results, it isnecessary to normalize the original matrix to ensure that all the attributes are equivalent and the sameformat, then the normalized decision matrix is $R=[r_{ij}]m\times n$, which is calculated by (6)

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{j=1}^{m} x^2_{ij}}}, (i = 1, \dots, m; j = 1. \dots, n) \quad (6)$$

2.3.3 Determination of the weighted decision matrix

The weighted decision matrix is determined by the normalized decision matrix multiplication with weights of indexes and shown by (7)

$$v_{ij} = w_i r_{ij}, (\mathrm{i} = 1, \dots, \mathrm{m}; \mathrm{j} = 1. \dots, \mathrm{n}) \quad (7)$$

2.3.4 Determination of the ideal solution

The ideal solution is composed of the optimal value of every attribute from the weighted decisionmatrix and shown by (8), and the negative ideal solution is composed of the worst value of every attributefrom the weighted decision matrix and shown by (9)

$$V^+ = (V_1{}^+, V_2{}^+, \dots, V_m{}^+) \quad (8)$$

$$V^- = (V_1{}^-, V_2{}^-, \dots, V_m{}^-) \quad (9)$$

Wherein, the ideal value and negative ideal value are determined by (10) and (11)

$$V_j{}^+ = \begin{cases} max\ v_{ij}, the\ benifit\ criteria \\ min\ v_{ij}, the\ cost\ criteria \end{cases} \quad (10)$$

$$V_j{}^- = \begin{cases} max\ v_{ij}, the\ cost\ criteria \\ \min v_{ij}, the\ benifit\ criteria \end{cases} \quad (11)$$

2.3.5 Calculation of the distance

The distance of every feasible solution from the ideal solution and the negative ideal solution iscalculated respectively by (12) and (13)

$$S_i{}^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j{}^+)^2}, (\mathrm{i} = 1, \dots, \mathrm{m}; \mathrm{j} = 1. \dots, \mathrm{n}) \quad (12)$$

$$S_i{}^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j{}^-)^2}, (\mathrm{i} = 1, \dots, \mathrm{m}; \mathrm{j} = 1. \dots, \mathrm{n}) \quad (13)$$

2.3.6 Calculation of the relative degree of approximation

The relative degree of approximation is determined by (14)

$$C_i = \frac{S_i{}^-}{(S_i{}^+ - S_i{}^-)}, (0 \leq C_i \leq 1; i = 1.2. \dots, \mathrm{m}) \quad (14)$$

The evaluation object is ranked according to the value of the relative degree of approximation. The bigger the value is, the better the evaluation object is.

3. Results

All the criteria above mentioned for seventy countries are evaluated according to surveyed data from the Global Islamic Economic Report 2019 and results are shown in table 2.

Table 2: The surveyed data of evaluation criteria of the seventy countries

	Islamic Finance	Halal Food	Halal Travel	Modest Fashion	Halal Media & Recreation	Halal Pharmaceuticals & Cosmetics
Afghanistan	13.78	28.65	18.82	1.63	7.64	25.5
Albania	0.73	14.73	34.55	18.73	25.03	14.9
Algeria	2.24	38.64	22.42	11.37	16.21	40.63
Australia	3.81	59.47	15.86	16.75	36.66	25.15
Azerbaijan	1.81	42.45	40.53	8.72	33.53	44.43
Bahrain	86.26	44.85	19.83	19.01	43.79	45.47
Bangladesh	33.26	34.81	18.99	27.83	6.9	33.9
Benin	0.22	23.85	3.05	16.41	4.59	28.16
Brazil	0.02	62.82	3.39	10.29	23.26	14.61
Brunei	43.22	57.99	26.06	11.65	37.16	57.26
Burkina Faso	0.52	32.08	10.55	22.25	5.26	35.19
Cameroon	1.6	24.44	22.27	17.26	9.43	23.86
Canada	2.07	27.05	7.93	22.5	37.04	22.82
Chad	0.21	13.39	10.4	18.8	1.89	16.49
China	0.06	22.99	6.27	31.2	35.01	20.89
Djibouti	10.64	18.16	16.84	17.36	4.95	12.43
Egypt	14.61	37.5	30.91	15.34	17.19	50.24
France	0.74	22.85	12.6	29.49	38.56	39.61
Gabon	0.23	16.74	11.56	6.73	18.12	18.93
Gambia	6.76	17.05	25.96	0	6.97	17.34
Germany	0.19	19.78	8.27	26.33	38.61	27.14
Guinea	0.46	26.07	12.27	10.15	26.92	31.01
Guinea-Bissau	0.3	14.77	0	9.92	1.42	19.3
Guyana	0.06	0.03	4.25	0	13.44	0.68
India	3.01	44.2	3.79	27.09	12.81	41.28
Indonesia	46.45	47.82	64.58	34.26	16.03	44.39
Iran	37.4	36.03	19.02	10.98	21.51	37.17
Iraq	13.74	39.91	12.99	12.74	8	38.46
Italy	0.5	18.48	14.9	30.92	30.39	19.87
Ivory Coast	0.41	14.84	24.19	9.4	10.04	20.6
Jordan	49.09	60.2	34.98	22.54	25.29	58.29
Kazakhstan	12.11	32.21	14.4	11.29	30.17	32.38
Kenya	15.31	25.53	7.27	27.18	13.71	28.45
Kuwait	56.52	42.1	12.36	12.14	30.4	34.44
Kyrgyzstan	5.03	15.01	31.28	7.11	16.08	19.81
Lebanon	9.38	18.86	21.63	10.87	44.36	27
Libya	5.17	25.33	19.05	4.13	7.64	25.04
Malaysia	172.83	80.5	91.5	32.79	50.53	95.57
Mali	0.25	34.19	19.9	24.41	4.19	37.53
Mauritania	1.93	25.61	16.67	24.76	6.79	27.79
Morocco	14.71	41.32	29.37	25.33	26.46	41.78
Mozambique	0.22	26.25	24.87	7.64	6.61	27.53
Niger	0.43	22.68	19.11	16.27	1.63	25.42
Nigeria	26.21	7.78	21.1	12.33	10.54	12.12
Oman	51.57	62.49	28.1	25.19	28.05	43.33
Pakistan	52.98	57.86	15.04	22.11	9.34	58.12
Palestine	22.35	21.79	17.91	15.77	23.07	21.5
Qatar	54.68	49.39	27.17	11.59	62.92	35.08
Russia	0.62	21.18	14.59	17.46	35.57	20.42
Saudi Arabia	64.02	48.47	34.37	16.14	32.77	46.57
Senegal	1.49	39.75	23.63	20.74	9.83	43.46
Sierra Leone	0.3	8.83	1.91	18.87	4.44	13
Somalia	3.45	25.24	0	4.13	0.71	8.33
South Africa	24.45	41.33	9.27	22.4	21.85	35.38
Sri Lanka	22.9	25.63	8.31	27.68	13.38	26.98
Sudan	33.87	54.81	29.26	7.68	10.56	20.57
Suriname	0.4	13.89	10.51	4.39	17.12	14.72
Syria	6.83	7.92	8.68	10.61	14.7	2.42

Tajikistan	4.29	38.26	4.99	8.24	7.92	44.43
Thailand	4.51	40.91	42.14	26.81	20.84	43.56
Togo	0.11	14.59	12.96	12.95	4.36	23.18
Tunisia	10.01	37.72	40.63	14.12	19.7	39.08
Turkey	20.69	44.46	70.92	31.93	24.98	40.63
Turkmenistan	0.07	25.99	0	0	6.78	26.74
Uganda	4.91	33.96	14.8	19.61	8.25	35.7
United Arab Emirates	82.53	90.55	97.08	106	108.6	103.77
United Kingdom	16.9	34.05	10.55	19.54	41.29	32.91
United States	0.36	29.84	5.27	13.69	31.61	23.35
Uzbekistan	0.65	16.75	1.12	0.89	17.81	16.72
Yemen	6.62	34.34	2.66	15.74	9.27	38.55

3.1. Calculation of the entropy weight

According to evaluation criteria which are the benefit indexes or the cost indexes, standardization of criteria is calculated by (1) ~ (2) and shown as follows in table 3.

Table 3: Normalized criteria

	Islamic Finance	Halal Food	Halal Travel	Modest Fashion	Halal Media & Recreation	Halal Pharmaceuticals & Cosmetics
Afghanistan	0.0116183	0.01256573	0.01326835	0.00132716	0.005274495	0.011489799
Albania	0.00061548	0.0064605	0.024358209	0.01525017	0.017280183	0.006713647
Algeria	0.00188861	0.01694729	0.015806398	0.00925758	0.011191042	0.01830708
Australia	0.00321232	0.02608322	0.011181511	0.01363803	0.02530929	0.011332096
Azerbaijan	0.00152606	0.01861834	0.028574188	0.00709992	0.023148404	0.020019285
Bahrain	0.07272819	0.01967097	0.013980413	0.01547815	0.030231691	0.020487888
Bangladesh	0.02804243	0.01526748	0.013388202	0.02265949	0.004763614	0.015274674
Benin	0.00018549	0.01046048	0.002150291	0.0133612	0.003168839	0.012688343
Brazil	1.6863E-05	0.02755251	0.002389995	0.00837823	0.016058213	0.006582979
Brunei	0.03643998	0.0254341	0.018372646	0.00948556	0.025654479	0.025800231
Burkina Faso	0.00043843	0.01407011	0.00743789	0.01811619	0.003631393	0.015855922
Cameroon	0.001349	0.01071925	0.015700646	0.01405328	0.006510273	0.010750847
Canada	0.00174527	0.01186398	0.005590755	0.01831975	0.025571634	0.010282244
Chad	0.00017706	0.00587278	0.007332138	0.01530717	0.001304816	0.00743007
China	5.0588E-05	0.01008329	0.004420433	0.02540338	0.024170165	0.009412623
Djibouti	0.00897088	0.00796488	0.011872424	0.0141347	0.003417375	0.005600714
Egypt	0.0123181	0.0164473	0.02179196	0.01249	0.011867613	0.022637157
France	0.00062391	0.01002189	0.008883167	0.02401108	0.02662101	0.017847488
Gabon	0.00019392	0.00734207	0.008149954	0.00547964	0.012509665	0.008529486
Gambia	0.00569954	0.00747804	0.018302145	8.1421E-07	0.004811941	0.007813063
Germany	0.00016019	0.0086754	0.00583046	0.02143817	0.026655529	0.012228751
Guinea	0.00038784	0.01143416	0.008650513	0.00826424	0.018584999	0.013972497
Guinea-Bissau	0.00025294	0.00647804	7.05013E-07	0.00807697	0.000980338	0.008696201
Guyana	5.0588E-05	1.3158E-05	0.002996306	8.1421E-07	0.009278692	0.000306395
India	0.00253781	0.01938588	0.002672	0.02205697	0.008843753	0.018599957
Indonesia	0.03916328	0.02097359	0.045529758	0.02789487	0.011066773	0.020001262
Iran	0.03153297	0.01580256	0.013409353	0.00894004	0.01485005	0.016748072
Iraq	0.01158457	0.01750431	0.009158122	0.01037305	0.005523031	0.01732932
Italy	0.00042156	0.00810523	0.010504698	0.0251754	0.020980614	0.008953032
Ivory Coast	0.00034568	0.00650874	0.017054271	0.00765358	0.006931404	0.009281955
Jordan	0.04138914	0.02640339	0.024661364	0.01835231	0.017459682	0.026264328
Kazakhstan	0.01021028	0.01412713	0.010152191	0.00919244	0.020828731	0.014589792
Kenya	0.01290828	0.01119732	0.005125447	0.02213025	0.009465094	0.012819011
Kuwait	0.04765358	0.01846483	0.008713964	0.00988452	0.020987518	0.015517987
Kyrgyzstan	0.00424093	0.0065833	0.022052815	0.00578904	0.011101292	0.008925997
Lebanon	0.00790854	0.00827189	0.015249437	0.00885047	0.030625207	0.012165669
Libya	0.00435897	0.0111096	0.013430503	0.00336269	0.005274495	0.011282532
Malaysia	0.14571775	0.03530686	0.064508715	0.02669798	0.034884845	0.043061964
Mali	0.00021078	0.01499555	0.014029764	0.01987489	0.002892688	0.01691028
Mauritania	0.00162724	0.01123241	0.011752571	0.02015986	0.004687673	0.012521628
Morocco	0.01240241	0.01812273	0.02070624	0.02062396	0.018267425	0.018825247
Mozambique	0.00018549	0.01151311	0.01753368	0.00622057	0.004563404	0.012404477
Niger	0.00036254	0.00994732	0.013472804	0.01324721	0.001125318	0.011453752
Nigeria	0.02209838	0.00341227	0.01487578	0.01003922	0.007276593	0.005461034
Oman	0.04348009	0.02740777	0.019810873	0.02050997	0.019365128	0.019523646
Pakistan	0.0446689	0.02537708	0.0106034	0.0180022	0.006448139	0.02618773

Palestine	0.0188439	0.00955698	0.012626788	0.01284011	0.015927041	0.009687477
Qatar	0.04610222	0.02166219	0.019155211	0.0094367	0.043438639	0.015806359
Russia	0.00052274	0.00928943	0.010286144	0.01421612	0.024556777	0.009200851
Saudi Arabia	0.05397703	0.02125868	0.024231306	0.01314136	0.022623716	0.020983527
Senegal	0.00125626	0.01743413	0.016659464	0.01688673	0.006786424	0.019582222
Sierra Leone	0.00025294	0.00387279	0.001346575	0.01536416	0.003065282	0.005857545
Somalia	0.00290879	0.01107013	7.05013E-07	0.00336269	0.000490169	0.003753334
South Africa	0.02061447	0.01812711	0.006535473	0.01823832	0.015084779	0.015941533
Sri Lanka	0.01930762	0.01124118	0.00585866	0.02253736	0.009237269	0.012156658
Sudan	0.02855673	0.02403937	0.020628689	0.00625314	0.007290401	0.009268438
Suriname	0.00033725	0.00609208	0.00740969	0.00357439	0.011819286	0.006632543
Syria	0.00575856	0.00347367	0.006119515	0.00863878	0.01014857	0.001090404
Tajikistan	0.00361702	0.01678063	0.003518016	0.0067091	0.005467801	0.020019285
Thailand	0.00380251	0.0179429	0.02970926	0.02182899	0.014387496	0.01962728
Togo	9.2744E-05	0.00639909	0.009136972	0.01054403	0.003010052	0.010444452
Tunisia	0.00843971	0.01654379	0.02864469	0.01149666	0.013600464	0.01760868
Turkey	0.01744431	0.01949991	0.049999542	0.02599775	0.017245664	0.01830708
Turkmenistan	5.9019E-05	0.01139907	7.05013E-07	8.1421E-07	0.004680769	0.012048518
Uganda	0.00413976	0.01489467	0.010434197	0.01596668	0.005695626	0.016085718
UnitedArabEmirates	0.06958333	0.03971474	0.068442689	0.08630636	0.074975146	0.046756723
UnitedKingdom	0.01424886	0.01493415	0.00743789	0.01590968	0.028505744	0.014828599
UnitedStates	0.00030353	0.01308766	0.00371542	0.01114655	0.021822876	0.010521051
Uzbekistan	0.00054803	0.00734646	0.000789615	0.00072465	0.012295648	0.007533703
Yemen	0.00558151	0.01506134	0.001875335	0.01281568	0.006399812	0.017369872

Weighs of ten indexes are calculated by (3) ~ (5) and shown in the table 4

Table 4: Weight of criteria

	C_1	C_2	C_3	C_4	C_5	C_6
Weight	0.08455736	0.19618964	0.16749802	0.18146325	0.17395984	0.19633968

3.2 Determination of evaluation rank

The decision matrix of seventy countries decision-making and six evaluation criteria are established according to the data in the table 2. The normalized decision matrix is established by (6) and shown as follows in table 5.

Table 5: Normalized matrix

	Islamic Finance	Halal Food	Halal Travel	Modest Fashion	Halal Media & Recreation	Halal Pharmaceuticals & Cosmetics
Afghanistan	0.050390	0.093147	0.082034	0.008744	0.033944	0.084612
Albania	0.002669	0.047890	0.150599	0.100480	0.111208	0.049440
Algeria	0.008191	0.125626	0.097726	0.060996	0.072021	0.134816
Australia	0.013932	0.193348	0.069132	0.089858	0.162879	0.083451
Azerbaijan	0.006619	0.138013	0.176665	0.046780	0.148973	0.147425
Bahrain	0.315432	0.145816	0.086436	0.101982	0.194558	0.150876
Bangladesh	0.121624	0.113174	0.082775	0.149298	0.030657	0.112485
Benin	0.000804	0.077541	0.013295	0.088034	0.020393	0.093439
Brazil	0.000073	0.204240	0.014777	0.055202	0.103344	0.048478
Brunei	0.158045	0.188537	0.113592	0.062498	0.165101	0.189996
Burkina Faso	0.001902	0.104298	0.045986	0.119363	0.023370	0.116765
Cameroon	0.005851	0.079459	0.097072	0.092594	0.041897	0.079171
Canada	0.007569	0.087945	0.034566	0.120704	0.164568	0.075720
Chad	0.000768	0.043533	0.045332	0.100855	0.008397	0.054716
China	0.000219	0.074745	0.027330	0.167377	0.155548	0.069316
Djibouti	0.038908	0.059042	0.073403	0.093130	0.021993	0.041244
Egypt	0.053425	0.121920	0.134732	0.082294	0.076375	0.166703
France	0.002706	0.074290	0.054922	0.158203	0.171321	0.131431
Gabon	0.000841	0.054425	0.050388	0.036104	0.080507	0.062812
Gambia	0.024720	0.055433	0.113156	0.000000	0.030968	0.057536
Germany	0.000695	0.064309	0.036048	0.141251	0.171543	0.090054
Guinea	0.001682	0.084759	0.053483	0.054451	0.119605	0.102895
Guinea-Bissau	0.001097	0.048020	0.000000	0.053217	0.006309	0.064040
Guyana	0.000219	0.000098	0.018525	0.000000	0.059714	0.002256
India	0.011007	0.143703	0.016520	0.145328	0.056914	0.136973
Indonesia	0.169856	0.155472	0.281495	0.183793	0.071221	0.147292
Iran	0.136763	0.117140	0.082906	0.058904	0.095568	0.123335
Iraq	0.050244	0.129755	0.056622	0.068346	0.035544	0.127615
Italy	0.001828	0.060082	0.064947	0.165875	0.135022	0.065931

Ivory Coast	0.001499	0.048248	0.105441	0.050428	0.044607	0.068354
Jordan	0.179510	0.195722	0.152473	0.120919	0.112363	0.193414
Kazakhstan	0.044283	0.104721	0.062768	0.060567	0.134044	0.107441
Kenya	0.055985	0.083003	0.031689	0.145811	0.060913	0.094401
Kuwait	0.206680	0.136875	0.053876	0.065127	0.135066	0.114276
Kyrgyzstan	0.018393	0.048800	0.136345	0.038143	0.071443	0.065732
Lebanon	0.034300	0.061318	0.094282	0.058314	0.197090	0.089590
Libya	0.018905	0.082353	0.083036	0.022156	0.033944	0.083086
Malaysia	0.631998	0.261721	0.398836	0.175907	0.224503	0.317114
Mali	0.000914	0.111158	0.086741	0.130951	0.018616	0.124530
Mauritania	0.007058	0.083263	0.072662	0.132829	0.030168	0.092211
Morocco	0.053791	0.134339	0.128020	0.135886	0.117561	0.138632
Mozambique	0.000804	0.085344	0.108405	0.040986	0.029368	0.091348
Niger	0.001572	0.073737	0.083298	0.087283	0.007242	0.084347
Nigeria	0.095844	0.025294	0.091972	0.066146	0.046829	0.040216
Oman	0.188579	0.203167	0.122484	0.135135	0.124625	0.143775
Pakistan	0.193735	0.188114	0.065557	0.118612	0.041497	0.192850
Palestine	0.081729	0.070844	0.078067	0.084600	0.102499	0.071340
Qatar	0.199952	0.160576	0.118430	0.062176	0.279552	0.116400
Russia	0.002267	0.068860	0.063596	0.093667	0.158037	0.067756
Saudi Arabia	0.234106	0.157585	0.149814	0.086585	0.145596	0.154525
Senegal	0.005449	0.129235	0.103000	0.111263	0.043674	0.144206
Sierra Leone	0.001097	0.028708	0.008325	0.101231	0.019727	0.043136
Somalia	0.012616	0.082060	0.000000	0.022156	0.003155	0.027640
South Africa	0.089408	0.134372	0.040407	0.120168	0.097079	0.117396
Sri Lanka	0.083740	0.083328	0.036222	0.148493	0.059447	0.089523
Sudan	0.123854	0.178198	0.127540	0.041200	0.046918	0.068254
Suriname	0.001463	0.045159	0.045812	0.023551	0.076064	0.048843
Syria	0.024976	0.025749	0.037835	0.056919	0.065312	0.008030
Tajikistan	0.015687	0.124391	0.021751	0.044205	0.035188	0.147425
Thailand	0.016492	0.133006	0.183682	0.143826	0.092592	0.144538
Togo	0.000402	0.047435	0.056491	0.069472	0.019371	0.076914
Tunisia	0.036604	0.122635	0.177100	0.075749	0.087527	0.129673
Turkey	0.075658	0.144548	0.309130	0.171293	0.110985	0.134816
Turkmenistan	0.000256	0.084499	0.000000	0.000000	0.030123	0.088727
Uganda	0.017955	0.110411	0.064511	0.105201	0.036655	0.118457
UnitedArabEmirates	0.301792	0.294396	0.423158	0.568652	0.482507	0.344323
UnitedKingdom	0.061799	0.110703	0.045986	0.104825	0.183450	0.109200
UnitedStates	0.001316	0.097016	0.022971	0.073442	0.140442	0.077478
Uzbekistan	0.002377	0.054457	0.004882	0.004775	0.079129	0.055479
Yemen	0.024208	0.111646	0.011595	0.084439	0.041186	0.127914

The weighted decision matrix is gotten by (7), the ideal solution and the negative ideal solution are obtained by (8) ~ (9) and then, the ideal value and the negative ideal value are obtained by (10) ~ (11). Results are shown in table 6 as follows.

Table 6: Ideal positive value and the ideal negative value

	C_1	C_2	C_3	C_4	C_5	C_6
V^+	5.34400 E-02	5.77574 E-02	7.08768 E-02	1.03189 E-01	8.39364 E-02	6.76029 E-02
V^-	6.18412 E-06	1.91355 E-05	0.00000 E+00	0.00000 E+00	5.48755 E-04	4.42999 E-04

The distance of every feasible solution from the ideal solution and the negative ideal solution is obtained according to (12) ~ (13). The relative degree of approximation is determined according to (14). Criteria of seventy countries could be ranked by the relative degree of approximation and are shown in the table 7.

Table 7: Distance, relative degree of approximation and rank position

	S^+	S^-		
Afghanistan	0.16203125	0.02885843	0.15117858	53
Albania	0.148311243	0.03867603	0.20683778	36
Algeria	0.148751761	0.04264154	0.22279537	34
Australia	0.141082268	0.05352531	0.27504227	15
Azerbaijan	0.138821225	0.05599891	0.28743903	14
Bahrain	0.125976442	0.06356507	0.33536226	8
Bangladesh	0.142892005	0.04489148	0.23905977	25
Benin	0.16083063	0.02864424	0.151177	54
Brazil	0.155731643	0.04578908	0.22721771	30
Brunei	0.130877381	0.06471582	0.33086946	9
Burkina Faso	0.152456955	0.03826546	0.20063431	42
Cameroon	0.153662764	0.03260063	0.17502435	49
Canada	0.145300654	0.04251118	0.22634984	31
Chad	0.162841315	0.02391938	0.128075	60
China	0.143384393	0.04510078	0.23928026	24
Djibouti	0.159635288	0.02550701	0.13776978	57
Egypt	0.140957519	0.0502844	0.26293609	17
France	0.136840458	0.05118313	0.27221654	16
Gabon	0.162010086	0.02345598	0.12647045	62
Gambia	0.165889356	0.02495247	0.13074948	59
Germany	0.143265445	0.04480353	0.23822926	26
Guinea	0.152659339	0.03541988	0.18832427	47

Guinea-Bissau	0.169837308	0.01814131	0.09650732	67
Guyana	0.177055902	0.01031663	0.05505948	70
India	0.145978719	0.04779946	0.24667103	21
Indonesia	0.119689851	0.07363245	0.38087924	4
Iran	0.145535335	0.04232622	0.22530538	32
Iraq	0.152742985	0.03932355	0.20473919	40
Italy	0.14330363	0.04295797	0.23063246	29
Ivory Coast	0.159963224	0.02655751	0.1423837	56
Jordan	0.12457631	0.06787027	0.35267069	5
Kazakhstan	0.147771319	0.04014414	0.21362873	35
Kenya	0.148544938	0.03799245	0.20367203	41
Kuwait	0.141830827	0.04750454	0.25090156	20
Kyrgyzstan	0.157143917	0.030977	0.16466536	51
Lebanon	0.145678863	0.04411544	0.23243817	27
Libya	0.161918643	0.02744263	0.14492207	55
Malaysia	0.08473414	0.12757511	0.60089285	2
Mali	0.148317236	0.04282605	0.22405206	33
Mauritania	0.1511661	0.03646468	0.19434276	44
Morocco	0.132848167	0.0538061	0.2882661	13
Mozambique	0.158616511	0.03148768	0.1656338	50
Niger	0.158199617	0.03024126	0.16048141	52
Nigeria	0.159824289	0.02417986	0.1314093	58
Oman	0.126004973	0.06389095	0.33645247	7
Pakistan	0.137240568	0.0604766	0.30587429	11
Palestine	0.149624451	0.03360968	0.18342478	48
Qatar	0.127768873	0.06791014	0.34704865	6
Russia	0.148269584	0.0384149	0.20577446	38
Saudi Arabia	0.128157771	0.06107832	0.32276253	10
Senegal	0.144888233	0.04662374	0.24345077	22
Sierra Leone	0.166021011	0.02106259	0.11258386	64
Somalia	0.173654056	0.0173407	0.09079151	69
South Africa	0.142493498	0.04528056	0.24114385	23
Sri Lanka	0.147635116	0.03832808	0.20610571	37
Sudan	0.150526503	0.04548143	0.23203872	28
Suriname	0.165460906	0.01999591	0.10781976	65
Syria	0.166815879	0.01716986	0.0933217	68
Tajikistan	0.157972144	0.03895374	0.19780914	43
Thailand	0.131918481	0.0577233	0.3043807	12
Togo	0.162555127	0.02361193	0.12683193	61
Tunisia	0.140947061	0.04997594	0.26175965	18
Turkey	0.12045867	0.07429891	0.38149432	3
Turkmenistan	0.170094844	0.02417489	0.12443981	63
Uganda	0.150539599	0.03881131	0.20497029	39
UnitedArabEmirates	0.027921285	0.17640899	0.86335219	1
UnitedKingdom	0.1397715	0.04841333	0.2572648	19
UnitedStates	0.152306822	0.03663956	0.19391514	45
Uzbekistan	0.169022595	0.01997663	0.10569689	66
Yemen	0.155236887	0.03706877	0.19275964	46

3.3 Evaluation results analysis and comparison

As was anticipated before, results provided by the EWM + TOPSIS are slightly different to those provided by the latest Global Islamic Economy Report (GIER). In table 8. positions of the top 10 countries analyzed in the present research are compared with those in the GIER.

UAE and Malaysia are keeping the first positions but with different order. Comparing the GIER 2018 with the 2019 version, the case of Turkey is striking. In the GIER the country experiences an important risefrom the previous year, up to position number 13. But the EWM + TOPSIS method gives it the third position. Also Bahrain can be considered a case study because the GIER places it in the third position but theEWM + TOPSIS analysisplaces it only ineighth place. The rest of the countries do not present significant changes, but their rank is more precise thanks to the objectivity of the method used in this research.

Table 8: Ranking comparation (EWM+TOPSIS vs GIER) for top 10 countries

	EWM+TOPSIS	GIER
United Arab Emirates	1	2
Malaysia	2	1
Turkey	3	13
Indonesia	4	5
Jordan	5	7
Qatar	6	10
Oman	7	6
Bahrain	8	3
Brunei	9	11
Saudi Arabia	10	4

4. Discussion

When working with multicriteria decision making methods, determining the weight of criteria is really important. In this research, Entropy Weight Method appears as an effective solution to get objective results and to avoid subjectivity when calculating the weights of the criteria.

In this research, seventy countries have been evaluated according to theEWM + TOPSIS method. The study is feasible and rational, so it can be applied to identify the advances of any country when facing the Halal standards and therefore, the methodology should be applied widely for evaluation matters in other relevant fields.

Compared to equally ranked methodologies, this combination of Entropy Weight and TOPSIS is clear, reasonable and it provides more accurate results because the criteria are weighed based on objective information and it is reasonable to think that not all criteria are equally important to determine the improvements of a country in terms of Halal principles.

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