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Evaluating the Rank of Performance of Countries of the Middle East and North Africa with MADM

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Abstract. Over the past few decades, countries of Middle East and North Africa(MANA) have achieved varying levels of economic development. In this paper, Multiple Attribute Decision Making (MADM) is employed to study the rank of performance of selected MENA countries. MADM problem is a management science technique, which is popularly used to rank the priority of alternatives with respect to their computing attributes. this paper indicated that the MENA countries achieved higher values of desirable attributes and lower values of undesirable attributes.

1. Introduction

Over the past few decades, countries of Middle East and North Africa (MENA) have achieved varying levels of economic development. In recent literature, the performances of countries of the region have been studied using sophisticated methodologies. Notable among them are:

(i) comparative analysis of poverty in the Mediterranean region using principal component analysis [2],
(ii) policy-oriented analysis of the performance of countries of the Gulf Cooperation Council (GCC) [9],
(iii) econometric analysis of the fiscal expenditure policy and the non-oil economic growth of the GCC countries [3], and
(iv) estimation of the aggregate demand for imports in the GCC countries using econometric techniques [11].

Research studies are also available on the performance of individual MENA countries, such as Saudi Arabia [5] and the united Arab emirates (UAE).

Most of these studies have used econometric methods for their analysis. To the best of our knowledge, Multiple Attribute Decision Making (MADM) has not employed to study the economic performance of MENA countries, although it has been used to compare countries in other contexts [4, 5, 6, 7]. In this paper, MADM

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helps provide a comparative picture of performance of selected MENA. MADM problem is the process of finding the best option from all the feasible alternatives. Technique for order preference by similarity to ideal solution (TOPSIS) approach has been dealt with multiple attribute decision making problems (MADM briefly discussed in section 2, TOPSIS method discussed in section 3, we illustrate our proposed method with an example in section 4 and the final section summary.

2. **Multiple Attribute Decision Making (MADM)**

Multiple attribute decision making has been one of the fastest growing areas during the last decade depending on the changing. Decision marker(s) need a decision aid to decide between the alternatives and mainly excel less preferable alternatives fast. With the help of computers the decision making methods have found great acceptance in all area of the decision making processes. Since multiple attribute decision making (MADM) has found acceptance in area of operation research and management science, the discipline usage has increased significantly, the application of MADM methods has considerably become easier for the users the decision makers. In discrete alternative multiple attribute decision problems; the primary concern for the decision aid is the following:

(i) choosing the most preferred alternative to the decision maker (DM),
(ii) ranking alternative in order of importance for selection problems, or
(iii) screening alternative for the final decision.

The general concepts of domination structures and non-dominated solutions play an important role in describing the decision problems and the decision marker's revealed preferences describes above. So far, various approaches have been developed as the decision aid. That is, for many such problems, the decision maker wants to solve a multiple attribute decision making (MADM) problem. A MADM problem can be concisely expressed in matrix form as:

	C_1	C_2	$\dots$	C_n
A_1	x_{11}	x_{12}	$\dots$	x_{1n}
A_2	x_{21}	x_{22}	$\dots$	x_{2n}
$\vdots$	$\vdots$	$\vdots$	$\dots$	$\vdots$
A_m	x_{m1}	x_{m2}	$\dots$	x_{mn}

$W = \{w_1, w_2, \dots, w_n\}$

Where $A_1, A_2, \dots, A_m$ are possible alternatives among which decision makers have to choose, $x_1, x_2, \dots, x_n$ are attribute with which alternative performance are measured, x_{ij} is the rating of alternatives A_i with respect to attribute x_j, w_j is the weight of attribute C_j.

The main steps of multiple attribute decision making are the following:

(i) Establishing system evaluation attribute that relate system capabilities to goal.
(ii) Developing alternative systems attaining the goal(generating alternatives).

(iii) Evaluation alternatives in terms of attribute (the value of the attribute function).
(iv) Applying a normative multi attribute analysis method.
(v) Accepting one alternative as "optimal" (preferred).
(vi) If the final solution is not accepted, gather new information and into the next interaction of multiple attribute optimization.

Step (i) and (v) are preformed at the upper level, where decision makers have the central role, and the other steps are mostly engineering task. For step (iv), a decision maker should express his/her preference by similarity to ideal solution (TOPSIS), one of known classical MADM method, was first developed by Hwang and Yoon for solving a MADM problem. TOPSIS, known as one of the most classical MADM methods, is based on the idea, that the chosen alternative should have the shortest distance from the positive ideal solution and on the other side the farthest distance of the negative ideal solution. The TOPISIS method will be applied to a case study, which is described in detail. In classical MADM methods, the rating and the weight of the attribute are known precisely. A survey of the methods has been presented in C.L. Hwang and Yoon [1]. In the process of Topsis, the performance rating and the weights of the attribute are given as exact values. In this section, the performances of 18 countries in the MENA region are analyzed using MADM. several economic, educational and health attributes, listed in Table 1, are considered. the choice of attributes and countries is influenced by issues of data consistency and reliability. Of the seven attributes, AGEDEP, ILLITER, MOTRTINF represent undesirable attributes while the other four represent desirable attributes.

Table 1. Attributes used in the study

Attribute	Description
LABOR	Ratio of total labor to population
LIFFEEXP	Life expectancy at birth, total
PRITEACH	primary education, teachers
GNPCAP	GNP per capita
AGEDEP	Age dependency ratio
ILLITER	Illiteracy rate, adult female
MORTINF	Mortality rate, infant

3. **TOPSIS Method**

TOPSIS (technique for order preference by similarity to an ideal solution) method is presented in Chen and Hwang [10], with reference to Hwang and Yoon. TOPSIS is a multiple attribute method to identify solutions from a finite set of alternatives. The basic principle is that the chosen alternative should have the shortest distance from the positive ideal solution and farthest distance from

the negative ideal solution. The procedure of TOPSIS can be expressed in a series of step:

(i) Calculate the normalize decision matrix. The normalize value n_{ij} is calculated as:

$$n_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad i = 1, \ldots m,\ j = 1, \ldots, n\,.$$

(ii) Calculate the weighted normalized decision matrix. The weighted normalized value v_{ij} is calculated as:

$$v_{ij} = w_j n_{ij}, \quad i = 1, \ldots, m,\ j = 1, \ldots, n$$

where w_{ij} is the weight of the i-th attribute, and $\sum_{j=1}^{n} w_j = 1$.

(iii) Determine the positive ideal and negative ideal solution:

$$A^+ = \{v_1^+, \ldots, v_n^+\} = \{\big(\max_j v_{ij}/i \in I\big), \big(\min_j v_{ij}/i \in J\big)\},$$
$$A^- = \{v_1^-, \ldots, v_n^-\} = \{\big(\min_j v_{ij}/i \in I\big), \big(\max_j v_{ij}/i \in J\big)\}$$

where I is associated with benefit attribute, and J is associated with cost attribute.

(iv) Calculate the separation from the positive ideal solution is given as:

$$d_i^+ = \left\{\sum_{j=1}^{n}(v_{ij} - v_j^+)^2\right\}^{\frac{1}{2}}, \quad i = 1, \ldots, m\,.$$

Similarity, the separation from the negative ideal solution is given as:

$$d_i^- = \left\{\sum_{j=1}^{n}(v_{ij} - v_j^-)^2\right\}^{\frac{1}{2}}, \quad i = 1, \ldots, m\,.$$

(v) Calculate the relative closeness to the ideal solution. The relative closeness of the alternative A_i with respect to A^+ is defined as:

$$R_i = \frac{d_i^-}{(d_i^+ + d_i^-)}, \quad i = 1, \ldots, m\,.$$

Since $d_i^- \geq 0$ and $\mathrm{d}_j^+ \geq 0$ than, clearly, $R_i \in [0, 1]$.

(vi) rank the preference order, for ranking alternatives using this index; we can rank alternatives in decreasing order.

4. Application of the Proposed Method for Evaluating the Comparative Performance of Countries of the MENA

Most of the data for MENA countries are available in public domain. A large portion of the data used in the present analysis was obtained from the Gender Statistics Database of the World Bank. While the initial focus is on the performance during 1999, time-series analysis of performance for 1997, 1998 and 1999 is also

presented here. For want of consistent data, some countries, namely Djibouti, Iraq, Libya, Somalia and West Bank and Gaza could not be considered in the analysis. Unfortunately, Qatar, one of the rapidly growing and modernizing countries of the MENA region, is not included in the analysis as the Gender Statistic Database dose not contain its GNP data. A list of countries, and the data used for the analysis, is given in Table 2. Most of the data pertaining to the year 1999 were available, though not all. whenever not, data for the nearest available year were substituted, they are so noted in the table.

Table 2. Social and economic performance of selected MENA countries

	LABOR	LIFFEEXP	PRITEACH	GNPCAP	AGEDEP	ILLITER	MORTINF
Algeria	33.10	70.81	44.76	1540	0.68	44.30	33.98
Bahrain	45.00	72.99	65.30	7640	0.51	17.80	7.70
Comoros	45.60	60.57	20.67	390	0.89	47.90	60.80
Egypt	37.80	66.82	52.22	1380	0.66	57.20	47.28
Iran	30.70	71.11	54.35	1600	0.66	31.30	25.50
Jordan	29.50	71.29	62.08	1630	0.73	16.60	26.20
Kuwait	39.70	76.62	59.40	19020	0.57	20.60	10.70
Lebanan	34.70	70.22	48.94	3730	0.62	20.20	26.36
Mauritania	46.10	53.94	24.07	390	0.88	68.60	88.04
Morocco	39.70	67.18	37.70	1190	0.60	64.90	47.80
Oman	26.60	73.34	52.25	5050	0.84	40.40	17.38
Saudi Arabia	32.80	72.21	49.91	6900	0.78	34.10	18.8
Sudan	39.70	55.55	62.03	310	0.74	55.10	67.16
Syria	31.40	69.45	65.22	1020	0.81	40.70	26.00
Tunisia	39.10	72.53	49.18	2090	0.59	40.70	24.02
Turkey	47.50	69.48	43.57	2880	0.53	24.10	36.17
UAE	49.50	75.25	70.14	18060	0.42	22.00	7.64
Yemen	31.60	56.00	16.60	360	1.02	76.1	79.00

Source: The World Bank's gender statistics available at the internet site: `genderstats.worldbank.org`
Egypt = Egypt, Arab republic, Iran = Iran Islamic Republic, Syria = Syrian Arab Republic,
UAE =United Arab Emirates $W = (w_{1,\ldots,w_7}) = (0.2, 0.1, 0.1, 0.1, 0.2, 0.1, 0.2)$

We work out a numerical example to illustrate the TOPSIS method for decision making problem. Suppose that we have 18 alternatives $A_1, \ldots, A_{18}$ among which decision countries have to choose and, also, 7 benefits $C_1, \ldots, C_7$ are identified as the evaluation attribute for these alternatives.

5. **Summary**

Decision making problem is the process of finding the best option from all the feasible alternatives. In this paper, multiple attribute models for the most preferable choice, technique for order preference by similarity to deal solution (TOPSIS) approach has been dealt with. The data (attribute) are often not so deterministic, the aim of this paper used the TOPSIS method and decision making problem for rank of performance of countries of MENA.

Table 3. The normalized decision matrix

	LABOR	LIFFEEXP	PRITEACH	GNPCAP	AGEDEP	ILLITER	MORTINF
Algeria	0.2033	0.2439	0.2064	0.0525	0.2250	0.2372	0.1860
Bahrain	0.2764	0.2514	0.3012	0.2607	0.1688	0.0953	0.0421
Comoros	0.2801	0.2087	0.0953	0.0133	0.2946	0.2565	0.3329
Egypt	0.2321	0.2302	0.2409	0.0470	0.2184	0.3063	0.2588
Iran	0.1885	0.2450	0.2507	0.0546	0.2184	0.1676	0.1396
Jordan	0.1812	0.2456	0.2863	0.0556	0.2416	0.0889	0.1434
Kuwait	0.2438	0.2640	0.2740	0.6491	0.1886	0.1103	0.0585
Lebanan	0.2131	0.2419	0.2257	0.1273	0.2052	0.1082	0.1443
Mauritania	0.2831	0.1858	0.1110	0.0133	0.2913	0.3674	0.4820
Morocco	0.2438	0.2314	0.1739	0.0406	0.1986	0.3476	0.2617
Oman	0.1633	0.2527	0.2410	0.1723	0.2780	0.2164	0.0951
Saudi Arabia	0.2014	0.2488	0.2302	0.2354	0.2582	0.1826	0.1029
Sudan	0.2438	0.1914	0.2861	0.0105	0.2449	0.2951	0.3677
Syria	0.1928	0.2393	0.3008	0.0348	0.2681	0.2180	0.1423
Tunisia	02401	0.2499	0.2268	0.0713	0.1953	0.2180	0.1315
Turkey	0.2917	0.2394	0.2009	0.0982	0.1754	0.1290	0.1980
UAE	0.3040	0.2592	0.3235	0.6163	0.1390	0.1178	0.0418
Yemen	0.1941	0.1929	0.0765	0.0122	0.3376	0.4076	0.4325

Table 4. The weighted normalized decision matrix

	LABOR	LIFFEEXP	PRITEACH	GNPCAP	AGEDEP	ILLITER	MORTINF
Algeria	0.0406	0.0243	0.0206	0.0052	0.045	0.0237	0.0372
Bahrain	0.0552	0.0251	0.0301	0.0260	0.0337	0.0095	0.0084
Comoros	0.0560	0.0208	0.0095	0.0013	0.0589	0.0256	0.0665
Egypt	0.0464	0.0230	0.0240	0.0047	0.0436	0.0306	0.0517
Iran	0.0377	0.0245	0.0250	0.0054	0.0436	0.0167	0.0279
Jordan	0.0362	0.0245	0.0286	0.0055	0.0483	0.0088	0.0286
Kuwait	0.0487	0.0264	0.0274	0.0649	0.0377	0.0110	0.0117
Lebanan	0.0426	0.0241	0.0225	0.0127	0.0410	0.0108	0.0288
Mauritania	0.0566	0.0185	0.0111	0.0013	0.0582	0.0367	0.0964
Morocco	0.0487	0.0231	0.0173	0.0040	0.0397	0.0347	0.0523
Oman	0.0326	0.0252	0.0241	0.0172	0.0556	0.0216	0.0190
Saudi Arabia	0.0402	0.0248	0.0230	0.0235	0.0516	0.0182	0.0205
Sudan	0.0487	0.0191	0.0286	0.0010	0.0489	0.0295	0.0735
Syria	0.0385	0.0239	0.0300	0.0034	0.0536	0.0218	0.0284
Tunisia	0.0480	0.0249	0.0226	0.0071	0.0390	0.0218	0.0263
Turkey	0.0583	0.0239	0.0200	0.0098	0.0350	0.0129	0.0396
UAE	0.0608	0.0259	0.0323	0.0616	0.0278	0.0117	0.0083
Yemen	0.0388	0.0192	0.0076	0.0012	0.0675	0.0407	0.0865

$A^+ = \{0.0608, 0.0264, 0.0323, 0.0649, 0.0675, 0.0407, 0.0964\}$,
$A^- = \{0.0326, 0.0185, 0.0076, 0.0010, 0.0278, 0.0088, 0.0083\}$,
$d_1^+ = 0.09127$, $d_2^+ = 0.10682$, $d_3^+ = 0.07625$, $d_4^+ = 0.08113$, $d_5^+ = 0.09986$, $d_6^+ = 0.10066$, $d_7^+ = 0.09547$, $d_8^+ = 0.09655$, $d_9^+ = 0.06838$, $d_{10}^+ = 0.07279$, $d_{11}^+ = 0.09816$, $d_{12}^+ = 0.09352$, $d_{13}^+ = 0.07274$, $d_{14}^+ = 0.09729$, $d_{15}^+ = 0.09840$, $d_{16}^+ = 0.09085$, $d_{17}^+ = 0.10094$, $d_{18}^+ = 0.07281$, $d_1^- = 0.04046$, $d_2^- = 0.04148$, $d_3^- = 0.07206$, $d_4^- = 0.05569$, $d_5^- = 0.03286$, $d_6^- = 0.03664$, $d_7^- = 0.07008$, $d_8^- = 0.03299$, $d_9^- = 0.10026$, $d_{10}^- = 0.05596$, $d_{11}^- = 0.04038$, $d_{12}^- = 0.04055$, $d_{13}^- = 0.07613$, $d_{14}^- = 0.04254$, $d_{15}^- = 0.03404$, $d_{16}^- = 0.04437$, $d_{17}^- = 0.07169$, $d_{18}^- = 0.09353$

Table 5. Ranking

	R_i $(i = 1, \ldots, 18)$	Rank
Algeria	0.30714	10
Bahrain	0.27970	14
Comoros	0.48587	4
Egypt	0.40703	8
Iran	0.24758	18
Jordan	0.26686	15
Kuwait	0.42331	6
Lebanan	0.25467	17
Mauritania	0.59452	1
Morocco	0.43464	5
Oman	0.29146	13
Saudi Arabia	0.30245	12
Sudan	0.51138	3
Syria	0.30422	11
Tunisia	0.25702	16
Turkey	0.32813	9
UAE	0.41528	7
Yemen	0.56228	2

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