

# **Can We Assess a Health Care System's Performance?**

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# Can We Assess a Health Care System's Performance?

## 1. Background

Health systems consist of all the people and actions whose primary purpose is to improve health. They may be integrated and centrally directed, but often they are not. After centuries as small-scale, largely private or charitable, mostly ineffectual entities, they have grown explosively in this century as knowledge has been gained and applied. They have contributed enormously to better health, but their contribution could be greater still, especially for the poor. Failure to achieve that potential is due more to systemic failings than to technical limitations. It is therefore urgent to assess current performance and to judge how health systems can reach their potential.

The World Health Organization (WHO) is a specialized agency of the United Nations (UN) that acts as a coordinating authority on international public health. Established on 7 April 1948, and headquartered in Geneva, Switzerland, the agency inherited the mandate and resources of its predecessor, the Health Organization, which had been an agency of the League of Nations.

The WHO's constitution states that its objective "is the attainment by all peoples of the highest possible level of health." Its major task is to combat disease, especially key infectious diseases, and to promote the general health of the people of the world.

As well as coordinating international efforts to monitor outbreaks of infectious diseases, such as SARS, malaria, and AIDS, the WHO also sponsors programs to prevent and treat such diseases. The WHO supports the development and distribution of safe and effective vaccines, pharmaceutical diagnostics, and drugs. The WHO also carries out various health-related campaigns — for example, to boost the consumption of fruits and vegetables worldwide and to discourage tobacco use.

The annual World Health Report (<http://www.who.int/whr/en/index.html>) assesses global health factors and World Health Statistics provides health statistics for the countries in the UN. The production and dissemination of health statistics is a major function of the WHO. To many people, these data and the associated analyses are considered unbiased and very valuable to the world community.

## 2. Basic Assumption and Hypotheses

1. Assume that in a certain interval such as 5 years the main components (metrics) of the health care system stays steady, that is to say the metric won't change continually.
2. Assume that all the statistics we get from the database of the WHO is authentic.
3. Assume that the ranking of the world's health systems in 2000 made by WHO is scientific and dependable.
4. During the data processing if a data little than  $x$  we can replace it with  $x$ .
5. If there existing data missing for some year's indicator we can value it with the corresponding value of the near years.

### 3. Symbols

Symbol	Definition and Property
$Z'$	The matrix before standardization
$Z$	The matrix after standardization
$z_j$	The statistic of the $j$ indicator to each country
$u$	The main component to be evaluated
$u_m$	The $m$ th main component of the indicator
$l_{ij}$	The load of the original indicator
$R1$	The correlation matrix of $Z$
$c_i$	The contribution rate of the $i$ th main component
$S_i$	The summation of the front $i$ main components' contribution rate
$Q$	The integrated score of each country
$X$	The project set ( the Member States)
$U$	The attribute set which also means main component set
$a_{ij}$	The attribute value of $x_i$ in reference to $u_j$
$A$	The decision making matrix
$a_i$	The mean value of the line $I$ in the primitive matrix
$b_i$	The standard deviation of row $I$ in the primitive matrix

### 4. Problem Analysis

To determine several important and viable metrics for assessing the performance of a health care system and comparing health care systems in different countries. We have to know what metrics or indicators are there in a health care system, as is shown in the problem we search the web of the WHO and get the database of the indicators. There exists statistics for 50 core indicators on mortality, morbidity, risk factors, service coverage, and health systems, which take on more than one hundred and fifty terms of raw indicators. We must use some data mining technology or method to distill the crucial metrics.

Considering the data is promiscuous and inconsistent and not all the countries have the corresponding data to each indicator from the year 1960 to 2006, we first need to choose certain year's data as our study object. Then to the mass actual statistical data we can't expect all the indicators are complete so what to do with the incomplete data to make sure that all the indicators or all the data we used below are universal or effective is an inevitable problem. There are 159 raw indicators how could we select the most important ones and combine them scientifically to make them more useful in measuring quality is another basal problem. Then how could we accomplish this goal? The main components analysis method which we could use to devise our first model will help a lot.

Furthermore how could we assess a country's health care system and make some comparisons with the combined metrics? This situation much agrees with the multiple attribute decision problems. So we could solve this problem by ranking all the countries health care systems using this multiple attribute decision method.

## 5. The Establishment of Model

### 5.1 The Primary Data and Indicators Processing

According to the above problem analysis part we know that we could obtain enough raw data for almost 159 indicators from 1960 to 2006. We first choose a year 2004 whose data is much completer than other years as our study object. Then if some of the indicators of certain country in 2004 have no value and the year close to 2004 such as the year of 2005 or 2003 has the corresponding value we treat this close value as the valve of the country in that indicator in 2004.

Based on these we select the indicators that 95% of the country has the corresponding data for them from all the 159 raw indicators. By doing this primary selection we make sure that all the indicators or all the data we used below are universal or effective. After the primary selection we get 48 crucial indicators as our primary outcomes (metrics).

### 5.2 Model 1 Design

Following the above analysis we utilize the main components analysis method to devise our first model.

When it comes to main components analysis the biggest effect to it is the dimension of the data. So in the practical application we first should make standardization to the data.

Assume that  $Z'$  is the matrix before standardization  $Z$  is the matrix after standardization  $z_j$  is the statistic of the  $j$  indicator to each country;  $u$  is the main component to be evaluated, so the objective function could be:

$$\begin{cases} u_1 = l_{11}z_1 + l_{12}z_2 + \cdots l_{1p}z_p \\ u_2 = l_{21}z_1 + l_{22}z_2 + \cdots l_{2p}z_p \\ \dots\dots\dots \\ u_m = l_{m1}z_1 + l_{m2}z_2 + \cdots l_{mp}z_p \end{cases} \quad (1)$$

Where  $u_1, u_2, \dots, u_m$  is called the 1st, 2nd, ... mth main component of the indicator  $z_1, z_2, z_p$ ;  $l_{ij}$  is the load of the original indicator  $z_j$  ( $j=1,2, \dots, p$ ) in each main component.

The detailed process of this solution is as follows:

Step1: Evaluate the standardized matrix  $Z$  of the matrix

$Z'$  The standardization of the  $Z'$  is just replace the  $z_i'$  ( $i=1,2, \dots, p$ ) and the  $z_{ij}$

of the matrix  $Z'$  with  $z_i(i=1,2, \dots,p)$  and with  $z_{ij}$  respectively, which is shown in table1

Table1. The process of the standardization of the matrix

number	$z_1$	$z_2$	$z_3$	$z_4$	...	$z_p$
1	$z'_{ij} = \frac{z'_{ij} - \bar{z}'_j}{\sqrt{Dz'_j}}, i = 1, 2, \dots, n; j = 1, 2, \dots, p$					
2						
3						
...						
n						

Step 2: Evaluate the correlation matrix R1 of matrix Z

R1 could be evaluated by the following matrix:

$$R1 = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1p} \\ r_{21} & r_{22} & \cdots & r_{2p} \\ \vdots & \vdots & \cdots & \vdots \\ r_{p1} & r_{p2} & \cdots & r_{pp} \end{bmatrix} \quad (2)$$

Where  $r_{ij}$  ( $i, j = 1, 2, \dots, p$ ) is the original indicator  $z_i$  and  $z_j$ 's correlation coefficient specially  $r_{ij}=r_{ji}$ .  $r_{ij}$  could be derived by the following formula:

$$r_{ij} = \frac{\sum_{k=1}^n (z_{ki} - \bar{z}_i)(z_{kj} - \bar{z}_j)}{\sqrt{\sum_{k=1}^n (z_{ki} - \bar{z}_i)^2 \sum_{k=1}^n (z_{kj} - \bar{z}_j)^2}} \quad (3)$$

Step 3: By formula 1 we can compute the characteristic root and characteristic vector of matrix R1 then rank the characteristic values of R1 as expression 1

$$|\lambda I - R_1| = 0 \quad (4)$$

$$\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_p \geq 0 \quad (5)$$

Step 4: Evaluate the contribution rate and the accumulative contribution rate according to formula 1 and 1 of the main components, determine the proper number of the main components.

$$c_i = \frac{\lambda_i}{\sum_{k=1}^p \lambda_k} \quad (i = 1, 2, \dots, p) \quad (6)$$

Where  $c_i$  is the contribution rate of the  $i$  th main component.

$$S_i = \frac{\sum_{k=1}^i \lambda_k}{\sum_{k=1}^p \lambda_k} \quad (i=1, 2, \dots, p) \quad (7)$$

Here  $S_i$  is the summation of the front  $i$  main components' contribution rate. If the value of the accumulative contribution rate reaches to more than 80% we can approbate the effect of the main components.

Step 5: Compute the load of the main component  $l_{ij}$

$$l_{ij} = p(y_i, z_j) = \sqrt{\lambda_i} e_{ij} \quad (i, j = 1, 2, \dots, p) \quad (8)$$

Step 6: Sum up the above five steps get our objective function

$$\begin{cases} u_1 = l_{11}z_1 + l_{12}z_2 + \dots + l_{1p}z_p \\ u_2 = l_{21}z_1 + l_{22}z_2 + \dots + l_{2p}z_p \\ \dots\dots\dots \\ u_m = l_{m1}z_1 + l_{m2}z_2 + \dots + l_{mp}z_p \end{cases}$$

Step 7: Evaluate the integrated value of each country and make a ranking of them with the formula 1.

$$Q = \frac{1}{\sum_{i=1}^m \lambda_i} (\lambda_1 u_1 + \lambda_2 u_2 + \dots + \lambda_m u_m) \quad (9)$$

$Q$  is the integrated score of each country.

## 5.3 Model 2 Design

### 5.3.1 The Description of the Principle

The method of the multiple attribute decision making based on dispersion maximization is used to solve the multiple attribute decision making problems with the uncertain weight attribute. We can use this method to make ranking and comparison between different projects with multiple attributes.

In more details the smaller the difference between certain attribute for all the projects is the less affection it has on the decision making and ranking of the projects. On the contrary the bigger it is the more affection it has on the decision making and ranking. As a result in the view of ranking the bigger of one attribute's deviation is the bigger weight of this attribute should be given. Especially if there is no deviation for certain attribute to all the projects which means that this attribute will have little affection on the ranking we can value a zero to its weight.

### 5.3.2 Model Development

Step 1. Structure and Normalize the Decision Making Matrix

### 1.1 Structure the Decision Making Matrix

Assume that:

$$M=\{1,2,\dots,m\}, N=\{1,2,\dots,n\} \quad (10)$$

The projects set which also is the set of the Member States in WHO is X

$$X=\{x_1, x_2, \dots, x_n\} \quad (11)$$

The attribute set which means main component set here is U

$$U=\{u_1, u_2, \dots, u_m\} \quad (12)$$

$a_{ij}$  is the attribute value of  $x_i$  in reference to  $u_j$  so we obtain the decision

making matrix  $A = (a_{ij})_{n \times m}$  whose form is shown as table 2

Table2. The form of the decision making matrix

	$u_1$	$u_2$	$\dots$	$u_m$
$x_1$	$a_{11}$	$a_{12}$	$\dots$	$a_{1m}$
$x_2$	$a_{21}$	$a_{22}$	$\dots$	$a_{2m}$
$\vdots$	$\vdots$	$\vdots$		$\vdots$
$x_n$	$a_{n1}$	$a_{n2}$	$\dots$	$a_{nm}$

## 5.4 Model 3 Design

Model 3 is our predictive model, from model 1 we can get the objective function with the data of that year.

When it comes to predicating for the convenience of evaluating the main components we can change the main component which is expressed by the standardization indicator  $z_i$  into the form that expressed by nonstandard indicator  $z_i'$  to predicate the main components.

$$\begin{cases} u_1 = l'_{11}z'_1 + l'_{12}z'_2 + \dots + l'_{1p}z'_p + l_{10} \\ u_2 = l'_{21}z'_1 + l'_{22}z'_2 + \dots + l'_{2p}z'_p + l_{20} \\ \dots\dots\dots \\ u_m = l'_{m1}z'_1 + l'_{m2}z'_2 + \dots + l'_{mp}z'_p + l_{m0} \end{cases} \quad (13)$$

Here

$$z_i = (z'_i - a_i) / b_i \quad (14)$$

Substitute  $z'_i$  into formula 1 can we obtain the formula 2.

$a_i$  is the mean value of the line i in the primitive matrix;  $b_i$  is the standard deviation of row i in the primitive matrix.

Then utilize the formula 9 to compute the synthetic score and get variability of

the system.

### Normalize the Decision Making Matrix

There are many types of attributes such as benefit type, cost type, fixation type, deviate type, interval type, deviate interval type etc. In our model all the attribute could be sorted to two types the benefit type and the cost type approximately. The benefit cost requires the value of the attribute as big as possible; the cost type requires the value of the attribute as small as possible.

To eliminate the impact of the different dimensions to the decision making result we should normalize the decision making matrix  $A$  whose values could be obtained from the model 1.

Assume that  $I_i$  ( $i=1, 2$ ) stands for the subscript set of the benefit type and cost type. If the attribute is benefit type we value  $i$  in  $I_1$  as 1. If the attribute is cost type we value  $i$  in  $I_2$  as 2.

$$r_{ij} = \frac{a_{ij} - \min_i(a_{ij})}{\max_i(a_{ij}) - \min_i(a_{ij})}, \quad i \in N, \quad j \in I_1 \quad (15)$$

$$r_{ij} = \frac{\max_i(a_{ij}) - a_{ij}}{\max_i(a_{ij}) - \min_i(a_{ij})}, \quad i \in N, \quad j \in I_2 \quad (16)$$

After this step we get the normalized matrix  $R = (r_{ij})_{n \times m}$  whose form is the same with the matrix  $A$ .

Step 2: Calculus the optimization weight vector  $w$

$$w_j = \frac{\sum_{i=1}^n \sum_{k=1}^n |r_{ji} - r_{kj}|}{\sum_{j=1}^m \sum_{i=1}^n \sum_{k=1}^n |r_{ij} - r_{kj}|}, \quad j \in M \quad (17)$$

Where  $w_j$  is the  $j$  th main component's weight.

Step 3: Computer the synthetic attribute  $z_i(w)$  ( $i = 1, \dots, N$ ) of project  $x_i$ .

$$z_i(w) = \sum_{j=1}^m r_{ij} w_j, \quad i \in N, \quad j \in M \quad (18)$$

Step 4: Make ranking and comparison to the projects (countries) using  $z_i(w)$  ( $i = 1, \dots, N$ )

## 6. Applying the Model1 and Model 2

### 6.1 Applying the Model 1 to the Statistics of the Year 2004

#### 6.1.1 Data for Model 1 in the Year of 2004

We first select the indicators that 95% of the countries own these indicators from all 159 indicators getting 28 indicators which could be seen in appendix . Then we



select the countries that have the data for all these 28 indicators from all 193 Member States getting 163 countries. By doing these we have made good preparation for our model 1's solution.

### 6.1.2 Solution of the Model 1 for the Year of 2004

Based on the above data we solve our model 1 in matlab using the function of zscore to normalize the data, and then we calculate the characteristic roots and characteristic vector. The characteristic roots are shown in the table 3.

Table3. Part Valves of Model 1

Sequence Number	Characteristic Value	Contribution Rate	Accumulative Contribution Rate
1	13.496	0.482007402	0.48201
2	3.708	0.132430605	0.61444
3	1.9735	0.070483225	0.68492
4	1.5611	0.055754428	0.74068
5	1.0659	0.038068442	0.77875
6	1.0171	0.036325558	0.81507
7	0.83573	0.029847958	0.84492
8	0.77819	0.027792927	0.87271
9	0.67073	0.023955011	0.89667
10	0.59147	0.021124253	0.91779
11	0.52243	0.018658501	0.93645
12	0.41191	0.014711297	0.95116
13	0.38932	0.013904499	0.96506
14	0.29002	0.010358016	0.97542
15	0.20652	0.007375828	0.9828
16	0.17762	0.006343669	0.98914
17	0.080718	0.00288283	0.99202
18	0.054959	0.001962852	0.99399
19	0.047736	0.001704883	0.99569
20	0.041992	0.001499737	0.99719
21	0.030305	0.001082338	0.99827
22	0.02605	0.000930371	0.9992
23	0.007605	0.000271611	0.99948
24	0.0073298	0.000261783	0.99974
25	0.0053926	0.000192596	0.99993
26	0.0014271	5.09686E-05	0.99998
27	0.00051166	1.82739E-05	1
28	4.79E-32	1.71249E-33	1

From the table 3 we can see that the front six red colored components' accumulative contribution rate reaches to 81.5% which means that most of the main components are involved, so these six components are just our combined metrics. We renamed these six combined indicators with A, B, C, D, E, F metrics all of which are constituted by several raw indicators and could reflect certain performance of a health care system.

In more detail the metric A is much positively related with life expectancy, per capita total expenditure on health at international dollar rate etc and much negatively related with mortality rate, incidence of tuberculosis (per 100 000 population per year) etc. The visual relationship between the metric and the 28 indicators is shown in figure 1. The x axis is the order of the 28 indicators which maps to corresponding 28 indicators in appendix . The y axis is the affection of each of the 28 indicator on metric A. All the rest five figures follow this instruction so we won't explain the rest five figures again.

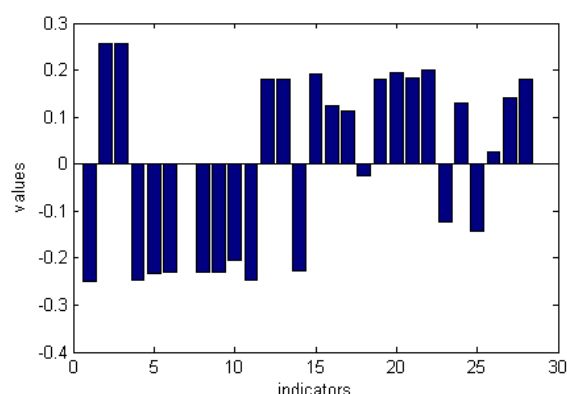


Figure1. The affection of the 28 indicators on metric A

The metric B is much positively related with expenditure on health, disease detection rate etc and much negatively related with government expenditure on health, alcohol consumption etc.

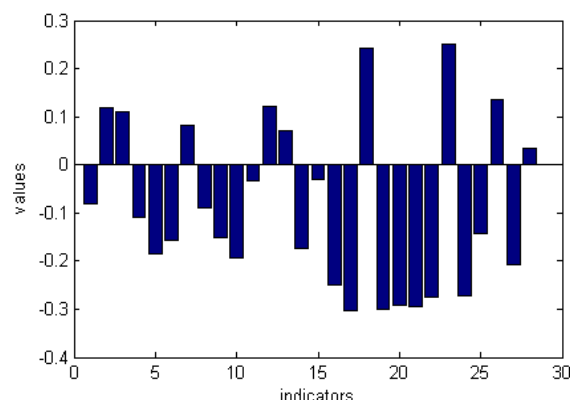


Figure2. The affection of the 28 indicators on metric B

The metric C is much positively related with General government expenditure on health as percentage of total expenditure on health, immunized with disease etc and much negatively related with private expenditure on health as percentage of total expenditure on health, population (in thousands) total etc.

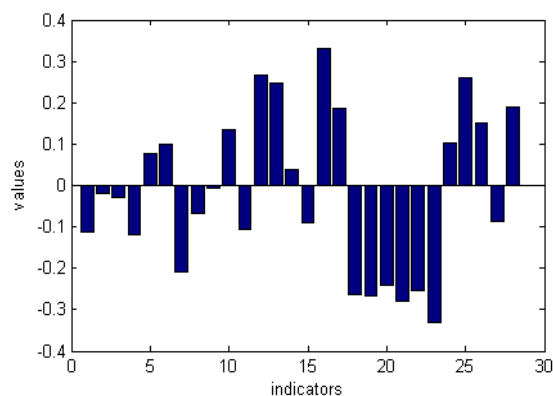


Figure3. The affection of the 28 indicators on metric C

The metric D is much positively related with private expenditure on health as percentage of total expenditure on health, immunized with disease etc and much

negatively related with General government expenditure on health as percentage of total expenditure on health etc.

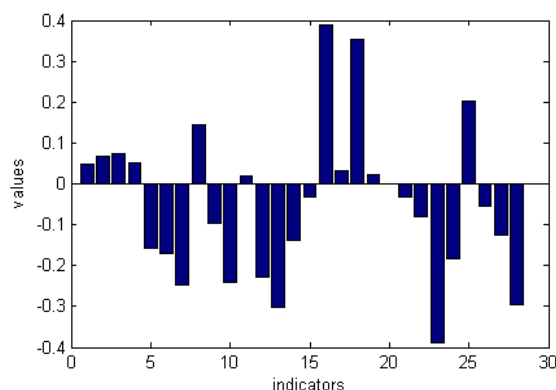


Figure4. The affection of the 28 indicators on metric D

The metric E is much positively related with external resources for health as percentage of total expenditure on health etc and much negatively related with tuberculosis: DOTS case detection rate, probability of dying (per 1 000 population) between 15 and 60 years etc.

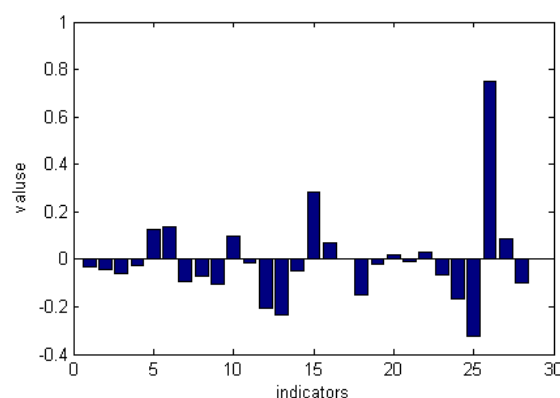


Figure5. The affection of the 28 indicators on metric E

The metric F is much positively related with immunized with disease, out-of-pocket expenditure as percentage of private expenditure on health etc and much negatively related with general government expenditure on health as percentage of total government expenditure, population (in thousands) total etc.

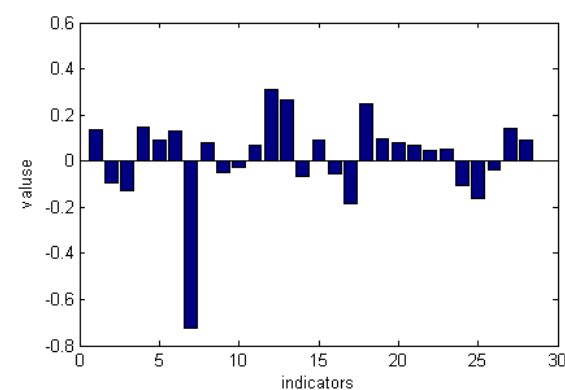


Figure6. The affection of the 28 indicators on metric F

The above descriptions show that our metrics is reasonable, moreover all the 28 indicators we selected could be found in 92% of all Member States, which means that our metrics could be easily collected.

Furthermore we get the ranking for all the 163 countries that own orbicular and effective data. The front and the back 20 countries in our ranking and their scores calculated by our model 1 are listed as table 4:

Table4. Part of our Ranking by Our Model1

Country	Score	Ranking	Country	Score	Ranking
Luxembourg	5.2874	1	Mozambique	-2.754	144
United States of America	4.4794	2	Cambodia	-2.7745	145
Norway	4.3477	3	Togo	-2.8043	146
Iceland	4.1734	4	Kenya	-2.9057	147
Switzerland	4.1183	5	Guinea	-2.9058	148
Germany	3.9429	6	Mali	-2.9975	149
France	3.8955	7	Swaziland	-3.0032	150
Denmark	3.6953	8	Guinea-Bissau	-3.1324	151
Sweden	3.6642	9	Niger	-3.3279	152
Australia	3.5854	10	Burundi	-3.3493	153
Canada	3.5684	11	Angola	-3.4365	154
Austria	3.5472	12	Equatorial Guinea	-3.6926	155
Netherlands	3.5175	13	Democratic Republic of the Congo	-3.7246	156
Belgium	3.4395	14	Liberia	-3.7657	157
United Kingdom	3.4018	15	Côte d'Ivoire	-3.8409	158
Ireland	3.32	16	Central African Republic	-3.9118	159
Japan	3.3151	17	Nigeria	-3.9251	160
Italy	3.0163	18	Chad	-4.0163	161
Spain	3.0122	19	Sierra Leone	-4.1661	162
Finland	3.011	20	Afghanistan	-4.3923	163

The whole ranking is shown in appendix .

After obtaining the six metrics we treat the still missing value's indicator as zero then recompute the ranking of the year 2004 with the model 1 and get another ranking for all the Member States which we list in appendix .

In conclusion we put forward 28 important indicators from all the 159 indicators furthermore we combine the 28 important indicators getting 6 main components which we renamed as metric A, B, C, D, E and F. Then we assess the health care system with these six metrics and make a ranking of all the 163 countries.

### 6.1.3 Applying model 1 to the Statistics of the Year 2000

Using model 1 and the six metrics obtained from 4.11 we assess the health care system of each country in the year of 2000. This time we only utilize the data of this year, which means that we just substitute the data of 2004 with that of 2000.

By doing this we get the ranking of this year as table 5 which just show out the front and the back 20 countries too.

Table5. The Part Ranking of the Year 2000 by Model 1

(There are 194 Member States in 2000; the score here is just a relative value computed by our model; the whole ranking is shown in appendix )

Member States	Score	Ranking	Member States	Score	Ranking
United States of America	77.36	1	Mauritania	-34.198	175
Norway	69.76	2	Rwanda	-35.303	176
Monaco	68.556	3	Angola	-35.372	177
Luxembourg	65.459	4	Iraq	-36.277	178
Germany	64	5	Mali	-36.886	179
Iceland	63.443	6	Zambia	-37.149	180
Switzerland	63.029	7	Myanmar	-37.178	181
San Marino	61.709	8	Togo	-37.593	182
Austria	60.207	9	Guinea-Bissau	-37.886	183
Denmark	55.989	10	Guinea	-38.026	184
Japan	55.252	11	Pakistan	-38.947	185
France	54.478	12	Nigeria	-39.523	186
Sweden	54.14	13	Cambodia	-40.099	187
Canada	51.894	14	Somalia	-40.755	188
Andorra	50.228	15	Burundi	-43.947	189
Australia	49.207	16	Liberia	-44.322	190
Belgium	48.348	17	Côte D'Ivoire	-44.511	191
United Kingdom	46.465	18	Sierra Leone	-44.698	192
Netherlands	44.77	19	Democratic Republic of the Congo	-49.363	193
Ireland	41.18	20	Afghanistan	-52.047	194

## 6.2 Applying the Model 2

The six metrics obtained from model1 is ordered. Although the six metrics keep the same in the model 2 as what they are in model 1 according to our assumptions, there is no certain order among them in our model 2. The data processing methods for the raw data are the same with what we have described and used before.

### 6.2.1 Applying the Model 2 to the year of 2004

With the help of the software matlab we realize the algorithm of dispersion maximization computing the weight of the six metrics, and then we calculate the synthetic score of each of the 163 country that own holonomic statistics after our data mining process. After comparing the synthetic score of these countries we get the ranking of their health system as shown in table 6.

Table6. Part of the ranking for the 163Member States

Member States	Score	Ranking	Member States	Score	Ranking
Tuvalu	0.69041	1	Gabon	0.38086	144
United States of America	0.67464	2	Yemen	0.37207	145
Luxembourg	0.66132	3	Congo	0.36751	146
France	0.65474	4	Côte d'Ivoire	0.36701	147
Malawi	0.64782	5	Democratic Republic of the Congo	0.36697	148
Switzerland	0.64488	6	Guinea	0.36565	149
Germany	0.63153	7	Vanuatu	0.36396	150
Niue	0.63121	8	Sudan	0.35663	151
Netherlands	0.61982	9	Mauritania	0.35272	152
Norway	0.61622	10	Myanmar	0.34684	153
Australia	0.61126	11	Pakistan	0.34684	154
Iceland	0.60876	12	Liberia	0.34468	155
Canada	0.60601	13	Fiji	0.32832	156
Ireland	0.60218	14	Angola	0.32804	157
Spain	0.59422	15	Afghanistan	0.31317	158
Finland	0.59382	16	Chad	0.31109	159
Botswana	0.59175	17	Lao People's Democratic Republic	0.31079	160
Denmark	0.59164	18	India	0.30405	161
Austria	0.58813	19	Nigeria	0.29663	162
Sweden	0.58743	20	Equatorial Guinea	0.27507	163

(The score here is just a relative value computed by our model; the whole ranking is shown in appendix )

### 6.2.2 Applying the Model 2 to the year of 2000

Similar to 4.1.2 we just replace the data of 4.2.1 with the data of the year 2000 then compute the synthetic score of all the 194 Member States. After comparing the different countries we get the ranking as table7.

Table7. Part of the ranking for 2000 by model 2

Member States	Score	Ranking	Member States	Score	Ranking
Costa Rica	0.68915	1	Burkina Faso	0.34237	175
Oman	0.6795	2	Tajikistan	0.341	176
Colombia	0.66084	3	Somalia	0.33705	177
Uruguay	0.65102	4	Sao Tome and Principe	0.33694	178
Bahamas	0.64974	5	Gambia	0.32748	179
Cuba	0.64754	6	Equatorial Guinea	0.32623	180
Tonga	0.64387	7	Timor-Leste	0.32357	181
Antigua and Barbuda	0.6417	8	Chad	0.32349	182
Chile	0.64048	9	Burundi	0.32176	183
Jamaica	0.63568	10	Côte d'Ivoire	0.32156	184
Algeria	0.63098	11	Togo	0.32074	185
Slovenia	0.62925	12	Central African Republic	0.30826	186
Honduras	0.6116	13	Mali	0.29905	187
Portugal	0.61139	14	Pakistan	0.29638	188
San Marino	0.60958	15	Nigeria	0.288	189
Namibia	0.60651	16	Liberia	0.28702	190
Libyan Arab Jamahiriya	0.60643	17	Zambia	0.28557	191
Tunisia	0.60619	18	Sierra Leone	0.26862	192
Seychelles	0.60016	19	Mauritania	0.26745	193
United States of America	0.59965	20	Afghanistan	0.25838	194

## 7. Comparisons

### 7.1 Comparisons between Different Rankings

From the above solution we obtain 4 different rankings. The precise clues of our models have already showed their validity. Besides we can load a ranking for all the 190 Member states in 2000 from the WHO's official web which we list in appendix

.By making comparisons between our two rankings with the official ranking of the year 2000 we can test the reliability and practicability of our model to a certain extent. The figure7 shows their relationship clearly.

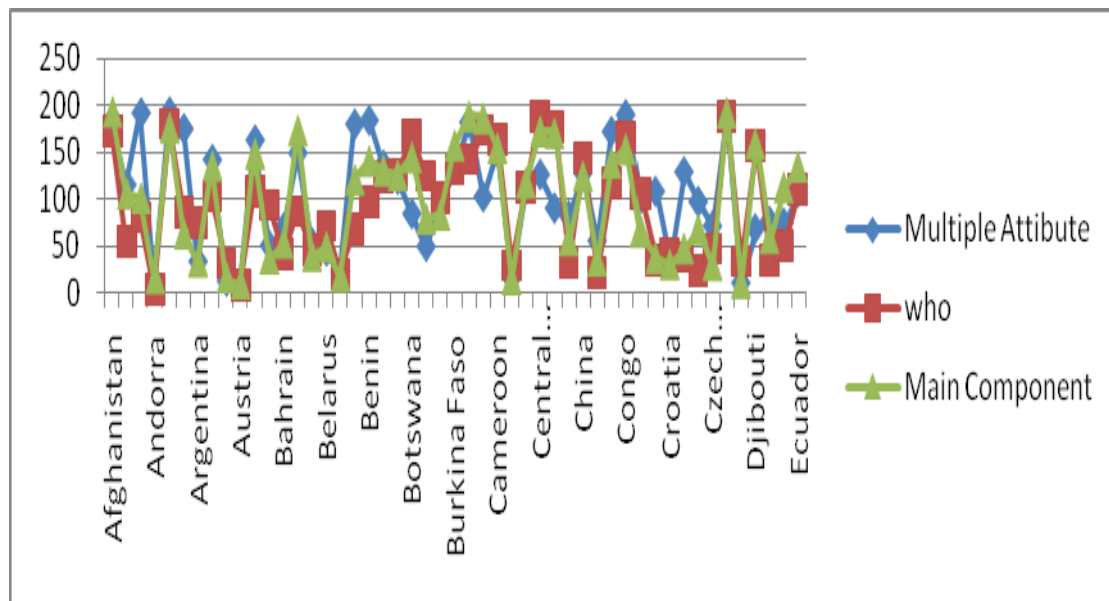


Figure7. The corresponding relationship between our rankings and the WHO's

We can see that the dots which stand for parts of the countries in the rankings match quite well with each other in the three polygonal lines. That means the model1 and model 2's results not only agree with each other but also agree with the official results quite well. So we can conclude that our two models are practical and reasonable.

Since the solution for the year of 2000 is dependable, we have reason enough to predicate that our solution for 2004 is authentic as the only difference between 2004 and 2000 is the substituted statistics and the data of 2004 is more holonomic than that of 2000.

To make sure that both of our models' results for the year 2004 are unitive we make a comparison between their rankings. We select some characteristic countries in both rankings and compare those countries rankings as shown in figure 8.

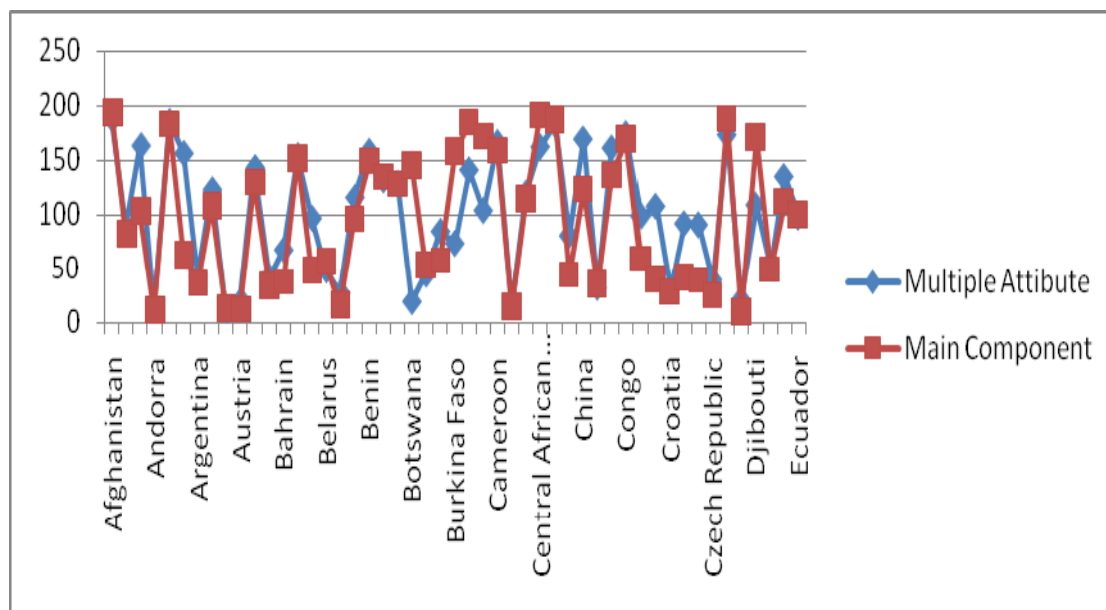


Figure8. The comparison between the two rankings for the year 2004  
 From the figure we find that the two rankings match quite well.  
 In conclusion our models are scientific and our results are authentic.

## 7.2 Comparisons between US and France

In the 2000's ranking of WHO France takes the first place, which also could be seen clearly in the appendix. In the year 2004 there is no official ranking so we assess these two countries health care system with our model 1 to see which country has the better health care system then.

The table8 shows their score according to our six metrics:

Table8. The comparisons between US and France's health system according to our metrics

Member State	Metric A	Metric B	Metric C	Metric D	Metric E	Metric F
France	5.3925	-3.408	-1.2958	-0.53662	-0.81021	-0.27097
United States of America	6.2475	-4.3459	-3.2301	-3.1138	0.42037	-1.5453

The metric A, C, F belongs to benefit type and the rest belong to cost type. Base on this we can see that the health care system of US in 2004 is better than France in metric A, B, D. According to our table 1 we know that the synthetic score of US is better than France.

## 7.3 Comparisons between US and India

In the ranking of WHO the health system of US is better than India. With the help of our mode 1 we consider that India has the poor health care system in 2004, so we make a comparison between them.



Table9. The comparisons between US and India's health system according to our metrics

Member State	Metric A	Metric B	Metric C	Metric D	Metric E	Metric F
India	-2.6483	2.7494	-3.6632	-2.812	-0.75113	-6.18
United States of America	6.2475	-4.3459	-3.2301	-3.1138	0.42037	-1.5453

Similar to 7.2 we can see that the health care system of US is better than India in metric A, B, C, D, F. Also from the table 9 we know that the ranking of US is much better than India.

## 8. Applying the Model 3

Based on model 1 and model 2 with the help of the software matlab we realize the algorithm in model 3 and get the predictive function of the synthetic scores as follows:

$$\begin{aligned}
 Q = & -0.003381z'_1 + 0.0096692z'_2 + 0.010559z'_3 - 0.0019468z'_4 - 0.00052279z'_5 \\
 & - 0.00052406z'_6 - 3.06 \times 10^{-7}z'_7 - 0.078213z'_8 - 0.0042194z'_9 - 0.000362z'_{10} \\
 & - 0.0087351z'_{11} + 0.0095689z'_{12} + 0.0098489z'_{13} - 0.00039226z'_{14} + 0.0043929z'_{15} \\
 & + 0.005344z'_{16} + 0.025752z'_{17} - 0.0037719z'_{18} + 0.00014346z'_{19} + 0.00018277z'_{20} \\
 & + 0.00010941z'_{21} + 0.00013679z'_{22} - 0.0053441z'_{23} + 0.05644z'_{24} - 0.0029234z'_{25} \\
 & - 0.00084042z'_{26} + 0.02965z'_{27} + 0.012447z'_{28} - 3.8668
 \end{aligned} \quad (19)$$

Considering the affection of the weight on the synthetic score we could find that the bigger the absolute value of weight is the bigger the impact is on the synthetic score of the country. On the contrary if the absolute value of weight is small then the variation of the metric won't produce big changes to the synthetic score. Then we take some indicators of the all 28 indicators as examples to discuss what affection it will has on the health care system if the various changes are occurred.

$z'_8$  is the formula is the total fertility rate (per woman). It has a negative correlation with the synthetic score. What's more it has a big affection on the score so this indicator should be as small as possible, which means that the government should take some measures to control the population within a proper range to improve the health care system of the nation.

$z'_{24}$  is the total expenditure on health as percentage of gross domestic product. It is an indicator that positively related with the synthetic score which means that the more it spend on the total expenditure on health as percentage of gross domestic product the better score it has in the system.

$z'_{17}$  is the general government expenditure on health as percentage of total government expenditure. It is an indicator that positively related with the synthetic score which means that the bigger the general government expenditure on health as percentage of total government expenditure is the better score it has in the system

$z'_3$  is the life expectancy at birth (years) males. It is an indicator that positively

related with the synthetic score which means that the longer the life expectancy at birth (years) males is the better score it has in the system.

$z'_{11}$  stands for the neonatal mortality rate (per 1 000 live births). It has a negative correlation with the synthetic score. That's to say the smaller the neonatal mortality rate (per 1 000 live births) is the better the health care system will become.

## 9. The Strength and Weakness

### 9.1 The Strength

We obtain the statistics directly from the raw database of the WHO's official web not from the report of the WHO. We use some data mining technology to draw the available and effective data from thousands terms of data ourselves.

We develop three different models to solve all the six parts of the problem, those models are built with precise logic, scientific principle which could solve the problems efficaciously.

We don't solve the problem part by part but solve them in our models' development and solution process, which keeps the whole paper's with a good continuity.

We compare our result with the practical result, which tests our models' practicability and validity greatly.

Our models could be easily extended to other fields to solve the multiple attribute decision making problems.

Our models are independent to the metric (indicators) to a certain extent as the algorithm of our models has the universal applications.

### 9.2 The Weakness

The raw data we get is the data from the real world, which means that there must be some imperfect data which do have some negative impact on our result.

As there are so many indicators that it is hard to select proper metrics to assess the health system properly without some kind of error.

Because the limitation of the time and resource it's inevitable to have some imperfect aspects in our models, analysis and paper.

## 10. References

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## 11. Appendix

Appendix : The list of all the 28 indicators and their sequence number

Name of the Indicator	Sequence Number
Infant mortality rate (per 1 000 live births)	1
Life expectancy at birth (years) females	2
Life expectancy at birth (years) males	3
Probability of dying (per 1 000 live births) under five years of age (under-5 mortality rate)	4
Probability of dying (per 1 000 population) between 15 and 60 years (adult mortality rate) females	5
Probability of dying (per 1 000 population) between 15 and 60 years (adult mortality rate) males	6
Population (in thousands) total	7
Total fertility rate (per woman)	8
Deaths due to tuberculosis among HIV-negative people (per 100 000 population)	9
Incidence of tuberculosis (per 100 000 population per year)	10
Neonatal mortality rate (per 1 000 live births)	11
One-year-olds immunized with one dose of measles (%)	12
One-year-olds immunized with three doses of diphtheria tetanus toxoid and pertussis (DTP3) (%)	13
Prevalence of tuberculosis (per 100 000 population)	14
Population in urban areas (%)	15
General government expenditure on health as percentage of total expenditure on health	16
General government expenditure on health as percentage of total government expenditure	17
Out-of-pocket expenditure as percentage of private expenditure on health	18
Per capita government expenditure on health at average exchange rate (US\$)	19
Per capita government expenditure on health at international dollar rate	20
Per capita total expenditure on health at average exchange rate (US\$)	21
Per capita total expenditure on health at international dollar rate	22
Private expenditure on health as percentage of total expenditure on health	23
Total expenditure on health as percentage of gross domestic product	24
External resources for health as percentage of total expenditure on health	25
Tuberculosis: DOTS case detection rate (%)	26
Per capita recorded alcohol consumption (litres of pure alcohol) among adults (>=15 years)	27
Population with sustainable access to improved drinking water sources (%) urban	28

Appendix : The Ranking of all 163 Countries in 2004 by model 1

Member States	Score	Ranking	Member States	Score	Ranking
Luxembourg	5.2874	1	Argentina	1.7204	31
United States of America	4.4794	2	Bahrain	1.6935	32
Norway	4.3477	3	Costa Rica	1.6646	33
Iceland	4.1734	4	Poland	1.6544	34
Switzerland	4.1183	5	Cyprus	1.6224	35
Germany	3.9429	6	Chile	1.5936	36
France	3.8955	7	Cuba	1.5877	37
Denmark	3.6953	8	Uruguay	1.5737	38
Sweden	3.6642	9	Estonia	1.5674	39
Australia	3.5854	10	Republic of Korea	1.566	40
Canada	3.5684	11	Qatar	1.5031	41
Austria	3.5472	12	Seychelles	1.4263	42
Netherlands	3.5175	13	Brazil	1.4239	43
Belgium	3.4395	14	Panama	1.4226	44
United Kingdom	3.4018	15	Latvia	1.3886	45
Ireland	3.32	16	United Arab Emirates	1.3233	46
Japan	3.3151	17	Bulgaria	1.3187	47
Italy	3.0163	18	Singapore	1.2079	48
Spain	3.0122	19	Saudi Arabia	1.1352	49
Finland	3.011	20	Cook Islands	1.1203	50
New Zealand	2.9639	21	Mexico	1.0758	51
Czech Republic	2.6476	22	Turkey	1.0249	52
Israel	2.507	23	Saint Kitts and Nevis	1.0172	53
Malta	2.2475	24	Russian Federation	0.99065	54
Croatia	2.1812	25	Antigua and Barbuda	0.99055	55
Hungary	2.1787	26	Saint Lucia	0.97548	56
Slovakia	2.112	27	Bosnia and Herzegovina	0.94075	57
Niue	1.9779	28	Lebanon	0.93761	58
Bahamas	1.8505	29	Jordan	0.92958	59
Colombia	1.7791	30	Tuvalu	0.91241	60

Member States	Score	Ranking	Member States	Score	Ranking
Romania	0.89348	61	Democratic People's Republic of Korea	-0.16612	91
Tonga	0.88711	62	Viet Nam	-0.17424	92
Republic of Moldova	0.85033	63	Turkmenistan	-0.20799	93
Tunisia	0.80508	64	Cape Verde	-0.22579	94
Mauritius	0.78214	65	Georgia	-0.24204	95
El Salvador	0.76433	66	Uzbekistan	-0.26085	96
Malaysia	0.68516	67	China	-0.30967	97
Albania	0.68375	68	Kazakhstan	-0.40979	98
Iran (Islamic Republic of)	0.62103	69	Kyrgyzstan	-0.41333	99
Thailand	0.57527	70	Bolivia	-0.47525	100
Paraguay	0.43349	71	Azerbaijan	-0.6092	101
Venezuela (Bolivarian Republic of)	0.40807	72	South Africa	-0.68403	102
Syrian Arab Republic	0.34479	73	Vanuatu	-0.73088	103
Belize	0.33629	74	Kiribati	-0.78125	104
Micronesia (Federated States of)	0.32696	75	Fiji	-0.78464	105
Honduras	0.31882	76	Philippines	-0.80541	106
Jamaica	0.30699	77	Namibia	-0.80905	107
Sri Lanka	0.24876	78	Bhutan	-1.0007	108
Ecuador	0.2382	79	Comoros	-1.022	109
Peru	0.0861	80	Iraq	-1.1864	110
Egypt	0.07724	81	Indonesia	-1.2211	111
Nicaragua	0.058604	82	Gabon	-1.2789	112
Algeria	0.057633	83	Malawi	-1.2841	113
Mongolia	0.038882	84	Botswana	-1.3832	114
Armenia	0.016966	85	Gambia	-1.4877	115
Morocco	0.011734	86	Nepal	-1.5079	116
Solomon Islands	-0.00622	87	Ghana	-1.5567	117
Dominican Republic	-0.08867	88	Tajikistan	-1.6313	118
Guyana	-0.13234	89	Papua New Guinea	-1.7368	119
Guatemala	-0.13485	90	Uganda	-1.7412	120

Member States	Score	Ranking	Member States	Score	Ranking
Benin	-1.7993	121	Guinea-Bissau	-3.1324	151
Lesotho	-1.8736	122	Niger	-3.3279	152
Bangladesh	-1.8782	123	Burundi	-3.3493	153
Burkina Faso	-1.9332	124	Angola	-3.4365	154
Senegal	-1.9684	125	Equatorial Guinea	-3.6926	155
Rwanda	-1.999	126	Democratic Republic of the Congo	-3.7246	156
Yemen	-2.0143	127	Liberia	-3.7657	157
Cameroon	-2.0713	128	Côte d'Ivoire	-3.8409	158
United Republic of Tanzania	-2.0799	129	Central African Republic	-3.9118	159
Eritrea	-2.1068	130	Nigeria	-3.9251	160
Haiti	-2.1356	131	Chad	-4.0163	161
Myanmar	-2.261	132	Sierra Leone	-4.1661	162
Madagascar	-2.2989	133	Afghanistan	-4.3923	163
India	-2.3374	134			
Sudan	-2.3611	135			
Pakistan	-2.3894	136			
Zimbabwe	-2.3903	137			
Congo	-2.4751	138			
Mauritania	-2.5943	139			
Lao People's Democratic Republic	-2.5977	140			
Djibouti	-2.6539	141			
Zambia	-2.6996	142			
Ethiopia	-2.7152	143			
Mozambique	-2.754	144			
Cambodia	-2.7745	145			
Togo	-2.8043	146			
Kenya	-2.9057	147			
Guinea	-2.9058	148			
Malawi	-2.9975	149			
Swaziland	-3.0032	150			

## Appendix : The Ranking of all 194 Countries in 2004 by model 1

Member States	Score	Ranking	Member States	Score	Ranking
Luxembourg	116.38	1	Slovakia	43.796	31
Monaco	98.985	2	Slovenia	42.849	32
United States of America	96.9	3	Niue	39.972	33
Norway	95.298	4	Bahamas	38.32	34
Iceland	90.915	5	Colombia	35.651	35
Switzerland	89.962	6	Argentina	35.091	36
Germany	85.311	7	Greece	34.927	37
France	84.284	8	Bahrain	34.747	38
Denmark	80.283	9	Cyprus	34.441	39
Sweden	79.534	10	Costa Rica	34.055	40
Andorra	77.735	11	Poland	33.933	41
Austria	77.602	12	Cuba	33.14	42
Australia	77.333	13	Republic of Korea	32.578	43
Canada	76.924	14	Chile	32.473	44
Netherlands	75.779	15	Estonia	31.893	45
Belgium	74.734	16	Uruguay	31.758	46
United Kingdom	73.876	17	Qatar	30.945	47
Ireland	72.067	18	Barbados	29.081	48
Japan	71.28	19	Dominica	28.904	49
San Marino	67.712	20	Palau	28.823	50
Italy	65.214	21	Panama	28.62	51
Finland	64.735	22	Seychelles	28.429	52
Spain	64.459	23	Brazil	28.198	53
New Zealand	63.663	24	Latvia	27.704	54
Czech Republic	56.101	25	United Arab Emirates	26.913	55
Israel	53.11	26	Belarus	26.545	56
Malta	48.32	27	Bulgaria	26.307	57
Croatia	45.536	28	Singapore	24.972	58
Portugal	45.442	29	Cook Islands	22.187	59
Hungary	45.439	30	Lithuania	22.041	60

Member States	Score	Ranking	Member States	Score	Ranking
Saudi Arabia	21.956	61	Jamaica	5.0535	91
Mexico	20.719	62	Syrian Arab Republic	5.0077	92
Antigua and Barbuda	20.073	63	Saint Vincent and the Grenadines	4.7553	93
Turkey	19.824	64	Suriname	4.6532	94
Saint Kitts and Nevis	19.763	65	Micronesia (Federated States of)	4.5625	95
Saint Lucia	19.385	66	Belize	4.3802	96
Bosnia and Herzegovina	18.686	67	Honduras	3.9494	97
The former Yugoslav Republic of Macedonia	18.291	68	Trinidad and Tobago	3.0209	98
Russian Federation	18.082	69	Sri Lanka	2.7928	99
Romania	17.864	70	Ecuador	2.415	100
Lebanon	17.455	71	Libyan Arab Jamahiriya	1.6244	101
Jordan	17.171	72	Peru	0.53861	102
Ukraine	16.833	73	Algeria	0.46787	103
Tonga	15.782	74	Nicaragua	-0.19809	104
Republic of Moldova	15.71	75	Marshall Islands	-0.58082	105
Tunisia	14.951	76	Mongolia	-1.2768	106
Kuwait	14.927	77	Egypt	-1.5716	107
Tuvalu	14.615	78	Armenia	-2.5356	108
Mauritius	14.156	79	Morocco	-2.8437	109
El Salvador	14.117	80	Solomon Islands	-3.1057	110
Grenada	12.629	81	Guyana	-4.2069	111
Albania	12.284	82	Dominican Republic	-4.2132	112
Malaysia	12.084	83	Sao Tome and Principe	-4.3126	113
Maldives	10.854	84	Cape Verde	-5.7065	114
Iran (Islamic Republic of)	10.41	85	Guatemala	-6.2095	115
Brunei Darussalam	9.6522	86	Viet Nam	-6.8597	116
Thailand	9.5419	87	Democratic People's Republic of Korea	-6.8833	117
Oman	9.332	88	Serbia	-6.9816	118
Venezuela (Bolivarian Republic of)	9.1506	89	Nauru	-7.1559	119
Paraguay	6.5848	90	Georgia	-7.3254	120

Member States	Score	Ranking	Member States	Score	Ranking
Turkmenistan	-8.34	121	Montenegro	-42.552	151
Uzbekistan	-8.9854	122	Bangladesh	-42.726	152
China	-9.6806	123	Yemen	-43.917	153
Fiji	-10.557	124	Haiti	-44.255	154
Kazakhstan	-12.731	125	Senegal	-46.605	155
Samoa	-12.945	126	Lesotho	-46.778	156
Kyrgyzstan	-13.098	127	Eritrea	-46.902	157
Bolivia	-13.18	128	Burkina Faso	-47.671	158
Vanuatu	-15.786	129	Cameroon	-47.794	159
Azerbaijan	-16.303	130	United Republic of Tanzania	-49.761	160
Kiribati	-17.112	131	Rwanda	-50.244	161
Philippines	-18.972	132	Myanmar	-50.41	162
South Africa	-20.731	133	Madagascar	-51.208	163
Namibia	-22.772	134	Sudan	-52.046	164
Bhutan	-23.79	135	India	-54.262	165
Comoros	-24.251	136	Mauritania	-55.096	166
Indonesia	-27.821	137	Pakistan	-55.314	167
Iraq	-30.353	138	Lao People's Democratic Republic	-55.993	168
Gabon	-30.405	139	Congo	-56.144	169
The former state union Serbia and Montenegro	-31.545	140	Zimbabwe	-59.626	170
Malawi	-36.287	141	Djibouti	-60.451	171
Nepal	-36.345	142	Cambodia	-61.743	172
Gambia	-37.235	143	Ethiopia	-62.758	173
Ghana	-37.414	144	Mozambique	-62.908	174
Botswana	-37.804	145	Togo	-63.809	175
Tajikistan	-38.763	146	Guinea	-65.172	176
Timor-Leste	-39.238	147	Zambia	-65.287	177
Papua New Guinea	-39.582	148	Kenya	-67.134	178
Benin	-41.205	149	Mali	-69.19	179
Uganda	-42.502	150	Guinea-Bissau	-71.404	180

Member States	Score	Ranking	Member States	Score	Ranking
Swaziland	-72.135	181	Democratic Republic of the Congo	-84.899	188
Niger	-76.29	182	Nigeria	-85.053	189
Angola	-77.33	183	Côte d'Ivoire	-89.157	190
Equatorial Guinea	-77.405	184	Central African Republic	-90.035	191
Burundi	-78.014	185	Somalia	-92.78	192
Liberia	-84.377	186	Sierra Leone	-94.733	193
Chad	-84.563	187	Afghanistan	-96.698	194

## Appendix : The Ranking of all 194 Countries in 2000 by model 1

Member States	Score	Ranking	Member States	Score	Ranking
United States of America	77.36	1	Palau	22.938	31
Norway	69.76	2	Greece	22.879	32
Monaco	68.556	3	Argentina	21.48	33
Luxembourg	65.459	4	Colombia	20.506	34
Germany	64	5	Slovakia	19.393	35
Iceland	63.443	6	Bahamas	19.32	36
Switzerland	63.029	7	Costa Rica	19.258	37
San Marino	61.709	8	Panama	18.45	38
Austria	60.207	9	Barbados	17.922	39
Denmark	55.989	10	Uruguay	16.116	40
Japan	55.252	11	Hungary	16.019	41
France	54.478	12	United Arab Emirates	14.367	42
Sweden	54.14	13	Tuvalu	14.227	43
Canada	51.894	14	Saudi Arabia	14.047	44
Andorra	50.228	15	Niue	13.77	45
Australia	49.207	16	Lithuania	13.669	46
Belgium	48.348	17	Cuba	13.532	47
United Kingdom	46.465	18	Marshall Islands	13.154	48
Netherlands	44.77	19	Belarus	12.295	49
Ireland	41.18	20	Nauru	11.679	50
Italy	40.859	21	The former Yugoslav Republic of Macedonia	11.667	51
Israel	39.537	22	Qatar	11.327	52
New Zealand	37.232	23	Bahrain	11.28	53
Finland	36.874	24	Estonia	10.859	54
Slovenia	35.45	25	Poland	10.184	55
Portugal	33.288	26	Chile	10.17	56
Spain	31.418	27	Seychelles	10.154	57
Malta	27.414	28	Dominica	9.7127	58
Czech Republic	25.482	29	Saint Kitts and Nevis	9.6448	59
Croatia	25.07	30	Brunei Darussalam	8.7682	60

Member States	Score	Ranking	Member States	Score	Ranking
El Salvador	8.7509	61	Fiji	0.54868	91
Kuwait	8.7388	62	Romania	0.38625	92
Antigua and Barbuda	8.6414	63	Vanuatu	0.29949	93
Oman	8.4291	64	Honduras	-0.022617	94
Cook Islands	8.1994	65	Nicaragua	-1.4568	95
Micronesia (Federated States of)	7.5529	66	Ukraine	-1.5467	96
Samoa	7.1751	67	Tunisia	-1.9609	97
Cyprus	7.0795	68	Libyan Arab Jamahiriya	-2.0592	98
Tonga	6.7986	69	Mauritius	-2.7068	99
Republic of Korea	6.474	70	Montenegro	-2.7789	100
Jordan	6.023	71	Algeria	-3.2463	101
Turkey	5.8317	72	Serbia	-3.2809	102
Saint Lucia	5.7858	73	Turkmenistan	-3.3158	103
Venezuela (Bolivarian Republic of)	4.6804	74	Mongolia	-3.4415	104
Bosnia and Herzegovina	4.6648	75	Guatemala	-3.9865	105
Paraguay	4.5502	76	Albania	-3.9943	106
Saint Vincent and the Grenadines	4.4848	77	Trinidad and Tobago	-4.1938	107
Lebanon	4.3843	78	Malaysia	-4.3409	108
Brazil	4.2739	79	Kiribati	-4.4302	109
Grenada	4.2738	80	Iran (Islamic Republic of)	-4.618	110
Suriname	3.9029	81	Namibia	-4.9933	111
Solomon Islands	3.7633	82	Thailand	-5.1117	112
Bulgaria	3.6736	83	Dominican Republic	-5.3205	113
Singapore	3.3044	84	Sri Lanka	-6.6576	114
Russian Federation	3.1878	85	Peru	-6.6896	115
Jamaica	2.339	86	The former state union Serbia and Montenegro	-6.7996	116
Maldives	2.188	87	Syrian Arab Republic	-6.853	117
Latvia	1.6464	88	Cape Verde	-7.1797	118
Mexico	1.363	89	Lesotho	-7.2898	119
Guyana	0.57018	90	Egypt	-7.5324	120

Member States	Score	Ranking	Member States	Score	Ranking
Belize	-7.54	121	Madagascar	-24.888	151
Republic of Moldova	-8.7125	122	Kenya	-25.227	152
South Africa	-9.3516	123	Equatorial Guinea	-25.29	153
Democratic People's Republic of Korea	-9.6866	124	Congo	-25.662	154
China	-11.13	125	Cameroon	-25.738	155
Bolivia	-11.149	126	Senegal	-26.43	156
Uzbekistan	-11.41	127	Indonesia	-26.541	157
Sao Tome and Principe	-12.162	128	Burkina Faso	-26.636	158
Gabon	-12.183	129	Tajikistan	-26.724	159
Kyrgyzstan	-13.041	130	Djibouti	-26.911	160
Bhutan	-14.043	131	Uganda	-27.134	161
Morocco	-14.344	132	Nepal	-27.368	162
Papua New Guinea	-14.58	133	Malawi	-28.522	163
Kazakhstan	-15.227	134	Gambia	-28.828	164
Ecuador	-15.47	135	Lao People's Democratic Republic	-28.875	165
Armenia	-15.488	136	Ethiopia	-29.014	166
Viet Nam	-15.879	137	United Republic of Tanzania	-29.383	167
Georgia	-16.09	138	Sudan	-29.44	168
Comoros	-17.347	139	Swaziland	-29.865	169
Ghana	-18.531	140	Niger	-29.966	170
Benin	-18.743	141	Chad	-30.746	171
Philippines	-18.918	142	India	-31.621	172
Haiti	-19.312	143	Central African Republic	-32.874	173
Yemen	-20.308	144	Bangladesh	-33.942	174
Botswana	-20.618	145	Mauritania	-34.198	175
Eritrea	-20.649	146	Rwanda	-35.303	176
Zimbabwe	-21.928	147	Angola	-35.372	177
Mozambique	-22.399	148	Iraq	-36.277	178
Azerbaijan	-22.649	149	Mali	-36.886	179
Timor-Leste	-24.423	150	Zambia	-37.149	180

Member States	Score	Ranking
Myanmar	-37.178	181
Togo	-37.593	182
Guinea-Bissau	-37.886	183
Guinea	-38.026	184
Pakistan	-38.947	185
Nigeria	-39.523	186
Cambodia	-40.099	187
Somalia	-40.755	188
Burundi	-43.947	189
Liberia	-44.322	190
Cote d'Ivoire	-44.511	191
Sierra Leone	-44.698	192
Democratic Republic of the Congo	-49.363	193
Afghanistan	-52.047	194

## Appendix : The Ranking of all 163 Countries in 2004 by model 2

Member State	Score	Ranking	Member State	Score	Ranking
Tuvalu	0.69041	1	Hungary	0.56258	31
United States of America	0.67464	2	Namibia	0.55943	32
Luxembourg	0.66132	3	Italy	0.55729	33
France	0.65474	4	New Zealand	0.5571	34
Malawi	0.64782	5	Czech Republic	0.55634	35
Switzerland	0.64488	6	Israel	0.55173	36
Germany	0.63153	7	Russian Federation	0.55154	37
Niue	0.63121	8	Uganda	0.55075	38
Netherlands	0.61982	9	Bahamas	0.54959	39
Norway	0.61622	10	Argentina	0.54502	40
Australia	0.61126	11	Lesotho	0.54422	41
Iceland	0.60876	12	Brazil	0.5419	42
Canada	0.60601	13	Uruguay	0.53178	43
Ireland	0.60218	14	Republic of Moldova	0.52985	44
Spain	0.59422	15	Micronesia (Federated States of)	0.52855	45
Finland	0.59382	16	Tonga	0.52533	46
Botswana	0.59175	17	Saudi Arabia	0.52154	47
Denmark	0.59164	18	Zambia	0.52017	48
Austria	0.58813	19	Republic of Korea	0.51983	49
Sweden	0.58743	20	Romania	0.51844	50
United Kingdom	0.58422	21	Poland	0.51789	51
Japan	0.58137	22	Saint Kitts and Nevis	0.51773	52
Swaziland	0.58074	23	Latvia	0.51769	53
Belgium	0.57825	24	Bahrain	0.51396	54
South Africa	0.57477	25	Estonia	0.51389	55
Rwanda	0.57051	26	Seychelles	0.51322	56
Croatia	0.57006	27	Solomon Islands	0.51307	57
Colombia	0.5667	28	Turkey	0.50877	58
Zimbabwe	0.56583	29	Mauritius	0.50619	59
Slovakia	0.56579	30	Jordan	0.50508	60

Member State	Score	Ranking	Member State	Score	Ranking
Malta	0.50395	61	Belize	0.47257	91
Lebanon	0.50354	62	Bosnia and Herzegovina	0.47177	92
Chile	0.50032	63	Tunisia	0.47147	93
El Salvador	0.49997	64	Sri Lanka	0.46816	94
Thailand	0.49946	65	Ghana	0.46582	95
United Republic of Tanzania	0.49761	66	Egypt	0.46217	96
Burkina Faso	0.49737	67	Armenia	0.46014	97
Bulgaria	0.49495	68	Syrian Arab Republic	0.45997	98
Paraguay	0.49395	69	Viet Nam	0.45663	99
Panama	0.49143	70	Guatemala	0.45549	100
Albania	0.48888	71	Kenya	0.45286	101
United Arab Emirates	0.48784	72	Cape Verde	0.44966	102
Honduras	0.48738	73	Kazakhstan	0.44957	103
Qatar	0.48733	74	Ethiopia	0.44863	104
Cyprus	0.48709	75	Bolivia	0.44838	105
Kyrgyzstan	0.48547	76	Cambodia	0.44781	106
Cuba	0.48491	77	Eritrea	0.4466	107
Turkmenistan	0.48378	78	Morocco	0.44605	108
Ecuador	0.481	79	Djibouti	0.44447	109
Malaysia	0.48088	80	Kiribati	0.44408	110
Cook Islands	0.4803	81	Dominican Republic	0.4439	111
Mozambique	0.47967	82	Democratic People's Republic of Korea	0.44309	112
Mongolia	0.47927	83	Singapore	0.4424	113
Guyana	0.47906	84	Peru	0.44234	114
Gambia	0.47745	85	Nicaragua	0.43906	115
Uzbekistan	0.47662	86	Azerbaijan	0.438	116
Costa Rica	0.47657	87	Bhutan	0.43724	117
Mexico	0.47656	88	Mali	0.43704	118
Iran (Islamic Republic of)	0.47635	89	Jamaica	0.42998	119
Saint Lucia	0.47587	90	Burundi	0.42725	120



Member State	Score	Ranking	Member State	Score	Ranking
Senegal	0.4262	121	Sudan	0.35663	151
Tajikistan	0.42488	122	Mauritania	0.35272	152
Nepal	0.42458	123	Myanmar	0.34684	153
Togo	0.42458	124	Pakistan	0.34684	154
Philippines	0.42321	125	Liberia	0.34468	155
Iraq	0.42189	126	Fiji	0.32832	156
Georgia	0.41815	127	Angola	0.32804	157
Antigua and Barbuda	0.4165	128	Afghanistan	0.31317	158
Venezuela (Bolivarian Republic of)	0.41529	129	Chad	0.31109	159
Papua New Guinea	0.41435	130	Lao People's Democratic Republic	0.31079	160
Bangladesh	0.40556	131	India	0.30405	161
Sierra Leone	0.40408	132	Nigeria	0.29663	162
Haiti	0.39958	133	Equatorial Guinea	0.27507	163
Benin	0.39861	134			
Comoros	0.39581	135			
Algeria	0.39317	136			
Guinea-Bissau	0.39274	137			
Madagascar	0.38947	138			
Niger	0.38915	139			
China	0.38914	140			
Indonesia	0.38533	141			
Central African Republic	0.38369	142			
Cameroon	0.38302	143			
Gabon	0.38086	144			
Yemen	0.37207	145			
Congo	0.36751	146			
Côte d'Ivoire	0.36701	147			
Democratic Republic of the Congo	0.36697	148			
Guinea	0.36565	149			
Vanuatu	0.36396	150			

### Appendix : The Ranking of all 194 Countries in 2004 by model 2

Member State	Score	ranking	Member State	Score	ranking
Tuvalu	0.68896	1	Croatia	0.56588	31
United States of America	0.6628	2	Namibia	0.5631	32
Luxembourg	0.65426	3	Colombia	0.56119	33
Malawi	0.64779	4	Slovakia	0.55987	34
France	0.64695	5	Uganda	0.5592	35
Monaco	0.64175	6	Hungary	0.55715	36
Switzerland	0.63911	7	Italy	0.55403	37
Niue	0.6287	8	New Zealand	0.55302	38
Germany	0.62375	9	Lesotho	0.55222	39
Norway	0.6121	10	Czech Republic	0.55149	40
Netherlands	0.61038	11	Russian Federation	0.54896	41
Australia	0.60391	12	Israel	0.54631	42
Iceland	0.60291	13	Bahamas	0.54464	43
Andorra	0.60183	14	Argentina	0.53923	44
Ireland	0.59869	15	Brazil	0.53736	45
Canada	0.59834	16	Micronesia (Federated States of)	0.53645	46
Swaziland	0.59483	17	San Marino	0.53621	47
Finland	0.58856	18	Ukraine	0.53567	48
Spain	0.58808	19	Belarus	0.53512	49
Botswana	0.58735	20	Zambia	0.53087	50
Austria	0.5862	21	Republic of Moldova	0.52878	51
Denmark	0.58604	22	Dominica	0.52639	52
Sweden	0.58227	23	Uruguay	0.52431	53
United Kingdom	0.58157	24	Romania	0.52371	54
Japan	0.57568	25	Tonga	0.52318	55
Rwanda	0.57543	26	Solomon Islands	0.52286	56
Sao Tome and Principe	0.57496	27	Palau	0.52119	57
Belgium	0.57422	28	Timor-Leste	0.52057	58
South Africa	0.57187	29	Republic of Korea	0.51834	59
Zimbabwe	0.56853	30	Saudi Arabia	0.51731	60

Member State	Score	ranking	Member State	Score	ranking
Saint Kitts and Nevis	0.51886	61	Cyprus	0.48549	91
Slovenia	0.5157	62	Cuba	0.48522	92
Poland	0.51402	63	United Arab Emirates	0.4852	93
Latvia	0.5136	64	Turkmenistan	0.485	94
Estonia	0.51083	65	Qatar	0.48461	95
Suriname	0.50947	66	Kyrgyzstan	0.48455	96
United Republic of Tanzania	0.50907	67	Barbados	0.48295	97
Bahrain	0.50874	68	Ecuador	0.48096	98
Seychelles	0.50841	69	Cook Islands	0.48062	99
Turkey	0.50838	70	Trinidad and Tobago	0.4806	100
Mozambique	0.50618	71	Greece	0.48023	101
Marshall Islands	0.50599	72	Gambia	0.48011	102
Malta	0.50497	73	Malaysia	0.47817	103
Burkina Faso	0.50453	74	Cambodia	0.47788	104
Portugal	0.50418	75	Uzbekistan	0.47766	105
Mauritius	0.50298	76	Ghana	0.47728	106
Jordan	0.50045	77	Saint Lucia	0.4761	107
El Salvador	0.50033	78	Costa Rica	0.47392	108
Thailand	0.49827	79	Djibouti	0.47379	109
Lebanon	0.49818	80	Eritrea	0.47341	110
Chile	0.49403	81	Kenya	0.47324	111
Grenada	0.49388	82	Iran (Islamic Republic of)	0.47305	112
Paraguay	0.49286	83	Bosnia and Herzegovina	0.47243	113
Guyana	0.49231	84	Mexico	0.47226	114
Bulgaria	0.49172	85	Kiribati	0.47168	115
Maldives	0.49008	86	Belize	0.47131	116
Honduras	0.48867	87	Ethiopia	0.46884	117
Panama	0.48738	88	Tunisia	0.46877	118
Albania	0.4869	89	Sri Lanka	0.46795	119
Mongolia	0.48642	90	Cape Verde	0.46689	120

Member State	Score	ranking	Member State	Score	ranking
Lithuania	0.4647	121	Serbia	0.42985	151
Egypt	0.4601	122	Venezuela (Bolivarian Republic of)	0.42651	152
Armenia	0.45959	123	Iraq	0.42466	153
Syrian Arab Republic	0.45941	124	Bangladesh	0.42338	154
Mali	0.45728	125	Georgia	0.42263	155
Guatemala	0.45697	126	Antigua and Barbuda	0.41837	156
Saint Vincent and the Grenadines	0.45634	127	Madagascar	0.41643	157
Viet Nam	0.4563	128	Benin	0.41601	158
Bolivia	0.45619	129	Guinea-Bissau	0.41249	159
The former Yugoslav Republic of Macedonia	0.4529	130	Niger	0.40979	160
Kazakhstan	0.45086	131	Comoros	0.40775	161
Bhutan	0.45003	132	Central African Republic	0.40675	162
Peru	0.44989	133	Algeria	0.40374	163
Democratic People's Republic of Korea	0.44918	134	Indonesia	0.40071	164
Dominican Republic	0.44752	135	Oman	0.3993	165
Nicaragua	0.4475	136	Cameroon	0.3983	166
Togo	0.44569	137	Yemen	0.39742	167
Nauru	0.44405	138	Gabon	0.39586	168
Morocco	0.4438	139	China	0.39397	169
Haiti	0.4424	140	Mauritania	0.39262	170
Burundi	0.4406	141	Kuwait	0.39176	171
Singapore	0.44053	142	Samoa	0.39126	172
Azerbaijan	0.43896	143	Democratic Republic of the Congo	0.38944	173
Senegal	0.43844	144	Congo	0.38817	174
Papua New Guinea	0.43671	145	Guinea	0.38798	175
Philippines	0.43632	146	Vanuatu	0.3856	176
Sierra Leone	0.43369	147	Sudan	0.38329	177
Jamaica	0.43324	148	Côte d'Ivoire	0.38164	178
Tajikistan	0.43277	149	Liberia	0.37979	179
Nepal	0.43242	150	Fiji	0.37696	180

Member State	Score	ranking
Brunei Darussalam	0.37194	181
Myanmar	0.36618	182
Chad	0.36479	183
Pakistan	0.35813	184
Angola	0.35543	185
Libyan Arab Jamahiriya	0.35341	186
Afghanistan	0.34791	187
Lao People's Democratic Republic	0.34145	188
Nigeria	0.33781	189
Equatorial Guinea	0.32816	190
India	0.317	191
The former state union Serbia and Montenegro	0.30154	192
Somalia	0.29848	193
Montenegro	0.23837	194

## Appendix : The Ranking of all 194 Countries in 2000 by model 2

Member States	Score	Ranking	Member States	Score	Ranking
United States of America	0.67891	1	Palau	0.51552	31
Tuvalu	0.64467	2	South Africa	0.51422	32
Switzerland	0.6398	3	Argentina	0.5117	33
Monaco	0.63618	4	Croatia	0.50539	34
France	0.61115	5	Greece	0.50456	35
Germany	0.61083	6	Kiribati	0.50147	36
Norway	0.61057	7	Uruguay	0.50121	37
Luxembourg	0.58834	8	Suriname	0.49719	38
Austria	0.58789	9	Namibia	0.49515	39
Denmark	0.5863	10	Portugal	0.49493	40
Andorra	0.58228	11	Micronesia (Federated States of)	0.49196	41
Australia	0.57787	12	Haiti	0.48677	42
Japan	0.57604	13	Panama	0.48554	43
Iceland	0.57341	14	Belarus	0.48312	44
Canada	0.56829	15	Malta	0.48208	45
Netherlands	0.56699	16	Paraguay	0.48118	46
United Kingdom	0.56559	17	Zimbabwe	0.48088	47
Ireland	0.55839	18	Lithuania	0.48001	48
Timor-Leste	0.55515	19	Brazil	0.47833	49
Sweden	0.55094	20	Bahamas	0.47348	50
Israel	0.54942	21	Zambia	0.47187	51
Belgium	0.54622	22	Lesotho	0.46982	52
San Marino	0.54375	23	Barbados	0.46749	53
Marshall Islands	0.54317	24	Saudi Arabia	0.4672	54
Italy	0.53294	25	Colombia	0.46658	55
Finland	0.53055	26	Hungary	0.46479	56
Swaziland	0.52596	27	Solomon Islands	0.46427	57
Spain	0.5239	28	Mozambique	0.46385	58
New Zealand	0.52257	29	Russian Federation	0.46376	59
Slovenia	0.52108	30	Niue	0.46357	60

Member States	Score	Ranking	Member States	Score	Ranking
Slovakia	0.46343	61	Vanuatu	0.43197	91
Republic of Korea	0.46326	62	Qatar	0.43196	92
Turkey	0.46172	63	Guyana	0.43179	93
El Salvador	0.45858	64	Bulgaria	0.43136	94
Papua New Guinea	0.45823	65	Singapore	0.43033	95
Mauru	0.45745	66	Kenya	0.42984	96
Lebanon	0.45657	67	Cyprus	0.42946	97
Djibouti	0.45568	68	Montenegro	0.42816	98
Bahrain	0.45562	69	Samoa	0.42752	99
Malawi	0.45557	70	Grenada	0.42729	100
Czech Republic	0.45465	71	Cook Islands	0.42725	101
Gambia	0.45399	72	Cambodia	0.42653	102
Saint Kitts and Nevis	0.45321	73	The former state union Serbia and Montenegro	0.42644	103
Dominican Republic	0.45288	74	Togo	0.42571	104
Uganda	0.45047	75	Estonia	0.42533	105
Dominica	0.4492	76	Eritrea	0.42439	106
Poland	0.44808	77	Ecuador	0.42415	107
Jordan	0.446	78	Costa Rica	0.42343	108
Mongolia	0.4447	79	Guatemala	0.42262	109
Rwanda	0.44457	80	Trinidad and Tobago	0.42191	110
United Arab Emirates	0.44426	81	Cape Verde	0.42187	111
Chile	0.44329	82	Ethiopia	0.42125	112
Ukraine	0.44316	83	Seychelles	0.42076	113
Botswana	0.44208	84	Turkmenistan	0.42051	114
The former Yugoslav Republic of Macedonia	0.44139	85	Albania	0.4195	115
Romania	0.43946	86	Uzbekistan	0.41902	116
Ghana	0.4361	87	Mali	0.41859	117
Sao Tome and Principe	0.4338	88	Republic of Moldova	0.41815	118
Bosnia and Herzegovina	0.4332	89	Philippines	0.4178	119
Chad	0.43198	90	Venezuela (Bolivarian Republic of)	0.4159	120

Member States	Score	Ranking	Member States	Score	Ranking
Bolivia	0.41535	121	Equatorial Guinea	0.39761	151
Thailand	0.41352	122	Cameroon	0.39654	152
Serbia	0.41327	123	Nigeria	0.39643	153
Mauritius	0.41314	124	Mauritania	0.39617	154
United Republic of Tanzania	0.41129	125	Syrian Arab Republic	0.39586	155
Central African Republic	0.41128	126	Madagascar	0.39581	156
Nicaragua	0.41187	127	India	0.39452	157
China	0.41186	128	Niger	0.39391	158
Cuba	0.41108	129	Sierra Leone	0.39356	159
Saint Vincent and the Grenadines	0.41092	130	Tajikistan	0.39331	160
Indonesia	0.40917	131	Malaysia	0.39308	161
Latvia	0.40915	132	Senegal	0.39208	162
Maldives	0.40883	133	Azerbaijan	0.39179	163
Burkina Faso	0.40864	134	Fiji	0.39081	164
Peru	0.40808	135	Nepal	0.38953	165
Bhutan	0.40746	136	Côte d' Ivoire	0.38922	166
Kyrgyzstan	0.40535	137	Viet Nam	0.38909	167
Honduras	0.40509	138	Sudan	0.38832	168
Mexico	0.40377	139	Sri Lanka	0.38792	169
Saint Lucia	0.40321	140	Lao People's Democratic Republic	0.38468	170
Tonga	0.40248	141	Tunisia	0.3832	171
Armenia	0.40079	142	Comoros	0.38011	172
Democratic People's Republic of Korea	0.40073	143	Oman	0.37811	173
Gabon	0.40055	144	Brunei Darussalam	0.37805	174
Iran (Islamic Republic of)	0.39981	145	Antigua and Barbuda	0.37624	175
Jamaica	0.39947	146	Morocco	0.37517	176
Egypt	0.39914	147	Yemen	0.37489	177
Kuwait	0.39875	148	Guinea-Bissau	0.37436	178
Bangladesh	0.39765	149	Pakistan	0.37115	179
Georgia	0.39764	150	Belize	0.37114	180

Member States	Score	Ranking	Member States	Score	Ranking
Liberia	0.37112	181	Democratic Republic of the Congo	0.3549	188
Burundi	0.37026	182	Libyan Arab Jamahiriya	0.35136	189
Guinea	0.36603	183	Congo	0.34653	190
Benin	0.36006	184	Myanmar	0.34382	191
Afghanistan	0.35934	185	Algeria	0.34218	192
Kazakhstan	0.35925	186	Angola	0.33657	193
Somalia	0.35797	187	Iraq	0.32349	194

### Appendix : The Ranking of all 190 Countries in 2000 by the WHO

Member States	Ranking	Member States	Ranking
France	1	Finland	31
Italy	2	Australia	32
San Marino	3	Chile	33
Andorra	4	Denmark	34
Malta	5	Dominica	35
Singapore	6	Costa Rica	36
Spain	7	United States	37
Oman	8	Slovenia	38
Austria	9	Cuba	39
Japan	10	Brunei	40
Norway	11	New Zealand	41
Portugal	12	Bahrain	42
Monaco	13	Croatia	43
Greece	14	Qatar	44
Iceland	15	Kuwait	45
Luxembourg	16	Barbados	46
Netherlands	17	Thailand	47
United Kingdom	18	Czech Republic	48
Ireland	19	Malaysia	49
Switzerland	20	Poland	50
Belgium	21	Dominican Republic	51
Colombia	22	Tunisia	52
Sweden	23	Jamaica	53
Cyprus	24	Venezuela	54
Germany	25	Albania	55
Saudi Arabia	26	Seychelles	56
United Arab Emirates	27	Paraguay	57
Israel	28	South Korea	58
Morocco	29	Senegal	59
Canada	30	Philippines	60

Member States	Ranking	Member States	Ranking
Mexico	61	Lebanon	91
Slovakia	62	Indonesia	92
Egypt	63	Iran	93
Kazakhstan	64	Bahamas	94
Uruguay	65	Panama	95
Hungary	66	Fiji	96
Trinidad and Tobago	67	Benin	97
Saint Lucia	68	Nauru	98
Belize	69	Romania	99
Turkey	70	Saint Kitts and Nevis	100
Nicaragua	71	Moldova	101
Belarus	72	Bulgaria	102
Lithuania	73	Iraq	103
Saint Vincent and the Grenadines	74	Armenia	104
Argentina	75	Latvia	105
Sri Lanka	76	Yugoslavia	106
Estonia	77	Cook Islands	107
Guatemala	78	Syria	108
Ukraine	79	Azerbaijan	109
Solomon Islands	80	Suriname	110
Algeria	81	Ecuador	111
Palau	82	India	112
Jordan	83	Cape Verde	113
Mauritius	84	Georgia	114
Grenada	85	El Salvador	115
Antigua and Barbuda	86	Tonga	116
Libya	87	Uzbekistan	117
Bangladesh	88	Comoros	118
Macedonia	89	Samoa	119
Bosnia-Herzegovina	90	Yemen	120

Member States	Ranking	Member States	Ranking
Niue	121	Kyrgyzstan	151
Pakistan	122	Togo	152
Micronesia	123	Turkmenistan	153
Bhutan	124	Tajikistan	154
Brazil	125	Zimbabwe	155
Bolivia	126	Tanzania	156
Vanuatu	127	Djibouti	157
Guyana	128	Eritrea	158
Peru	129	Madagascar	159
Russia	130	Vietnam	160
Honduras	131	Guinea	161
Burkina Faso	132	Mauritania	162
Sao Tome and Principe	133	Mali	163
Sudan	134	Cameroon	164
Ghana	135	Laos	165
Tuvalu	136	Congo	166
Ivory Coast	137	North Korea	167
Haiti	138	Namibia	168
Gabon	139	Botswana	169
Kenya	140	Niger	170
Marshall Islands	141	Equatorial Guinea	171
Kiribati	142	Rwanda	172
Burundi	143	Afghanistan	173
China	144	Cambodia	174
Mongolia	145	South Africa	175
Gambia	146	Guinea-Bissau	176
Maldives	147	Swaziland	177
Papua New Guinea	148	Chad	178
Uganda	149	Somalia	179
Nepal	150	Ethiopia	180

Member States	Ranking	Member States	Ranking
Angola	181	Liberia	186
Zambia	182	Nigeria	187
Lesotho	183	Democratic Republic of the Congo	188
Mozambique	184	Central African Republic	189
Malawi	185	Myanmar	190