

# Defining Poverty Using Dominance-Based Rough Set Theory and Proposing Strategic Objectives for the United Nations Developing Countries

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## Abstract

This article is the last of a series of three researches. The purpose of this research is to expose the results of using Dominance-based Rough Set Approach (DRSA) to help International organizations (both non-governmental organizations and governmental organizations) define poverty, identifying economical, sociological, political and technological strategic objectives for developing countries. More precisely, politicians, decision makers and international organizations will be able to study 23 various political, economical, sociological and technological indicators and classify all the countries according to the following three different categories: [A] Countries that are doing well according to the selected indicators; [B] Countries that need support to acquire category A status; [C] Countries ranked the lowest and meeting special support with regard to the criterion or criteria considered. The three categories are delimited by tertiles relative to the average ranking of the member states of the United Nations. The chosen criteria are measured in order to provide decision rules based on this classification. These decision rules thus focus on the strategic needs of countries with respect to improving their development and classification. We strongly believe that by targeting these identified needs, this research will help the sustainable development of countries in need to set realistic targets, prioritize International funding, evaluate economical growth and sociological improvements. Among the results of this article, priorities for countries ranked the lowest should focus on reducing adolescent fertility and increasing school life expectancy.

## Keywords

International Development, International Aid, Economic Growth, Strategic

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Objectives, Rough Set Theory, Dominance-Based Rough Set Approach (DRSA), Selection of Portfolio Projects, Multi-Criteria Analysis, Sustainable Development

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## 1. Introduction

This is the last research of a series of three articles using a combination of statistics and DRSA. This systematic approach was used in a first article discussing the classification of all the African countries [1]. The second article used the same methodology but to help potential candidates of the European Union (EU) to determine strategic objectives if they were to join the EU, more precisely the candidate country of Bosnia and Herzegovina [2]. This third article tests the systematic approach at a larger scale using a combination of statistics and DRSA on all the 193 member states of the United Nations.

### 1.1. Poverty Definition

The World Bank estimates that the global poor are living in a rural environment, young, lacking education and with a large family with many children [3]. Economic Poverty is defined as a person living under 1.90 USD per day or suffers an economic deprivation [4]. Sociologists will associate poverty with health, education or safety deprivation. All the member states of the United Nations (UN) have people living in poverty. Some states offer an environment where poverty is more present than other states. The United Nations classifies countries into three categories: Developed economies, economies in transition and developing countries [5]. Several reports will define poverty as the Gross National Income per capita levels for each of those three categories. We intent to use a methodology that is based on statistical data and an operational research methodology named Dominance-based Rough Set to determine this classification and propose to define poverty from four different perspectives: political poverty, economical poverty, sociological poverty and technological poverty.

### 1.2. Dominance-Based Rough Set

A bunch of artificial intelligence tools and algorithms exist in order to help decision makers and leaders defining strategy and courses of action. One of them is the Rough set theory, which was developed by Pawlak [6] [7] and by Pawlak and Slowinski [8]. It is a mathematical tool that is used to support decision-making processes in fields such as medicine, banking, engineering, learning, location selection, pharmacology, finance, market analysis and economics [9]-[17]. It was later modified by Greco, Matarazo and Slowinski [10] and renamed the “Dominance-based Rough Set Approach” (DRSA). And then, Zaras developed it for mixed data (deterministic, probabilistic and fuzzy) [11]. Because of its advantage of sorting decision rules explaining the classification of objects, this research uses DRSA. The purpose is one of developing sound strategic objectives for all

Third world countries in order to help decision makers, leaders, non-governmental organizations, help funds and other international organization or interest groups target specific objectives to improve the economical, political, sociological and technological situation of the Third world. A total of 23 indicators were selected by experts and categorized in four different perspectives (Political, Economical, Sociological and Technological).

Section 2 presents the statistical analysis which is a list of all the significant correlations between all the indicators classified per perspectives (PEST). Section 3 shows the application of DRSA to classify all the countries member of the United Nations, with regard to the perspectives (PEST) and explains the decision rules for each category (countries classified as: A, B and C). Section 4 proposes a strategy map for each individual country, proposing strategic objectives and performance measures to improve and monitor the sustainable development of all the selected Third world countries.

## 2. Political, Economical, Sociological and Technological Indicators

The 23 variables considered in this research were obtained from the World Bank, the United Nations and the International Institute for Strategic Studies [18] [19] [20]. The 23 variables were then classified into four perspectives, political, economical, sociological and technological (PEST) as summarized in **Table 1** where variables definitions are presented as well for the year of data collection in parentheses. Indicators are also summarized, with scales from 1 - 5, 1 - 7 or 0 - 100. Other indicators are US\$, percentages or number of years.

### 2.1. Portrait of the World in 2017

#### 2.1.1. Statistics

Researching the numerous databases presented earlier, we were able to calculate each indicator for all the member states of the United Nations.

Since correlation is defined as a measure of the linear relationship between variables [21], the research of relationship between variables could help determine the relationships between the various perspectives (PEST).

**Appendix A** presents the correlation matrix. All correlations presented in this research are significant at the 0.01 level (2-tailed).

#### 2.1.2. Relationship between the Various Indicators

Testing for significant relationship between the various indicators according to:

Null Hypothesis 0: There is no relation between the two indicators.

Alternative Hypothesis 1: There is relation between the two indicators.

Then, after reviewing the data, we reject or not the null hypothesis 0.

#### 2.1.3. Relationship between the Variables and Various Perspectives

**Table 2-5** are summaries of all the correlations between a selected perspective and the other variables. It is important to mention that the positive and negative signs in parenthesis explains if there is a positive or negative correlation between

**Table 1.** Summary of the PEST indicators considered in this research.

<b>Perspectives and Measurement</b>	<b>Definitions</b>	<b>Indicators</b>	<b>↑ = High is better ↓ = Low is better</b>
<b>Political</b>			
1.1 Political Stability Index	Political instability within a specific country (2017)	Scale 1-5	↓
1.2 Deaths From Internal Conflict	Number of battle deaths from internal conflict between at least one government armed forces (2017).	Scale 1-5	↓
1.3 Military Expenditure	Cash outlays of central or federal government to meet the costs of national armed forces (2017).	Scale 1-5	↓
1.4 Corruption Perception Index	A ranking of countries according to the extent to which corruption is believed to exist (2017).	Scale 0-100	↑
1.5 Global Competitiveness Index	Competitiveness along various pillars (2017).	Scale 1-7	↑
1.6 Ease of Doing Business Index	Ease of doing business index (2017).	Ranking	↓
<b>Economical</b>			
2.1 RNN per Capita	Adjusted net national income per capita (Current USD)	\$	↑
2.2 GNP Per Capita	Gross National Product (USD Constant 2016) divided per capita.	\$	↑
2.3 GNI Per Capita	Gross National Income per capita Atlas method (Current USD 2017).	\$	↑
2.4 Unemployment	Unemployment, total (% of labor force 2017).	%	↓
2.5 Exports of G&S	Exports of goods and services (% of GNP 2017).	%	↑
2.6 Exports of Merchandise	Exports of merchandise per capita (USD 2017).	%	↑
<b>Sociological</b>			
3.1 Life Expectancy Female	Life expectancy at birth, female (years 2017).	Number of years	↑
3.2 Life Expectancy Male	Life expectancy at birth, male (years 2017).	Number of years	↑
3.3 School Life	School life expectancy (2017).	Number of years	↑
3.4 Urban Population	Percentage of urban population (2018).	%	↑
3.5 Adolescent Fertility	Number of births per 1000 women ages 15 - 19 (2017).	Number	↓
3.6 Homicides	Intentional homicide refers to death deliberately inflicted on a person by another person (2017).	Scale 1-5	↓
<b>Technological</b>			
4.1 Academic Papers	Number of scientific published papers per capita (2017).	Number	↑
4.2 Internet Users	Individuals using the internet (2017)	Number	↑
4.3 Fixed Internet	Fixed broadband internet subscriptions per 100 people (2017).	Number	↑
4.4 Secure Internet	Secure internet servers per million people (2017).	Number	↑
4.5 Mobile Phones	Mobile cellular subscription per 100 people (2017).	Number	↑

the indicators. It does not correspond to the positiveness or negativeness of the correlation. For example, a smaller Political Stability Index is better for any country. Therefore, this indicator is positively correlated to the indicator “Deaths From Internal Conflicts” since this one is also better when the Index is smaller. It is important to mention that exportation of merchandise (% of GDP) is not correlated to any of the selected indicators.

Analyzing the correlation matrix helps determine that is plausible that:

1) RNN per capita is positively correlated to the corruption index, global competitiveness index, GNI per capita, GNP per capita, exports of goods and services, life expectancy for both women and men, school life, urban population and all the technological indicators. It is negatively correlated to the political stability index, deaths from internal conflicts, ease of doing business, unemployment, adolescent fertility and the homicides index.

2) GNP per capita is positively correlated to the corruption perception index, global competitiveness index, RNN per capita, GNI per capita, exports of goods and services, life expectancy for both women and men, school life, urban population and all the technological indicators. GNP per capita is negatively correlated to the political stability index, deaths from internal conflicts, ease of doing business, adolescent fertility and the homicides index.

3) GNI per capita is positively correlated to the corruption perception index, global competitiveness index, RNN per capita, GNP per capita, exports of goods and services, life expectancy for both women and men, school life, urban population and all the technological indicators. GNI per capita is negatively correlated to the political stability index, ease of doing business, adolescent fertility and the homicides index.

4) Unemployment is negatively correlated to the global competitiveness index and RNN per capita.

5) Exports of goods and services is positively correlated to the corruption perception index, global competitiveness index, RNN per capita, GNP per capita, GNI per capita, life expectancy for both women and men, school life, urban population and all the technological indicators. Exports of goods and services is negatively correlated to the political stability index, deaths from internal conflicts index, ease of doing business, adolescent fertility and homicides index.

**Table 2** is a summary of all the correlations for the Economical perspective.

**Table 3** is a summary of all the correlations for the Sociological perspective.

Using the correlation matrix, it is plausible that:

1) Life expectancy for women and men are both positively correlated to the corruption perception index, global competitiveness index, RNN per capita, GNP per capita, GNI per capita, exports of goods and services, life expectancy for men, school life, urban population and all the technological indicators. Life expectancy for women is negatively correlated to the political stability index, deaths from internal conflicts, ease of doing business, adolescent fertility and the homicides index.

2) School life is positively correlated to the corruption perception index, global competitiveness index, RNN per capita, GNP per capita, GNI per capita, exports of goods and services, life expectancy for both women and men, urban population and all technological indicators. School life is negatively correlated to the political stability index, deaths from internal conflicts, ease of doing business, adolescent fertility and the homicides index.

**Table 2.** Economical Perspective correlations.

Economical Perspective	Political	Other Economical	Sociological	Technological
2.1 RNN per Capita	(+) Corruption Perception Index (+) Global Competitive. Index (-) Political Stability Index (-) Deaths from Internal Conflicts (-) Ease of Doing Business	(+) GNP Per Capita (+) GNI Per Capita (+) Exports of G&S (-) Unemployment	(+) Life Exp. Women (+) Life Exp. Men (+) School Life (+) Urban Pop. (-) Adolescent Fertility (-) Homicides	(+) All Technological Indicators
2.2 GNP Per Capita	(+) Corruption Perception Index (+) Global Competitive. Index (-) Political Stability Index (-) Deaths from Internal Conflicts (-) Ease of Doing Business	(+) RNN Per Capita (+) GNI Per Capita (+) Exports of G&S	(+) Life Exp. Women (+) Life Exp. Men (+) School Life (+) Urban Pop. (-) Adolescent Fertility (-) Homicides	(+) All Technological Indicators
2.3 GNI Per Capita	(+) Corruption Perception Index (+) Global Competitive. Index (-) Political Stability Index (-) Ease of Doing Business	(+) RNN Per Capita (+) GNP Per Capita (+) Exports of G&S	(+) Life Exp. Women (+) Life Exp. Men (+) School Life (+) Urban Pop. (-) Adolescent Fertility (-) Homicides	(+) All Technological Indicators
2.4 Unemployment	(-) Global Competitive. Index	(-) RNN Per Capita		
2.5 Exports of G&S	(+) Corruption Perception Index (+) Global Competitive. Index (-) Political Stability Index (-) Deaths from Internal Conflicts (-) Ease of Doing Business	(+) RNN Per Capita (+) GNP Per Capita (+) GNI Per Capita	(+) Life Exp. Women (+) Life Exp. Men (+) School Life (+) Urban Pop. (-) Adolescent Fertility (-) Homicides	(+) All Technological Indicators

3) The percentage of a state's urban population is positively correlated to the corruption perception index, global competitiveness index, RNN per capita, GNP per capita, GNI per capita, exports of goods and services, life expectancy for both women and men, school life and all the technological indicators. Urban population percentages are negatively correlated to the political stability index, ease of doing business index, adolescent fertility and the homicides index.

4) Adolescent fertility per 1000 girls is positively correlated to the political stability index, ease of doing business and the homicides index. Adolescent fertility is negatively correlated to the corruption perception index, global competitiveness index, RNN per capita, GNP per capita, GNI per capita, exports of goods and services, life expectancy for both women and men, school life in years, urban population and all the technological indicators.

5) Homicides index is positively correlated to political stability index, ease of doing business, adolescent fertility. Homicides index is negatively correlated to the corruption perception index, global competitiveness index, RNN per capita, GNP per capita, GNI per capita, exports of goods and services, life expectancy for both women and men, school life, urban population percentages and all the technological indicators.

**Table 4** is a summary of all the correlations for the political perspective.

**Table 3.** Sociological Perspective correlations.

Sociological Perspective	Political	Economical	Other Sociological	Technological
3.1 Life Expectancy Female	(+) Corruption Perception Index (+) Global Competitive. Index (-) Political Stability Index (-) Deaths from Internal Conflicts (-) Ease of Doing Business	(+) RNN Per Capita (+) GNP Per Capita (+) GNI Per Capita (+) Exports of G&S	(+) Life Exp. Men (+) School Life (+) Urban Pop. (-) Adolescent Fertily (-) Homicides	(+) All Technological Indicators
3.2 Life Expectancy Male	(+) Corruption Perception Index (+) Global Competitive. Index (-) Political Stability Index (-) Deaths from Internal Conflicts (-) Ease of Doing Business	(+) RNN Per Capita (+) GNP Per Capita (+) GNI Per Capita (+) Exports of G&S	(+) Life Exp. Women (+) School Life (+) Urban Pop. (-) Adolescent Fertily (-) Homicides	(+) All Technological Indicators
3.3 School Life	(+) Corruption Perception Index (+) Global Competitive. Index (-) Political Stability Index (-) Deaths from Internal Conflicts (-) Ease of Doing Business	(+) RNN Per Capita (+) GNP Per Capita (+) GNI Per Capita (+) Exports of G&S	(+) Life Exp. Women (+) Life Exp. Men (+) Urban Pop. (-) Adolescent Fertily (-) Homicides	(+) All Technological Indicators
3.4 Urban Population	(+) Corruption Perception Index (+) Global Competitive. Index (-) Political Stability Index (-) Ease of Doing Business	(+) RNN Per Capita (+) GNP Per Capita (+) GNI Per Capita (+) Exports of G&S	(+) Life Exp. Women (+) Life Exp. Men (+) School Life (-) Adolescent Fertily (-) Homicides	(+) All Technological Indicators
3.5 Adolescent Fertility	(+) Political Stability Index (+) Ease of Doing Business (-) Corruption Perception Index (-) Global Competitive. Index	(-) RNN Per Capita (-) GNP Per Capita (-) GNI Per Capita (-) Exports of G&S	(+) Homicides (-) Life Exp. Women (-) Life Exp. Men (-) School Life (-) Urban Pop.	(-) All Technological Indicators
3.6 Homicides	(+) Political Stability Index (+) Ease of Doing Business (-) Corruption Perception Index (-) Global Competitive. Index	(-) RNN Per Capita (-) GNP Per Capita (-) GNI Per Capita (-) Exports of G&S	(+) Adolescent Fertility (-) Life Exp. Women (-) Life Exp. Men (-) School Life (-) Urban Pop.	(-) All Technological Indicators

**Table 5** is a summary of all the correlations for the Technological perspective.

### 3. The Dominance-Based Rough Set Approach (DRSA) Applied to Estimate the Strategic Developmental Goals of All the United Nations States

#### 3.1. Description

This section develops the application of the Dominance-based Rough Set Approach (DRSA) in order to determine the strategic objectives of each United Nations countries and improve their overall classification. First step is to classify all the Countries per perspectives in category A, B or C: Category [A] Countries that are doing well according to the selected indicators; [B] Countries that need support to acquire category A status; [C] Countries ranked the lowest and meeting special support with regard to the criterion or criteria considered. **Appendix B** presents the overall evaluation of all the United Nations countries with respect to the four conditional criteria as determined on the basis of each perspective



**Table 4.** Political perspective correlations.

Political Perspective	Other Political	Economical	Sociological	Technological
1.1 Political Stability Index	(+) Deaths From Internal Conflict		(+) Adolescent Fertility	
	(+) Military Expenditure	(-) RNN Per Capita	(+) Homicides	
	(+) Ease of Doing Business	(-) GNP Per Capita	(-) Life Exp. Women	(+) All technological Indicators
	(-) Corruption Perception Index	(-) GNI Per Capita	(-) Life Exp. Men	
	(-) Global Competitive. Index	(-) Exports G&S	(-) School Life	
1.2 Deaths From Internal Conflict	(-) Global Competitive. Index		(-) Urban Pop.	
	(+) Political Stability	(-) RNN Per Capita	(-) Life Exp. Women	(-) Academic Papers
	(+) Military Expenditure	(-) GNP Per Capita	(-) Life Exp. Men	(-) Internet Users
	(+) Ease of Doing Business	(-) Exports G&S	(-) School Life	(-) Fixed Internet
	(-) Corruption Index			(-) Mobile Phones
1.3 Military Expenditure	(+) Political Stability			
	(+) Deaths From Internal Conflicts			
	(+) Ease of Doing Business			
1.4 Corruption Perception Index	(+) Global Competitive. Index	(+) RNN Per Capita	(+) Life Exp. Women	
	(-) Political Stability	(+)GNP Per Capita	(+) Life Exp. Men	(+) All Technological Indicators
	(-) Deaths From Internal Conflicts	(+) GNI Per Capita	(+) School Life	
	(-) Ease of Doing Business Index	(+) Exports G&S	(+) Urban Pop.	
			(-) Adolescent Fertility	
1.5 Global Competitive. Index			(-) Homicides	
	(+) Corruption Perception Index	(+) RNN Per Capita	(+) Life Exp. Women	
	(-) Political Stability Index	(+) GNP Per Capita	(+) Life Exp. Men	
	(-) Ease of Doing Business Index	(+) GNI Per Capita	(+) School Life	(+) All Technological Indicators
		(+) Exports G&S	(+) Urban Pop.	
1.6 Ease of Doing Business Index		(-) Unemployment	(-) Adolescent Fertility	
	(+) Political Stability Index	(-) RNN Per Capita	(+) Adolescent Fertility	
	(+) Deaths From Internal Conflicts	(-) GNP Per Capita	(+) Homicides	(-) All Technological Indicators
	(+) Military Expenditure	(-) GNI Per Capita	(-) Life Exp. Women	
	(-) Corruption Perception Index	(-) Exports G&S	(-) Life Exp. Men	
	(-) Ease of Doing Business		(-) School Life	
			(-) Urban Pop.	

(PEST) and with respect to the decisional criterion. **Table 6** is a summary of all the classifications per Continent and Sub-Regions. Second step is to extract decision rules for all the variables on a first time, and on a second time individually on each perspective (PEST). Third step, for each country, we could determine and prioritize its strategic objectives with regard to their respective variables and values.

**Table 6** demonstrates each continent separately, their sub-regions (if required) and the number of countries per classification. Finally, the last column explains the number of people per sub-region and the percentage of the population compared to the world's population.

### 3.2. Formulation of the Multi-Criteria Problems

The ranking of the 193 countries members of the United Nations was performed on the basis of the 23 criteria measured by 23 indicators. The same was also done for each perspective on the basis of each respective criteria. That kind of problem can be represented using the AXE model, where:



**Table 5.** Technological perspectives correlations.

Technological Perspective	Political	Economical	Sociological	Other Technological
4.1 Academic Papers	(+) Political Stability Index (+) Corruption Perception Index (+) Global Competitive. index (-) Deaths from Internal Conflicts (-) Ease of Doing Business	(+) RNN Per Capita (+) GNP Per Capita (+) GNI Per Capita (+) Exports of G&S	(+) Life Exp. Women (+) Life Exp. Men (+) School Life (+) Urban Pop. (-) Adolescent Fertility (-) Homicides	(+) Internet Users (+) Fixed Internet (+) Secure Internet (+) Mobile Phones
4.2 Internet Users	(+) Political Stability Index (+) Corruption Perception Index (+) Global Competitive. index (-) Deaths from Internal Conflicts (-) Ease of Doing Business	(+) RNN Per Capita (+) GNP Per Capita (+) GNI Per Capita (+) Exports of G&S	(+) Life Exp. Women (+) Life Exp. Men (+) School Life (+) Urban Pop. (-) Adolescent Fertility (-) Homicides	(+) Academic Papers (+) Fixed Internet (+) Secure Internet (+) Mobile Phones
4.3 Fixed Internet	(+) Political Stability Index (+) Corruption Perception Index (+) Global Competitive. index (-) Deaths from Internal Conflicts (-) Ease of Doing Business	(+) RNN Per Capita (+) GNP Per Capita (+) GNI Per Capita (+) Exports of G&S	(+) Life Exp. Women (+) Life Exp. Men (+) School Life (+) Urban Pop. (-) Adolescent Fertility (-) Homicides	(+) Academic Papers (+) Internet Users (+) Secure Internet (+) Mobile Phones
4.4 Secure Internet	(+) Political Stability Index (+) Corruption Perception Index (+) Global Competitive. index (-) Ease of Doing Business	(+) RNN Per Capita (+) GNP Per Capita (+) GNI Per Capita (+) Exports of G&S	(+) Life Exp. Women (+) Life Exp. Men (+) School Life (+) Urban Pop. (-) Adolescent Fertility (-) Homicides	(+) Academic Papers (+) Internet Users (+) Fixed Internet
4.5 Mobile Phones	(+) Political Stability Index (+) Corruption Perception Index (+) Global Competitive. index (-) Deaths from Internal Conflicts (-) Ease of Doing Business	(+) RNN Per Capita (+) GNP Per Capita (+) GNI Per Capita (+) Exports of G&S	(+) Life Exp. Women (+) Life Exp. Men (+) School Life (+) Urban Pop. (-) Adolescent Fertility (-) Homicides	(+) Academic Papers (+) Internet Users (+) Fixed Internet

$A$  is a finite set of countries  $a_i$  for  $i = 1, 2 \dots 193$ ;

$X$  is a finite set of criteria  $X_k$  for  $k = 1, 2, \dots, 23$  or  $X_{kj}$  for  $k_j = 1, 2, \dots, n_j$  for each perspective  $j$ .

$E$  is the set of evaluations measured by indicators  $e_{ik}$  with respect to criterion  $X_k$  or indicators  $e_{ikj}$  with respect to criterion  $X_{kj}$  for each perspective  $j$ .

Since the weights of indicators are assumed equal, we performed the weighted average rank method in order to rank countries. In fact, the countries are ranked from the most to the least preferable in terms of each indicator in relation to each criterion. Calculation for each country of its weighted average rank were performed to obtain the rating of the countries with respect to a given perspective but also on overall classification of the 23 criteria.

For each perspective  $j$ , the weighted average of country  $i$ ,

$$r_{ij} = \sum_{kj} w_{kj} r_{kij} \tag{1}$$

The overall weighted average of country  $i$ ,

$$r_i = \sum_k w_k r_{ki} \tag{2}$$

**Table 6.** Classifications per region.

Continents	Sub-Region	Classified A	Classified B	Classified C	Region total and % of world population
<b>Europe</b>	(Including Russia)	38	10	0	<b>Europe Total</b>
	Population per 1000	542,422.03	294,411.38	0	836,833.41
	Population %	64.81%	35.19%	0	11.32%
<b>Asia</b>	<b>South East Asia</b>	3	5	3	<b>South East Asia Total</b>
	Population per 1000	37,217.74	529,136.93	75,405.94	641,760.61
	Population %	5.8%	82.45%	11.75%	8.68%
	<b>East Asia</b>	2	2	1	<b>East Asia Total</b>
	Population per 1000	178,240.22	1,381,692.40	25,368.62	1,585,301.24
	Population %	11.24%	87.16%	1.6%	21.44%
	<b>Middle East</b>	7	3	3	<b>Middle East Total</b>
	Population per 1000	62,562.61	95,739.9	83,217.23	241,519.74
	Population %	25.9%	39.64%	34.46	3.27%
	<b>South Asia</b>	0	4	4	<b>South Asia Total</b>
	Population per 1000	0	1,346,599.87	385,137.81	1,731,737.68
	Population %	0	77.76%	22.24%	23.42%
	<b>Central Asia</b>	0	1	4	<b>Central Asia Total</b>
	Population per 1000	0	17,794.4	52,324.89	70,119.29
	Population %		25.38%	74.62%	0.95%
<b>America</b>	<b>North America</b>	2	1	0	<b>N. America Total</b>
	Population per 1000	359,392.11	127,540.42	0	486,932.53
	Population %	73.81%	26.19%	0	6.59%
	<b>Central America</b>	2	5	0	<b>Central America Total</b>
	Population per 1000	8891.39	38,556.94	0	47,448.33
	Population %	18.7%	81.3%	0	0.64%
	<b>South America</b>	3	8	1	<b>S. America Total</b>
	Population per 1000	65,201.19	354,204.93	773.3	420,179.42
	Population %	15.52%	84.3%	0.18%	5.68%
	<b>Caribbean Islands</b>	4	8	1	<b>Caribbean I. Total</b>
Population per 1000	850.73	26,820.88	10,847.33	38,518.94	
Population %	2.21%	69.63%	28.16%	0.52%	
<b>Africa</b>	<b>East Africa</b>	1	1	16	<b>East Africa Total</b>
	Population per 1000	1263.47	94.68	404,608.08	405,966.23
	Population %	0.31%	0.02%	99.64%	5.49%
	<b>Southern Africa</b>	0	3	2	<b>Southern Africa Total</b>
	Population per 1000	0	60,745.44	3546.92	64,292.36
Population %	0	94.48%	5.52%	0.87%	

Continued

	<b>North Africa</b>	0	3	3	<b>North Africa Total</b>
	Population per 1000	0	87,286.09	141,560.76	228,846.85
	Population %	0	38.14%	61.86%	3.09%
	<b>West Africa</b>	0	2	14	<b>West Africa Total</b>
	Population per 1000	0	28,746.29	333,451.25	362,197.54
	Population %	0	7.94%	92.06%	4.9%
	<b>CentralAfrica</b>	0	1	8	<b>Central Africa Total</b>
	Population per 1000	0	1979.79	156,583.18	158,562.97
	Population %	0	1.25%	98.75%	2.14%
<b>Oceania/Australia</b>	<b>Oceania</b>	2	7	5	<b>Oceania Total</b>
	Population per 1000	28,904.01	1299.73	9174.14	39,377.88
	Population %	73.4%	3.3%	23.3%	0.53%
<b>World</b>	Population per 1000	1,284,945.5	4,392,650.07	1,716,655.48	7,394,251.05
<b>World</b>	Population %	17.38%	59.41%	23.21%	100%

where:

$w_k$  is the weight of criterion  $k$  and  $w_{kj}$  for perspective  $j$ ;

$r_{ki}$  is a rank of country  $i$  with respect to criterion  $k$  and  $r_{kij}$  for perspective  $j$ .

With the obtained ranking of 193 countries, overall and for each perspective, countries were classified into three categories A, B and C (**Appendix B**).

In rough set theory, the decision problem is represented as a table, the rows corresponding to objects and the columns to attributes (see **Table 7**). In our approach, the objects are the countries and we used two types of attributes: conditional and decisional. In according to ranking obtained by using multi-criteria method we classified countries to three categories A, B and C. The decision in the decision table with respect to the decisional attribute takes one of three values: Country belongs to the category A, B or C.

The remaining attributes will be called conditionals and these will be from our multi-criteria AXE problem (the  $n_j$  criteria, in the case of overall classification 23 criteria). With respect to each conditional attribute, the evaluation of the country takes the value of the indicator  $e_{kij}$  in relation to each criterion  $k$ .

Based on the approximations obtained by means of the dominance relations, it is possible using DRSA methodology to derive a generalized description of the preferential information contained in the decision table, in terms of decision rules.

### 3.3. The Decision Rules

Decision rules were extracted using the 4eMka2 software [22], developed by the intelligent decision support systems laboratory (IDSS) at the computing science institute of the Poznan University of Technology. **Table 8** presents the combination of decision rules for all the perspectives combined and **Table 9** presents

**Table 7.** Decision table for perspective  $j$ .

	$X_j$	...	$X_{n_j}$	D
$H_A$	$e[(a_{ieA}), 1]$	...	$e[(a_{ieA}), n_j]$	$e[(a_{ieA}), d] = A$
...	...	...	...	...
$H_B$	$e[(a_{ieB}), 1]$	...	$e[(a_{ieB}), n_j]$	$e[(a_{ieB}), d] = B$
...	...	...	...	...
$H_C$	$e[(a_{ieC}), 1]$	...	$e[(a_{ieC}), n_j]$	$e[(a_{ieC}), d] = C$

**Table 8.** Decision Rules for the all the perspectives combined.

#	Decision Rules	Condition 1	Condition 2	Condition 3	Condition 4
1	Decision $\geq A$	GNP per capita $\geq 17070.96\$$	Life expectancy for men $\geq 71.4$ years		
2	Decision $\geq B$	Life expectancy for men $\geq 70.63$ years			
3	Decision $\geq B$	Exports of goods & services $\geq 42.23\%$ of GDP	Ease of doing business Index $\leq 121$	Exports of Merchandise $\geq 556.31\$$ per capita	GNP per capita $\geq 2905.86\$$
4	Decision $\geq B$	Military exp. $\leq 1.4\%$ of GDP	Individuals using the internet $\geq 46.51\%$		
5	Decision $\leq C$	GNP per capita $\leq 917.56\$$			
6	Decision $\leq C$	Secure Internet $\leq 5.2$ per million	Homicides $\geq 2.03$		
7	Decision $\leq C$	Corruption Perception Index $\leq 28$	GNP per capita $\leq 1642.73\$$		

each combination of decision rules for each perspective individually. It is important to mention that all the rules that are presented have a minimum relative strength of 20% and limited to 4 conditional criteria.

#### 4. Identification of Poverty and Strategic Objectives

The concrete application of the decision rules is enlighten in this section thought the identification of conditions of the countries classified as [C] Countries ranked the lowest and meeting special support. The decision rules also may reveal specific targets to obtain in order for a state classified as C to be able to develop strategic objectives to improve their development towards the classification B and A. Decision rules  $\leq C$  identifies the conditions for poverty and decision rules  $\geq B$  and A determine what needs to be accomplish for a country categorized as C to improve it's ranking to B or A. These decision rules may be transformed into targets and strategic objectives. It is important to mention that some countries classified as C or B may meet some conditions already and should focus on the conditions they do not meet. Each state has to determine their own priorities.

##### 4.1. Poverty Defined When All Perspectives Are Combined

Decision rules 5, 6 and 7 help us determine poverty when all indicators and perspectives are combined. Therefore, for all the states within the United Nations, these are the following decision rules and conditions for poverty:

**Table 9.** Decision rules for each perspective individually.

#	Decision Rules	Condition 1	Condition 2	Condition 3	Condition 4
<b>Political Perspective</b>					
8	Decision $\geq$ A	Conflict $\leq$ 1			
9	Decision $\leq$ C	Conflict $\geq$ 1.26	Military exp. $\geq$ 2.18% of GNP		
10	Decision $\leq$ C	Conflict $\geq$ 1.26	Competitive. Index $\leq$ 4.35		
<b>Economical Perspective</b>					
11	Decision $\geq$ A	GNP Per Capita $\geq$ 14,465.13\$	Exports of Merchandise Per Capita $\geq$ 1780.27\$	Unemployment $\leq$ 12.6%	Exports of G & S $\leq$ 26.39%
12	Decision $\geq$ A	GNP Per Capita $\geq$ 7967.71\$	Unemployment $\leq$ 6%	Exports of Merchandise Per Capita $\geq$ 1780.27\$	Exports of G & S $\leq$ 38.16%
13	Decision $\geq$ A	GNP Per Capita $\geq$ 31,532.82\$	Exports of Merchandise Per Capita $\geq$ 12602.82\$	Exports of G & S $\geq$ 32.95%	RNN Per Capita $\geq$ 6894.29\$
14	Decision $\geq$ A	Exports of G & S $\geq$ 49.57%	Exports of Merchandise Per Capita $\geq$ 6544.18\$	GNP Per Capita $\geq$ 8108.24\$	Unemployment $\leq$ 8.9%
15	Decision $\geq$ B	GNP Per Capita $\geq$ 3582.65\$	Exports of Merchandise Per Capita $\geq$ 294.25\$	Exports of G & S $\geq$ 21.31%	RNN Per Capita $\geq$ 1735.74\$
16	Decision $\geq$ B	Unemployment $\leq$ 9.1%	GNP Per Capita $\geq$ 1642.73\$	Exports of Merchandise Per Capita $\geq$ 155.36\$	Exports of G & S $\geq$ 11.89%
17	Decision $\geq$ B	GNP Per Capita $\geq$ 10826.27\$	Exports of Merchandise Per Capita $\geq$ 1776.77\$	Unemployment $\leq$ 13.14%	
18	Decision $\leq$ C	GNP Per Capita $\leq$ 738.64\$	Exports of Merchandise Per Capita $\leq$ 200.74\$		
<b>Sociological Perspective</b>					
19	Decision $\geq$ A	Urban Population $\geq$ 89.55%	Life Exp. Men $\geq$ 73.68 years	School Life $\geq$ 11 years	
20	Decision $\geq$ B	Life Exp. Women $\geq$ 69.43 years	Urban Population $\geq$ 33.14%	Homicides Index $\leq$ 2.6	Adolescent Fert. $\leq$ 64.27 per 1000
21	Decision $\geq$ B	Urban Population $\geq$ 55.03%	Life Exp. Men $\geq$ 65.09 years		
22	Decision $\geq$ B	School Life $\geq$ 15 years	Life Exp. Women $\geq$ 76.9 years	Adolescent Fert. $\leq$ 39.44 per 1000	Urban Population $\geq$ 31.42%
23	Decision $\leq$ C	Life Exp. Women $\leq$ 68.79 years	Urban Population $\leq$ 59.79%	School Life $\leq$ 13 years	
24	Decision $\leq$ C	Urban Population $\leq$ 35.04%	School Life $\leq$ 10 years	Adolescent Fert. $\geq$ 42.75 per 1000	
<b>Technological Perspective</b>					
25	Decision $\geq$ A	Internet Users $\geq$ 80.48%	Secure Internet $\geq$ 186.79 per million	Academic Papers $\geq$ 18.05 per million	
26	Decision $\geq$ A	Fixed Internet $\geq$ 27.65 per 100	Cellular Sub. $\geq$ 112.76 per 100	Secure Internet $\geq$ 186.79 per million	
27	Decision $\geq$ A	Cellular Sub. $\geq$ 144.23 per 100	Secure Internet $\geq$ 186.79 per million		
28	Decision $\geq$ A	Fixed Internet $\geq$ 31.82 per 100	Academic Papers $\geq$ 262.19 per million	Cellular Sub. $\geq$ 109.09 per 100	Secure Internet $\geq$ 381.03 per million

**Continued**

29	Decision $\geq$ B	Secure Internet $\geq$ 190.36 per million	Cellular Sub. $\geq$ 102.98 per 100		
30	Decision $\geq$ B	Secure Internet $\geq$ 226.19 per million	Fixed Internet $\geq$ 6.19 per 100	Cellular Sub. $\geq$ 63.87 per 100	
31	Decision $\leq$ C	Secure Internet $\leq$ 3.4 per million	Internet Users $\leq$ 31.87%		
32	Decision $\leq$ C	Fixed Internet $\leq$ 2.79 per 100	Academic Papers $\leq$ 5.71 per million	Cellular Sub. $\leq$ 124.94 per 100	Secure Internet $\leq$ 62.87 per million
33	Decision $\leq$ C	Cellular Sub. $\leq$ 76.37 per 100	Fixed Internet $\leq$ 0.54 per 100	Secure Internet $\leq$ 15.64 per million	

- 1) The Gross National Product is equal or lower than 917.56\$ per capita;
- 2) The number of secure internet servers is equal or smaller than 5.2 per million users and the conflict index, which represents the number of battle deaths from internal conflict between at least one government armed forces is equal or greater than 2.03; and
- 3) The corruption perception index is equal or lower than 28 with a GNP equal or lower than 1642.73\$ per capita.

#### 4.2. Political Poverty

Decision rules 9 and 10 dictate what the conditions for political poverty are:

- 1) Conflict index, is equal or larger than 1.26 combined with military expenditures in % of GDP equal or larger than 2.18%; and
- 2) Conflict index same as the first example (1.26) combined with the global competitiveness index equal or lower than 4.35.

#### 4.3. Economical Poverty

Decision rule 18 dictates that economical poverty can be defined as these following sets of conditions:

- 1) GNP per capita is equal or lower than 738.64\$ (USD) per capita combined with exports of merchandise per capita equal or lower than 200.74\$.

#### 4.4. Sociological Poverty

Decision rules 23 and 24 give us the sets of conditions for sociological poverty:

- 1) Life expectancy for women equal or less than 68.79 years, urban population is equal or less than 59.79% of the entire population of the state and school life expectancy is equal or less than 13 years; and
- 2) Urban population is equal or less than 35.04%, school life expectancy is equal or less than 10 years and with an adolescent fertility equal or over 42.75 birth per 1000.

It is important to state that the sociological perspective has three core attributes that impact the most the classification of the states: School life expectancy, % of urban population and adolescent fertility index per 1000.

#### 4.5. Technological Poverty

Decision rules 31, 32 and 33 define technological poverty with the following conditions:

- 1) The number of secure internet servers is equal or smaller than 3.2 per million users and the number of internet user is equal or smaller than 31.87% of the population;
- 2) Fixed broadband internet is equal or less than 2.79 per 100 people, production of academic papers is equal or less than 5.71 articles per million people, cellular subscriptions is equal or less than 124.94 per 100 people and secure internet servers is equal or less than 62.87 per million people; and
- 3) Cellular phones subscriptions is equal or less than 76.37 per 100 people, fixed broadband internet is equal or less than 0.54 per 100 people and secure internet servers is equal or less than 15.64 per million people.

#### 4.6. Strategic Objectives and Targets

Several of the indicators selected are results. For example, GNP per capita cannot be increased or decreased voluntarily and decision makers have no or very little power in influencing the results. Other indicators, such as school life expectancy, adolescent fertility, corruption perception index, military expenditures and the number of academic papers are indicators where decision makers may influence by changing policies, targeting funding or creating programs to educate the population with regards to these factors. As proved with the correlation matrix, since economical and technological indicators are correlated with sociological and political indicators, it is plausible to set objectives with specific targets for each country categorized as C and dictate what needs to be done to improve their situation. All the decision rules equal or greater than A and decision rules equal or greater than B may be either used for prediction or transformed into strategic objectives with specific targets for each country. As an example, we selected randomly a country classified as C, the state of Cambodia. Again, any country in category C should have interest to reach the threshold pointed out in decision rules in order to reach category B or even A. However, their improvement objectives would be different since their actual performance is different. **Table 10** describes that decision rules equal or greater than B are transformed into strategic objectives and targets for the randomly selected Cambodia. You will find all the strategic objectives and targets for the decision rule 22 for all the countries classified as C in **Appendix C**.

### 5. Conclusions

Using statistics and 23 different indicators categorized into 4 perspectives (PEST) helped us classify all the member states of the United Nations into three categories: [A] Countries that are doing well according to the selected indicators; [B] Countries that need support to acquire category A status; [C] Countries ranked the lowest and meeting special support with regard to the criterion or



**Table 10.** Strategic objectives and targets for Cambodia.

All Perspectives	Strategic Objectives 1	Strategic Objectives 2	Strategic Objectives 3	Strategic Objectives 4
<b>Decision Rule #2</b>	Improve life expectancy for men equal or greater than 70.63 years			
<b>Target for Cambodia</b>	Improve life expectancy for men by 0.06 years			
<b>Decision Rule #3</b>	Exports of goods and services equal or greater than 42.34% of GDP	Improve the ease of doing business Index equal or smaller than 121	Improve exports of merchandise equal or greater than 556.31\$ per capita	Improve GDP equal or greater than 2905.86\$ per capita
<b>Targets for Cambodia</b>	Maintain	Improve the ease of doing business index by 14 points	Maintain	Improve GDP by 1826\$ per capita
<b>Decision Rule #4</b>	Lower Military expenditures equal or lower than 1.4% of GDP	Improve the number of individuals using the internet equal or greater than 46.51% of the population		
<b>Targets for Cambodia</b>	Lower military expenditures by 1.1% of GDP	Improve the number of internet user by 20.94% of the population		
<b>Political Perspective</b>	<b>Strategic Objectives 1</b>			
<b>Decision Rule #8</b>	Improve the number of homicides caused by conflict index equal to 1			
<b>Target for Cambodia</b>	Improve the number of homicides caused by conflict index by 0.9			
<b>Economical Perspective</b>	<b>Strategic Objectives 1</b>	<b>Strategic Objectives 2</b>	<b>Strategic Objectives 3</b>	<b>Strategic Objectives 4</b>
<b>Decision Rule #15</b>	Improve the GNP Per Capita equal or greater than 3582.65\$ per capita	Improve the Exports of Merchandise equal or greater than 294.25\$ per capita	Improve the Exports of G & S equal or greater than 21.31% of GDP	Improve the RNN equal or greater than 1735.74\$ per capita
<b>Targets for Cambodia</b>	Improve the GNP by 2503.54\$ per capita	Maintain	Maintain	Improve the RNN by 595.74\$ per capita
<b>Decision Rule #16</b>	Reduce Unemployment equal or below than 9.1%	Improve GNP equal or greater than 1642.73\$ per capita	Improve Exports of Merchandise equal or greater than 155.36\$ per capita	Improve Exports of G & S equal or greater than 11.89% of GDP
<b>Targets for Cambodia</b>	Maintain	Improve GNP by 563.62\$ per capita	Maintain	Maintain
<b>Decision Rule #17</b>	Improve GNP equal or greater than 10,826.27\$ per capita	Improve Exports of Merchandise equal or greater than 1776.77\$ per capita	Reduce unemployment equal or smaller than 13.14%	
<b>Targets for Cambodia</b>	Improve GNP by 9747.16\$ per capita	Improve exports of merchandise by 695.16\$ per capita	Maintain	
<b>Sociological Perspective</b>	<b>Strategic Objectives 1</b>	<b>Strategic Objectives 2</b>	<b>Strategic Objectives 3</b>	<b>Strategic Objectives 4</b>
<b>Decision Rules #20</b>	Increase life exp. for women equal or greater than 69.43 years	Increase the urban population equal or greater than 33.14%	Reduce the homicides Index equal or smaller than 2.6	Reduce the number of adolescent pregnancies equal or smaller than 64.27 per 1000
<b>Targets for Cambodia</b>	Maintain	Increase the urban population by 9.19%	Maintain	Maintain

## Continued

<b>Decision Rules #21</b>	Increase urban Population equal or greater than 55.03%	Increase life exp. for men equal or greater than 65.09 years		
<b>Targets for Cambodia</b>	Increase the urban population by 34.08%	Maintain		
<b>Decision Rules #22</b>	Increase school life equal or greater than 15 years	Increase life exp. for women equal or greater than 76.09 years	Reduce the number of adolescent pregnancies equal or smaller than 39.44 per 1000	Increase urban population equal or greater than 31.42%
<b>Targets for Cambodia</b>	Increase school life expectancy by 4 years	Increase life exp. for women by 5.52 years	Reduce the number of adoslescents pregnancies by 12.73 per 1000	Increase the urban population by 10.47%
<b>Technological Perspective</b>	<b>Strategic Objectives 1</b>	<b>Strategic Objectives 2</b>	<b>Strategic Objectives 3</b>	
<b>Decision Rules #29</b>	Increase the number of secure internet servers equal or greater than 190.36 per million	Increase the number of cellular sub. equal or greater than 102.98 per 100		
<b>Targets for Cambodia</b>	Increase the number of secure internet servers by 183.51 per million	Maintain		
<b>Decision Rules #30</b>	Increase the number of secure internet servers equal or greater than 226.19 per million per million	Increase the number of fixed broadband internet subscriptions equal or greater than 6.19 per 100	Increase the number of cellular sub. equal or greater than 63.87 per 100	
<b>Targets for Cambodia</b>	Increase the number of secure internet servers by 219.34 per million	Increase the number of fixed broadband internet subscriptions by 5.58 per 100	Maintain	

criteria considered (See [Appendix B](#)). The various correlations help us identify the plausibility that all perspectives (PEST) are related one another positively or negatively. There is no doubt that the adolescent fertility per 1000 and the school life expectancy indicators is related with economical indicators such as the GNP per capita, GNI per capita, RNN per capita and exports of goods and services. It is also highly probable that they are related with political indicators such as the ease of doing business and technological indicators such as the number of academic papers produced per capita. Finally, these indicators are also related with the life expectancy of women and men.

The number of people of all these classified states indicates that 17.38% of the world population lives in states categorized as A, 59.41% live in states categorized as B and 23.21% live in states categorized as C. Therefore, approximately 82.62% of the world population lives in states that require strategies and targets to improve their development. It is understandable that some indicators are results of environmental factors and cannot be changed in the short term. It is the same conclusion for economical and technological indicators. Identifying po-

verty using the four different perspectives helps decision makers and politician to define their priorities to reduce poverty. It is clear that reducing adolescent fertility index below 42.75 births per 1000 girls and increasing school life expectancy over 13 years should be priorities. So, education programs and teen pregnancy education programs should be priorities for states categorized as C.

The beauty of using DRSA is that it also clearly identifies what a country should exactly aim to be categorized as B or A.

### Future Research

The exploration of some indicators and correlations helped us discover interesting possibilities for future researches. The percentage of women in governments is negatively correlated to the political stability index and ease of doing business index. The same indicator is positively correlated to the corruption perception index, RNN per capita, GNP per capita, GNI per capita, exports of merchandise per capita (USD), life expectancy for women, school life in years, the number of academic papers per capita produced annually and fixed internet servers per 100 people. It is therefore plausible that the percentage of women in government has an impact on the politics, economy, sociological development and technological advancement within a state.

In the first article, we identified a phenomenon where most of the poorest countries of Africa were neighbouring one another and shared boundaries. We named this phenomenon the poverty string. In this research, it seems that the same phenomenon is observable where countries categorized as C are in clusters in various regions (West Africa, East Africa, Central Africa, South Asia, Central Asia) and are neighbouring one another. There are possibly several other reasons for this phenomenon such as environmental similarities (temperatures, dryness and other environmental factors) and these environmental factors should be added to other researches in strategy

### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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## Appendix A

Stability	1																					
Conflicts	.420**	1																				
Mil. Exp.	.420**	.320**	1																			
CPI index	-.765**	-.365**	-.199*	1																		
Comp. Ind.	-.629**	-.381**	0.011	.816**	1																	
Ease Busn.	.690**	.293**	.206**	-.721**	-.817**	1																
Women pol.	-.228**	-.091	-.198*	.245**	.206*	-.244**	1															
RNN	-.595**	-.201**	-0.043	.802**	.796**	-.602**	.235**	1														
GNP	-.605**	-.191**	-0.052	.785**	.775**	-.584**	.239**	.980**	1													
GNI	-.596**	-.187**	-0.015	.800**	.790**	-.595**	.227**	.997**	.982**	1												
Broad M.	-.276**	-0.095	0.077	.406**	.586**	-.350**	-0.083	.429**	.421**	.428**	1											
Unempl.	0.073	0.037	0.112	-0.084	-.251**	0.088	-0.062	-.196**	-.175*	-.194*	-0.138	1										
Export. Merch.	-0.047	-0.05	-0.045	0.045	0.004	0.013	.227**	0.055	0.061	0.055	0.095	-0.082	1									
Export. G&S	-.358**	-.229**	-0.068	.407**	.382**	-.383**	0.013	.432**	.498**	.425**	.240**	-0.115	-.115	1								
Petrol PIB	.298**	0.105	.518**	-.235*	-0.145	.279**	-.221*	-0.006	-0.008	0.021	-0.095	0.03	0.03	0.03	1							
Life expect woman	-.596**	-.228**	-0.023	.636**	.780**	-.747**	.201**	.620**	.610**	.617**	.553**	-0.083	-0.083	-0.083	1							
Life expect men	-.608**	-.242**	-0.007	.674**	.804**	-.707**	.188*	.677**	.659**	.672**	.592**	-0.106	-0.106	-0.106	1							
school life total	-.657**	-.293**	-0.154	.696**	.720**	-.745**	.249**	.627**	.590**	.617**	.330**	-0.045	-0.045	-0.045	1							
Urban pop.	-.434**	-0.117	0.086	.541**	.629**	-.461**	0.139	.615**	.581**	.593**	.370**	-0.055	-0.055	-0.055	1							
Fertility adol.	.418**	0.124	-0.117	-.537**	-.703**	.631**	-0.036	-.515**	-.502**	-.519**	-.509**	0.042	0.042	0.042	1							
Homicides UN	.284**	.162*	-0.02	-.480**	-.483**	-.482**	-0.047	-.444**	-.468**	-.450**	-.364**	.172*	.172*	.172*	1							
Academic papers	-.627**	-.197**	-0.133	.785**	.750**	-.670**	.334**	.827**	.827**	.824**	.419**	-0.099	-0.099	-0.099	1							
indiv using Internet	-.621**	-.263**	-0.046	.746**	.833**	-.785**	.183*	.744**	.732**	.741**	.522**	-0.066	-0.066	-0.066	1							
Fixed intern per 100	-.628**	-.216**	-0.132	.785**	.796**	-.720**	.253**	.776**	.773**	.763**	.524**	-0.098	-0.098	-0.098	1							
Secure Int.	-.558**	-0.142	-0.142	.748**	.689**	-.537**	0.132	.845**	.839**	.834**	.390**	-.188*	-.188*	-.188*	1							
Mobile cell sub 100	-.418**	-.193**	0.015	.421**	.516**	-.530**	0.014	.368**	.343**	.359**	.296**	0.008	0.008	0.008	1							

Correlation matrix. \*\*Correlation is significant at the 0.01 level (2-tailed). \*Correlation is significant at the 0.05 level (2-tailed).

## Appendix B

CLASS.	COUNTRY	POLITIC.	ECONO.	SOCIO.	TECHNO.
A	Switzerland	A	A	A	A
A	Iceland	A	A	A	A
A	Netherlands	A	A	A	A
A	Denmark	A	A	A	A
A	Sweden	A	A	A	A
A	Norway	A	A	A	A
A	Austria	A	A	A	A
A	Singapore	A	A	A	A
A	Japan	A	A	A	A
A	Belgium	A	A	A	A
A	Ireland	A	A	A	A
A	Finland	A	A	A	A
A	Luxembourg	A	A	A	A
A	Germany	A	A	A	A
A	United Kingdom	A	A	A	A
A	New Zealand	A	A	A	A
A	South Korea	A	A	A	A
A	Australia	A	A	A	A
A	Canada	A	A	A	A
A	Monaco	B	A	A	A
A	Czech Republic	A	A	A	A
A	Slovenia	A	A	A	A
A	United Arab Emirates	A	A	A	A
A	United States	A	A	A	A
A	Spain	A	A	A	A
A	Israel	A	A	A	A
A	France	A	A	A	A
A	Estonia	A	A	A	A
A	Malta	B	A	A	A
A	Portugal	A	A	A	A
A	Italy	A	A	A	A
A	Cyprus	A	A	A	A
A	Hungary	A	A	A	A
A	Poland	A	A	A	A
A	Liechtenstein	B	A	B	A
A	Bahrain	B	A	A	A
A	Slovakia	A	A	A	A
A	Lithuania	A	A	A	A
A	Qatar	A	A	A	A

## Continued

A	Latvia	A	A	A	A
A	Greece	A	B	A	A
A	Andorra	B	A	B	A
A	Saint-Marin	C	A	A	B
A	Malaysia	A	A	A	A
A	Chili	A	A	A	A
A	Brunei Darussalam	A	A	A	A
A	Croatia	A	A	A	A
A	Kuwait	B	A	A	A
A	Bulgaria	A	A	B	A
A	Uruguay	A	B	A	A
A	Belarus	A	A	A	A
A	Saudi Arabia	B	A	A	A
A	Costa Rica	A	B	B	A
A	Romania	A	A	B	B
A	Montenegro	A	B	A	A
A	Oman	B	B	A	A
A	Serbia	A	B	A	A
A	Panama	A	A	B	B
A	Mauritius	A	B	B	A
A	Argentina	B	B	B	A
A	Bahamas	B	A	A	B
A	Dominica	B	A	B	B
A	Barbados	B	A	B	A
A	Antigua & Barbuda	B	A	B	A
B	Maldives	C	A	A	B
B	Saint Kitts and Nevis	C	A	C	A
B	Trinidad & Tobago	B	A	C	A
B	Russian Federation	C	B	B	A
B	Kazakhstan	A	B	B	A
B	China	B	B	A	B
B	Palau	C	A	A	C
B	Macedonia	A	C	B	B
B	Thailand	B	B	B	B
B	Mexico	B	A	B	B
B	Georgia	A	B	B	B
B	Turkey	B	B	A	B
B	Grenada	B	A	B	B
B	Albania	A	C	A	B
B	Seychelles	C	B	B	A



**Continued**

B	Brazil	B	B	B	B
B	Bosnia & Herzegovina	B	B	A	B
B	Tunisia	B	B	A	B
B	Jordan	B	C	B	B
B	Viet Nam	B	B	B	B
B	Lebanon	C	B	A	B
B	Mongolia	A	B	B	B
B	Peru	A	B	B	B
B	Armenia	B	B	B	B
B	Bhutan	A	B	B	B
B	Azerbaijan	B	B	B	B
B	South Africa	A	B	C	B
B	Cuba	B	B	A	C
B	Botswana	A	B	C	B
B	Moldova	B	B	B	B
B	Jamaica	A	B	B	B
B	Sri Lanka	B	B	B	B
B	Nauru	C	A	B	C
B	Suriname	C	A	B	B
B	Iran	C	B	B	B
B	Morocco	B	C	B	B
B	Ecuador	B	B	B	B
B	Colombia	C	B	B	B
B	Algeria	C	C	A	B
B	El Salvador	A	B	B	B
B	Saint Vincent's & Grenadines	B	B	B	B
B	Venezuela	C	B	B	B
B	Saint Lucia	B	B	B	B
B	Paraguay	B	B	B	B
B	Ukraine	C	B	B	B
B	Dominica	B	B	B	B
B	Marshall Islands	C	C	A	B
B	Indonesia	B	C	B	B
B	Ghana	A	B	C	B
B	Gabon	B	B	C	B
B	Guatemala	A	B	C	B
B	Fiji	B	B	B	B
B	Tuvalu	C	B	B	B
B	Bolivia	B	B	B	C
B	Cabo Verde	B	C	B	B

## Continued

B	Nicaragua	B	B	B	C
B	Samoa	B	B	B	B
B	Belize	C	B	C	B
B	Tonga	C	B	B	B
B	Honduras	B	B	B	C
B	Namibia	B	B	C	B
B	Philippines	C	C	C	B
B	India	B	C	B	B
B	Timor Leste	B	B	B	C
C	Kyrgyz Republic	C	C	B	B
C	Guyana	B	B	C	B
C	Cambodia	C	B	C	C
C	Turkmenistan	C	B	B	C
C	Vanuatu	C	C	C	C
C	Papua new Guinea	B	B	C	C
C	Rwanda	A	C	C	C
C	Djibouti	B	C	C	C
C	Uzbekistan	C	C	B	B
C	Egypt	C	C	B	B
C	Equatorial Guinea	B	B	C	C
C	Korea Dem. (North)	C	B	B	C
C	Laos	B	B	C	C
C	Nepal	C	C	C	C
C	Swaziland	B	C	C	C
C	Libya	C	C	B	B
C	Bangladesh	C	C	C	C
C	Benin	B	C	C	C
C	Zambia	B	C	C	C
C	Micronesia	C	C	C	C
C	Lesotho	B	C	C	C
C	Côte d'Ivoire	C	C	C	B
C	Syria	C	B	B	C
C	Kenya	B	C	C	C
C	Senegal	C	C	C	C
C	Saoz Tome and Principe	C	C	C	C
C	Salomon Islands	B	C	C	C
C	Cameroon	C	C	C	C
C	Tanzania	B	C	C	C
C	Madagascar	B	C	C	C
C	Kiribati	C	C	B	C

**Continued**

C	Iraq	C	B	B	C
C	Togo	C	C	C	C
C	Tajikistan	C	C	B	C
C	Pakistan	C	C	C	C
C	Burkina Faso	C	C	C	C
C	Malawi	B	C	C	C
C	Gambia, the	C	C	C	B
C	Liberia	B	C	C	C
C	Myanmar	C	C	C	C
C	Mauritania	C	C	C	C
C	Congo Republic	C	C	C	C
C	Sierra Leone	B	C	C	C
C	Zimbabwe	C	C	C	C
C	Angola	C	B	C	C
C	Nigeria	C	C	C	C
C	Haiti	C	C	C	C
C	Uganda	C	C	C	C
C	Guinea	B	C	C	C
C	Mozambique	C	C	C	C
C	Niger	B	C	C	C
C	Eritrea	C	C	C	C
C	Guinea-Bissau	C	C	C	C
C	Ethiopia	C	C	C	C
C	Comoros	C	C	C	C
C	Burundi	C	C	C	C
C	Mali	C	C	C	C
C	Yemen	C	C	C	C
C	Sudan	C	C	C	C
C	Chad	C	C	C	C
C	Democratic Rep. of the Congo	C	C	C	C
C	Somalia	C	C	C	C
C	Central African Rep.	C	C	C	C
C	Afghanistan	C	C	C	C
C	South Sudan	C	C	C	C

## Appendix C

Decision Rule #22	Decision $\geq$ B	Strategic Obj 1	Strategic Obj 2	Strategic Obj 3	Strategic Obj 4
CLASS.	COUNTRY	School Life $\geq$ 15 years Improve school life expectancy by (in years)	Life Exp. Women $\geq$ 76.9 years Increase life expectancy for women by (in years)	Adolescent Fert. $\leq$ 39.44 per 1000 Reduce adolescent pregnancies by (per 1000)	Urban Population $\geq$ 31.42% Increase urban population by (% of population)
C	Kyrgyz Republic	2.00	2.10	Maintain	Maintain
C	Guyana	5.00	8.00	-48.14	2.76
C	Cambodia	4.00	6.33	-12.73	10.48
C	Turkmenistan	4.00	5.73	Maintain	Maintain
C	Vanuatu	no data	2.69	-3.31	4.98
C	Papua new Guinea	Maintain	9.00	-14.99	18.38
C	Rwanda	4.00	8.11	Maintain	1.65
C	Djibouti	9.00	12.96	Maintain	Maintain
C	Uzbekistan	3.00	2.95	Maintain	Maintain
C	Egypt	2.00	3.34	-11.89	Maintain
C	Equatorial Guinea	4.00	17.96	-68.09	Maintain
C	Korea Dem. (North)	4.00	2.08	Maintain	Maintain
C	Laos	4.00	9.06	-24.29	Maintain
C	Nepal	3.00	5.41	-31.85	12.43
C	Swaziland	4.00	16.58	-27.79	10.11
C	Libya	4.00	2.13	Maintain	Maintain
C	Bangladesh	5.00	2.96	-43.11	Maintain
C	Benin	3.00	14.79	-42.34	Maintain
C	Zambia	no data	13.00	-48.42	Maintain
C	Micronesia	no data	6.68	Maintain	8.94
C	Lesotho	Maintain	20.92	-53.73	3.58
C	Côte d'Ivoire	6.00	22.30	-96.19	Maintain
C	Syria	6.00	0.10	Maintain	Maintain
C	Kenya	4.00	7.78	-50.78	5.37
C	Senegal	6.00	8.22	-37.44	Maintain
C	Saoz Tome and Principe	2.00	8.31	-44.02	Maintain
C	Salomon Islands	6.00	4.90	-7.94	8.64
C	Cameroon	3.00	18.13	-62.92	Maintain
C	Tanzania	7.00	10.08	-78.28	Maintain
C	Madagascar	4.00	9.81	-75.38	Maintain
C	Kiribati	3.00	7.48	Maintain	Maintain
C	Iraq	no data	5.00	-45.41	Maintain
C	Togo	3.00	16.17	-52.62	Maintain

**Continued**

C	Tajikistan	4.00	2.90	Maintain	4.53
C	Pakistan	7.00	9.57	Maintain	Maintain
C	Burkina Faso	7.00	16.37	-67.71	0.73
C	Malawi	4.00	11.73	-95.91	14.97
C	Gambia, the	6.00	14.58	-73.02	Maintain
C	Liberia	4.00	13.94	-67.68	Maintain
C	Myanmar	7.00	8.13	Maintain	Maintain
C	Mauritania	6.00	12.34	-38.46	Maintain
C	Congo Republic	4.00	11.16	-76.68	Maintain
C	Sierra Leone	no data	24.91	-77.29	Maintain
C	Zimbabwe	5.00	14.85	-69.50	Maintain
C	Angola	5.00	12.81	-122.49	Maintain
C	Nigeria	6.00	23.14	-69.86	Maintain
C	Haiti	no data	11.68	Maintain	Maintain
C	Uganda	5.00	15.13	-69.51	14.98
C	Guinea	6.00	17.00	-100.13	Maintain
C	Mozambique	5.00	17.12	-97.49	Maintain
C	Niger	10.00	16.21	-161.72	12.41
C	Eritrea	10.00	10.09	-13.56	31.42
C	Guinea-Bissau	4.00	18.18	-48.09	Maintain
C	Ethiopia	7.00	9.99	-17.17	11.50
C	Comoros	4.00	11.70	-27.66	3.01
C	Burundi	4.00	17.81	Maintain	19.06
C	Mali	7.00	18.74	-134.30	Maintain
C	Yemen	6.00	10.71	-21.26	Maintain
C	Sudan	8.00	11.07	-32.61	Maintain
C	Chad	8.00	23.11	-90.31	8.80
C	Democratic Rep. of the Congo	6.00	16.22	-82.84	Maintain
C	Somalia	8.00	19.34	-63.18	Maintain
C	Central African Rep.	8.00	23.69	-51.22	Maintain
C	Afghanistan	4.00	12.29	-31.76	4.29
C	South Sudan	no data	19.57	-23.99	12.39