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Classifications of Countries Based on Their Standard of Living

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Abstract

In the body of the literature, it is celebrated that human well-being becomes the key subject in measuring the economic development. The purpose of this study is to classify the countries with respect to their standard of living on the basis of economic growth, health, education and quality of environment by using cluster analysis and self-organizing feature map. The data have been obtained from the World Bank Report 2011, United Nation Development Program and the United Nation Statistics Division. The results of this study reveal that health and quality of environment indicators playing most important role for classification of the countries.

Keywords: living standard, economic growth, health, education, quality of environment, cluster analysis, self organizing feature maps (SOFM)

1. Introduction:

The word “development” is a dynamic process of continuous improvement and the positive changes in the growth of the wealth of a given country and therefore the growth of the well-being of its citizens. Generally it implies changes in wealth and income, health, institutional, technological and environmental changes. Therefore development of a country has a fundamental cause of economic growth and development.

Economic development is a normative concept because it does not only discuss income but also discuss society economy and structural changes that improve the general population's quality of life. It entails more, particularly improvement in education, health and other aspects of human wellbeing. Countries that raise their Income but do not raise life expectancy, reduce infant mortality and increase literacy rate are actually missing an important aspects of development. Therefore, the intention of economic development is the overall well-being of the people of a country, which are ultimately beneficial for the development of the economy of their country.

Economic growth concerns with expansion of national or per capita income. It is usually measured through Gross domestic product (GDP) or through Gross national income (GNI). Therefore, it is an important aspect in reducing poverty, generating resources that are essential for human development and environmental protection. Various literature suggest that there is a strong correlation of gross domestic product (GDP) per capita with

other indicators of development such as life expectancy, infant mortality, adult literacy, and some indicators of environmental quality. On the other hand, only economic growth does not assurance of human development. Therefore, well-functioning civil organizations, assure individual and assets rights, and advancement in health and educational services are also very important to evoking the overall living standards.

Thus the development of a country is a sustainable improvement in the standards of living of a country. It implies an increase in the income level of every citizen and it also leads to the formation of more opportunities in the sectors of education, health care, employment and preservation of the environment.

A variety of socioeconomic outcomes is affecting the well-being of people in a country. However, the indicators utilize in this study for cross-country classification are; Gross Domestic Product (GDP) per capita in term of purchasing power parity, population average annual growth, life expectancy at birth, adult literacy rate, mean years of schooling, expected mean years of schooling, under-five mortality rate, maternal mortality rate, carbon dioxide emission per capita, infant mortality rate, improved drinking water coverage and improved sanitation coverage. The selection of these indicators, while subjective, is based on both their importance and their availability, so as to allow meaningful cross-country comparisons.

Economic growth is simply measure through Gross Domestic Product (GDP); refers to a as the total market value of goods and services produced in a country in a given period and GDP per capita is the total output per person of a country. Son (2010) determines in his study that GDP per capita is an important determinant of a country's living standard. The per capita GDP is especially useful when comparing one country to another because it shows the relative performance of the countries. When GDP per capita expressed in purchasing power parity (PPP) US$ terms, it is converted to international dollars using PPP rates. An international dollar has the same purchasing power over GDP that the U.S. dollar has in the United Stat. Another characteristic for the country development is its population growth rate. Rapid population growth could be an obstacle for the well-being of people worldwide.

Education factor perhaps having most importance for development as well as for endowing people. Education provides knowledge and information which bring changes in the way you think, feel and act. Educated people are more likely to have job, earn more and have a respectable position in society. Thus, it's focal share in changing the lives of the people, it becomes an important part of the development policy in every country. The education related indicators utilized in this study are adult literacy rate, mean years of schooling and expected mean years of schooling. In many previous studies "adult literacy rate" indicator were utilized for cross country comparison of living standard [Kaski and Kohonen (1996), Berenger and Chouchane (2007), Son (2010)]. In addition to this, mean years of schooling and expected years of schooling also utilized for determining classification of countries with respect to the human development.

Health has always been an important component of individual and social well-being. Furthermore healthy population is considering as a fundamental driver of labor, capital investment and for economic growth [Alleyne and Cohen (2002)]. In this study we utilize four indicators; life expectancy at birth, under-five mortality rate, infant mortality rate and maternal mortality rate. These indicators have been widely used for determining health status of population in a country [Wang (2002)].

Quality of the environment, itself has diverse meanings and explanations. Whereas air and water pollution related indicators are commonly utilized for environmental quality [Kerekes (2011)]. Air pollution is generally unpleasant for human health and measured by nitrogen oxide, sulfur dioxide, carbon monoxide and carbon dioxide [Kerekes (2011)]. In this study we utilize the carbon dioxide emission, further Berenger and Chouchane (2007) advocate that worse air quality is one cause of more carbon dioxide emission and used this indicator for cross country analysis of standard of living and quality of life. Whereas, worldwide emission of carbon dioxide increases, the condition of climate change deteriorate, however this emission are cause of high-consumption in wealthy countries and make growth achievable for low income countries [Stanton (2009)]. Furthermore, improved drinking water coverage and improved sanitation coverage indicators were analyzed to determine the environmental quality for socio-economic development of country.

1.1 Objective of the Study

In this study our basic purpose is to classify the countries with respect to their standard of living on the basis of GDP per capita, education, health and quality of environment, and also determine the indicators that play most important role in countries classification.

2. Literature Review

This section provides the critical summary and assessment of the previous studies that have been conducted by different people in different years.

Kaski and Kohonen (1996) conducted a study to analyzed the standard of living of different countries by using unsupervised neural network technique self organizing map (SOM). The dataset have been collected from world development report. A total 39 indicators were chosen that describe the factors like health, education, consumption and social services. The result showed the order of the countries on the map which reflect somewhat geographical information of the countries, while there was no geography information of the countries. Disparity in the indicators across order of the countries reflects overall standard of living decreases from OECD countries to the poorest African countries.

Mwabu (2002) conducted a study to inspect the process of health development in Africa through infant mortality rate, crude death rate, and fertility and longevity measures by using cross-section and time series data from 53 African countries. The result shows that over the past 15 years the African countries shows the progress in health development. While at the same level of socioeconomic development, the level of health development in the continent is fairly low as compared to the same measure of health in the continents. Further the health status in Africa by region demonstrates that, North Africa has best indicators, while Central and West Africa has worse indicators of health development. The results from regression analysis shows that improvement in per capita income, school enrollment rates and safe water supply were have dominant effect on health status.

Anderson and Morrissey (2006) conducted a study to classify the poor performer countries and to assess whether they share common characteristics which distinguish them to other countries. The data were taken from World Bank over two decade 1980s and 1990s. The countries were classified as poor performer or good performer on the basis of economic growth and infant mortality by using four different statistical criterions. The results indicate that only few countries were consistently identified poor performer across indicators or periods. Similarly good performer countries that were

identified on one indicator or one period were not same set of countries that identified on other indicator or in other period.

Ersoz and Bayrak (2008) accomplished a study to investigate the welfare and development indicators of countries for determining the similarities and disparities between them. The data were collected from EUROSTAT at 2005. Multidimensional scaling analysis was applied to fulfill the objective of the research. It was carried out in to two dimensions. The result from Euclidean distance model in term of variables demonstrated that poverty, Gini coefficient and inflation rate were important indicators in both dimension and the result from Euclidean distance model in term of countries demonstrate that first member countries of Europe Union has had higher welfare and development level as compare to new member countries of Europe Union from East and Central Europe.

Son (2009) plans a study to access the achievements and inequalities in living standard across countries. The analysis was based on six indicators for 177 countries cover the period 2000 to 2007. Findings reveal that regional inequality based on per capita GDP were higher than the other indicators of well-being. Theilx index were utilized to access the disparity between countries, which indicate that per capita GDP were extremely high cause of disparity between countries. The achievement index were derived by using Kakwani approach, the results were showing that the industrialized countries have higher average living standard than world average and within Asian region, South Asia countries have low achievement than other Asian region countries. The average elasticity of standard of living by region revealed that birth skill health personal were more responsive to economic growth and convergence in living standard estimate that South Asia would take 74 years to attain industrialized countries per capita income and 94 years would take to attain industrialized countries adult literacy rate.

Kumar and Mitra (2009) conducted a study to analyze the inter-connection between economic growth, health and poverty. The data set on economic growth, health, poverty and on all other indicators have been collected from united nation development program and World Bank. The results from the three equations have been analyzed through two-stage least square method. In the first stage each equation is estimated with respect to their independent variables then at the second stage the estimated values of dependent variables were used to construct the structural form of equation. The results from the analysis indicate that health in term of life expectancy positively contributes in economic growth. Further, higher growth and improved health make contribution in reducing the poverty. However, the economic growth was having insignificant effect on poverty.

3. Results and Discussion

3.1. Descriptive Statistics

Descriptive statistics are used to describe the basic features of the data. Table 1 contains the information about minimum, maximum values of the variables and with respective mean and standard deviation. It shows that minimum value of GDP per capita for given countries is 182.00 and maximum is 57834.00, with mean and standard deviation 12108.5162 and 13610.68947 respectively. Its mean value demonstrate that most of the countries have per capita GDP around this value and with greater variation. Further, the minimum value of population average annual growth rate is -1.50 and maximum 3.90, with mean and standard deviation 1.4682 and 1.11116 respectively. Its mean value demonstrate that most of the countries have average annual growth rate around this value. Likewise a country have minimum 28 percent and maximum value 100 percent adult

literacy rate, and most of the countries have adult literacy rate 81.0992 percent with 19.82232 standard deviation. In the same way, all variables are interpreted. However, on the basis of descriptive statistics, we can't compare theses indices because these all measures are different with respect to scale and severity.

Table 1: Descriptive Statistics

Variables	N	Min.	Max.	Mean	Std. Dev.
GDP_PC	129	182.00	57834	12108.5162	13610.68947
PAAG	129	-1.50	3.90	1.4682	1.11116
ALR	128	28.00	100.00	81.0992	19.82232
EYS	129	1.80	20.50	11.8946	3.56698
MYS	128	1.20	12.60	7.2789	3.13898
LEAB	129	44.30	83.00	68.1512	10.59130
UFMR	129	3.00	209.00	51.7829	56.10662
IMR	129	2.00	195.00	49.0233	50.61103
MMR	129	2.00	1400.00	229.0000	308.53540
CDE	128	.00	31.00	4.1781	5.01966
IDWC	128	30.00	100.00	83.3516	18.38289
IMSC	126	9.00	100.00	69.2063	31.46333
Valid N (list wise)	122				

The spearman correlation coefficient determines the rank-order association between two scale variables. Table 2 exhibits the information about these correlation coefficients. Where each cell contains two values, first value describes the strength of the relationship and second value (p-value) describes the significance of the relationship. The relationship between all the variables is significant at 0.01 levels.

Table 2: Spearman Correlation

	GDP_PC 1	PAAG 2	ALR 3	EYS 4	MYS 5	LEAB 6	UFMR 7	IMR 8	MMR 9	CDE 10	IDWC 11	IMSC 12
1	1	-.613 .000	.461 .003	.894 .000	.808 .000	.559 .000	-.909 .000	-.897 .000	-.892 .000	.920 .000	.861 .000	.872 .000
2	-.613 .000	1	-.549 .000	-.689 .000	-.729 .000	-.432 .000	.702 .000	.683 .000	.699 .000	-.616 .000	-.699 .000	-.666 .000
3	.461 .003	-.549 .000	1	.504 .000	.589 .000	.590 .000	-.475 .000	-.474 .000	-.511 .000	.483 .000	.444 .000	.489 .000
4	.894 .000	-.689 .000	.504 .000	1	.845 .000	.539 .000	-.890 .000	-.883 .000	-.863 .000	.867 .000	.844 .000	.845 .000
5	.808 .000	-.729 .000	.589 .000	.845 .000	1	.489 .000	-.823 .000	-.811 .000	-.840 .000	.809 .000	.789 .000	.801 .000
6	.559 .000	-.432 .000	.590 .000	.539 .000	.489 .000	1	-.620 .000	-.635 .000	-.592 .000	.521 .000	.528 .000	.546 .000
7	-.909 .000	.702 .000	-.475 .000	-.890 .000	-.823 .000	-.620 .000	1	.988 .000	.943 .000	-.859 .000	-.911 .000	-.880 .000
8	-.897 .000	.683 .000	-.474 .000	-.883 .000	-.811 .000	-.635 .000	.988 .000	1	.926 .000	-.851 .000	-.900 .000	-.874 .000
9	-.892 .000	.699 .000	-.511 .000	-.863 .000	-.840 .000	-.592 .000	.943 .000	.926 .000	1	-.867 .000	-.893 .000	-.872 .000
10	.920 .000	-.616 .000	.483 .000	.867 .000	.809 .000	.521 .000	-.859 .000	-.851 .000	-.867 .000	1	.820 .000	.853 .000
11	.861 .000	-.699 .000	.444 .000	.844 .000	.789 .000	.528 .000	-.911 .000	-.900 .000	-.893 .000	.820 .000	1	.864 .000
12	.872 .000	-.666 .000	.489 .000	.845 .000	.801 .000	.546 .000	-.880 .000	-.874 .000	-.872 .000	.853 .000	.864 .000	1

Correlation is significant at the 0.01 level (2-tailed).

3.2. Two Step Cluster Analysis

The two-step clustering method is scalable exploratory tool that reveals the natural grouping of the dataset. We apply this procedure to grouping the countries with respect to their standard of living on the basis of GDP per capita, education, health and quality of environment. The countries grouped into same cluster will demonstrate that these countries share same characteristics of living standard.

Table 3 contains information about auto-clustering procedure that summarizes the process by which optimal number of clusters is chosen in the analysis. Schwarz's Bayesian clustering Criterion (BIC) is computed for each possible number of clusters and the smallest BIC value determines the "best" cluster solution. Here smallest BIC

coefficient is for two number of cluster which is 747.027. Another criterion would also help in selection of optimal number of cluster. Such as changes in BIC and changes in the distance measures can be used to evaluate the best cluster solution. BIC change is the difference between model with (J) clusters and with (J+1) clusters. Such as BIC (1) = 1124.052, BIC (2) = 747.027, thus BIC change for two number of cluster solution is -377.025=747.027-1124.052. However, the results of BIC change does not reveal improvement in cluster solution as the number of cluster increased. In such situations, ratio of BIC changes and ratio of distance measure are evaluated, so a reasonably large Ratio of BIC Changes and a large Ratio of Distance Measures the optimal cluster based solution. Thus for two cluster solution we have large ratio of BIC changes is BIC (J)-BIC (J+1)/BIC (1) =1.00 and large ratio of distance measure is 5.453.

Table 3: Auto-Clustering

Number of Clusters	Schwarz's Bayesian Criterion (BIC)	BIC Change	Ratio of BIC Changes	Ratio of Distance Measures
1	1124.052			
2	747.027	-377.024	1.000	5.453
3	772.046	25.019	-.066	1.908
4	840.035	67.989	-.180	1.009
5	908.444	68.409	-.181	1.990
6	1000.185	91.740	-.243	1.247
7	1096.597	96.412	-.256	1.319
8	1197.578	100.981	-.268	1.016
9	1298.779	101.202	-.268	1.148
10	1401.799	103.020	-.273	1.096
11	1505.891	104.092	-.276	1.048
12	1610.498	104.607	-.277	1.039
13	1715.503	105.005	-.279	1.122
14	1821.629	106.126	-.281	1.143
15	1928.899	107.270	-.285	1.002

Table 4 examines the number of cases in the final cluster solution. As a result 122 countries out of 129 classified into the clusters, 43 countries have been classified into first cluster and 79 countries have been classified into second cluster.

Table 4: Cluster Distribution

		N	% of Combined	% of Total
Cluster	**1**	43	35.2%	33.3%
	2	79	64.8%	61.2%
	Combined	122	100.0%	94.6%
Excluded Cases		7		5.4%
Total		129		100.0%

Table 5 contains information about Cluster Centers, which demonstrate that the clusters are well separated with respect to these continuous variables, because variables mean have reasonable difference in each cluster. In first cluster, mean value of GDP per capita is less than the combined mean, which indicate that the countries classified in the first cluster have lower per capita GDP, as it is sign of poor living standard from those countries which are classified into second cluster. Furthermore, adult literacy rate, expected years of schooling, mean years of schooling, life expectancy at birth, carbon dioxide emission, improved drinking water coverage and improved sanitation coverage indicators mean less than the combined mean in the first cluster. As the small mean values of these indicators except carbon dioxide emission demonstrate that the situation of living standard in these countries is poor. Whereas the mean values of population average growth rate, under-five mortality rate, infant mortality rate and maternal mortality rate is greater than overall mean, which demonstrate the poor living standard condition for the countries allocated in that cluster. In the second cluster reverse situation occurred than the first cluster. The indicators which have lower values in first cluster show higher values for the countries grouped into second cluster. Thus the countries classified in second cluster have good condition of standard of living.

Table 5: Cluster Centroids

		Cluster		
		1	**2**	**Combined**
GDP_PC	**Mean**	1534.8372	17264.8809	11720.6852
	Std. Dev	1017.79023	14191.12542	13679.14492
PAAG	**Mean**	2.4209	.9873	1.4926
	Std. Dev	.69712	.92075	1.09001
ALR	**Mean**	66.0628	89.2595	81.0836
	Std. Dev	20.95767	13.34128	19.77419
EYS	**Mean**	7.9605	13.8228	11.7566
	Std. Dev	2.02051	2.08474	3.48240
MYS	**Mean**	3.8837	8.9051	7.1352
	Std. Dev	1.62553	2.17886	3.12724
LEAB	**Mean**	59.7512	72.4494	67.9738
	Std. Dev	9.49141	8.28345	10.61162
UFMR	**Mean**	119.9535	17.8734	53.8525
	Std. Dev	45.16739	14.08342	56.86735
IMR	**Mean**	109.2791	19.0000	50.8197
	Std. Dev	41.82066	15.08013	51.27579
MMR	**Mean**	584.6047	50.9747	239.0574
	Std. Dev	296.07642	60.61437	313.56798
CDE	**Mean**	.3209	6.0013	3.9992
	Std. Dev	.34404	5.13686	4.94733
IDWC	**Mean**	62.7674	93.9494	82.9590
	Std. Dev	14.70963	8.14909	18.48403
IMSC	**Mean**	32.4884	89.1772	69.1967
	Std. Dev	17.09967	14.96043	31.38922

GDP_PC: Gross Domestic Product per capita (PPP, US$), PAAG: Population average annual Growth, ALR: Adult Literacy Rate, EYS: Expected years of School, MYS: Mean Years of School, LEAB: Life Expectancy at Birth, UFMR: Under-Five Mortality Rate, IMR: Infant Mortality Rate, MMR: Maternal Mortality Rate, CDE: Carbon Dioxide Emission, IDWE: Improved Drinking Water Coverage, IMSC: Improved Sanitation Coverage.

Figure 1 to 12, represents the plots of simultaneous 95% confidence interval for means within each cluster. Furthermore, it is graphically representation of the cluster centroids table. From the figure 1, it can be seen that the average value of GDP per capita is largest for second cluster and the confidence limits (13615.80, 20913.96) are also wider for that cluster which demonstrate that this variable fluctuate more in second cluster as compare to first cluster. Similarly from figure 2, average value of population growth rate is largest for first cluster while this variable less fluctuate in both cluster, because of narrower

confidence limits. Furthermore, the average value of adult literacy rate is largest for first cluster and also fluctuate more in that cluster, because of wider confidence limits. In the same way, results from these plots demonstrate that all within cluster variable means are included in their respective confidence intervals. It can be seen that the average of expected years of schooling, mean years of schooling, life expectancy at birth and carbon dioxide emission is largest for the second cluster and average of all other variables such as under-five mortality rate, infant mortality rate and maternal mortality rate, improved drinking water coverage and improved sanitation coverage is largest for first cluster, as it can be seen from cluster centers table.

Within Cluster Simultaneous 95% Confidence Interval for Means

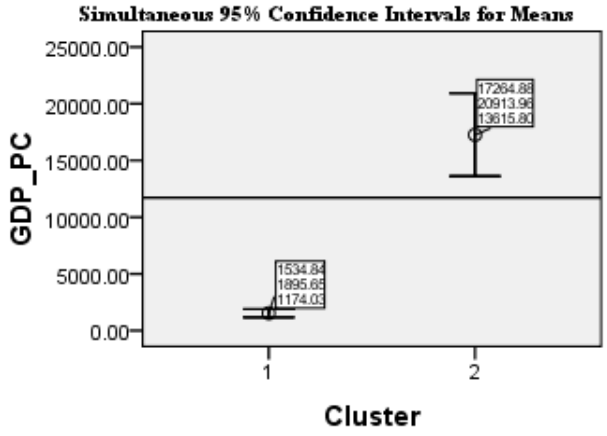


Figure 1

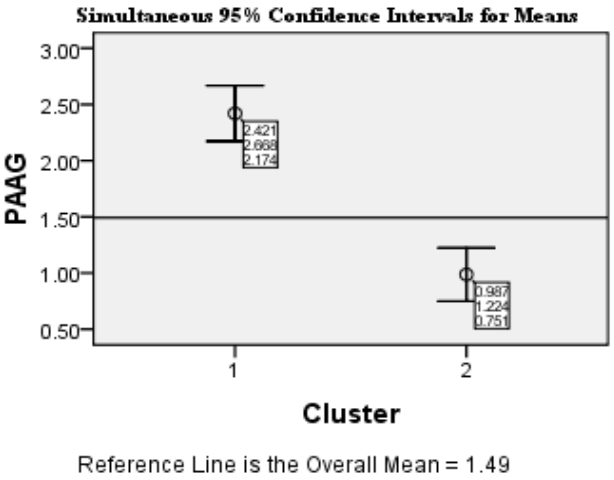


Figure 2

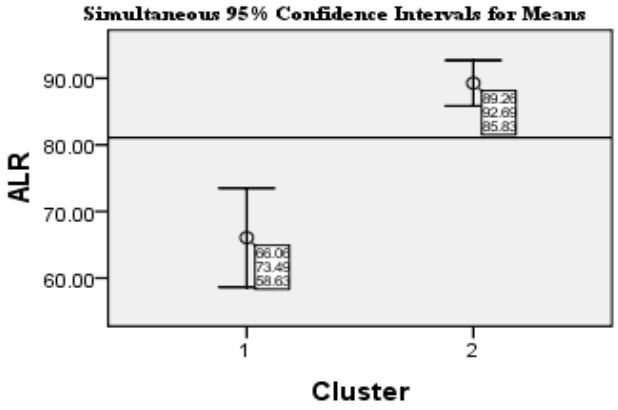


Figure 3

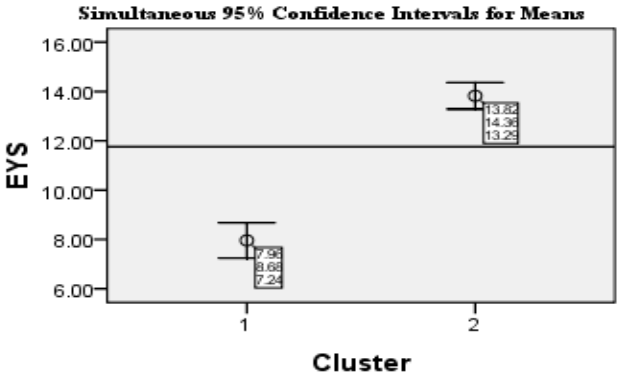


Figure 4

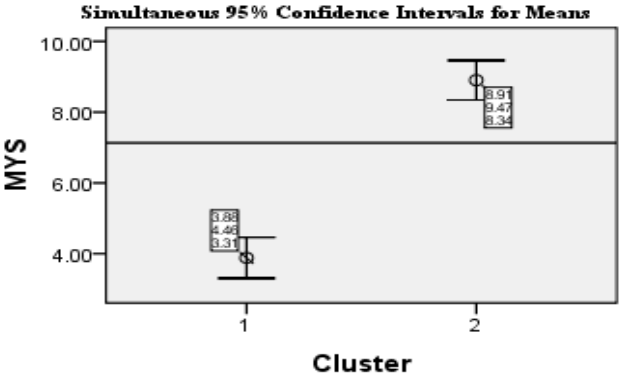
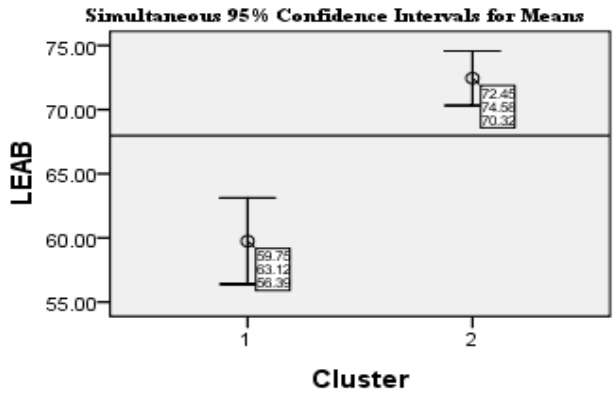
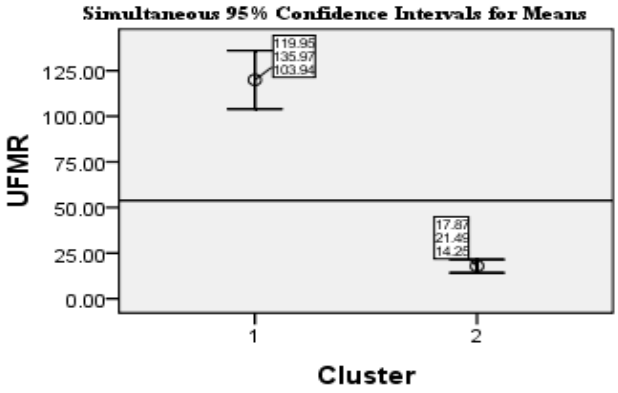


Figure 5



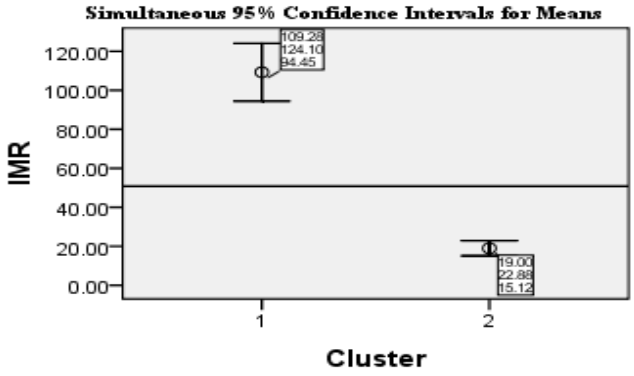
Reference Line is the Overall Mean = 67.97

Figure 6



Reference Line is the Overall Mean = 53.85

Figure 7



Reference Line is the Overall Mean = 50.82

Figure 8

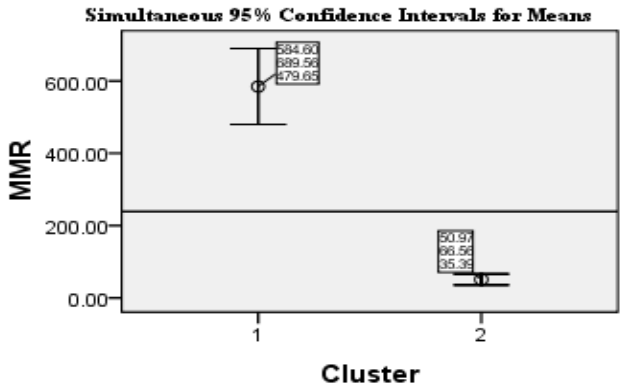


Figure 9

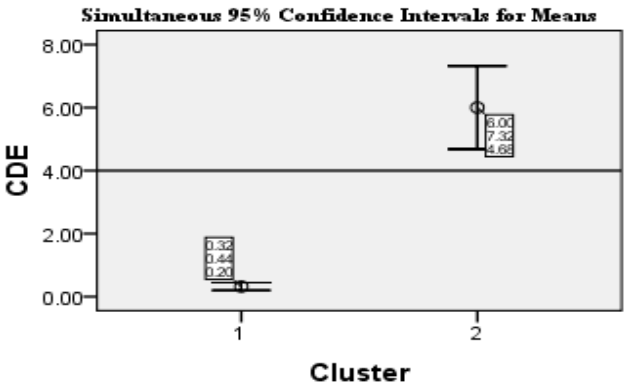


Figure 10

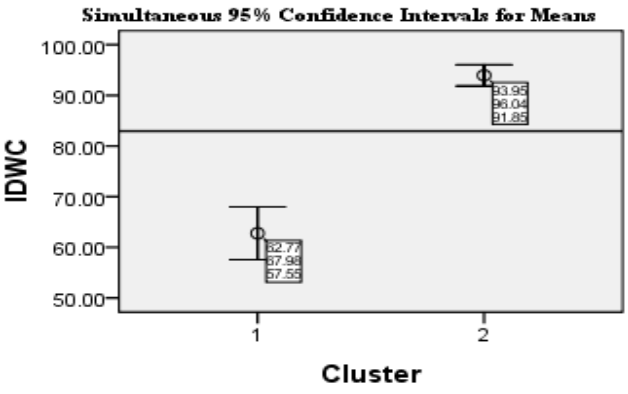


Figure 11

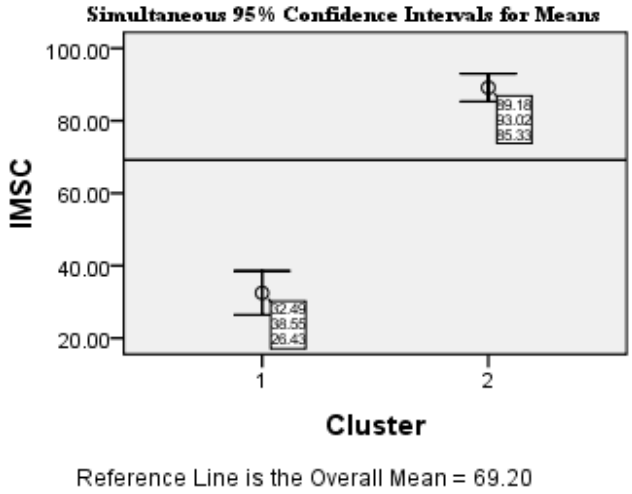


Figure 12

Figure 13 and 14 examine the variable wise importance for the formation of each cluster. On the X-axis is the "student's t statistic" and on the Y-axis is the list of continuous variables in descending order importance. If bars exceed the critical value line either from positive or negative direction. Then it indicates that the variables are significantly important to the formation of the cluster. As the positive t-statistic value, indicate the variable takes larger than average values within this cluster, while negative t-statistic value indicate the variable takes smaller than average values within this cluster, as it can be seen from centroids table.

From figure 13, it can be seen that all variables are significantly important to the formation of the first cluster. Furthermore, for first cluster, carbon dioxide emission, GDP per capita, improved sanitation coverage, mean years of schooling, expected years of schooling, improved drinking water coverage, life expectancy at birth and adult literacy rate takes smaller than average values within this cluster, thus take negative t-statistic value. While other variables under-five mortality rate, infant mortality rate, population average annual growth rate and maternal mortality rate takes larger than average values within this cluster, thus take positive t-statistic value. Carbon dioxide emission indicator contribute more, while adult literacy rate least contribute to the formation of first cluster.

From figure 14, it can be seen that all variables are significantly important to the formation of second cluster. The population average annual growth rate, maternal mortality rate, under five mortality rate and infant mortality rate variables takes smaller than average values within this cluster, while other variable takes larger than average values and takes positive t-statistic value. Furthermore, maternal mortality rate is most important indicator to the formation of that cluster, while carbon dioxide emission is least important to the construction of that cluster.

The position of the indicators demonstrates that the countries that are classified in first cluster have poor living standard and the countries classified in the second cluster have good standard of living. The list of the countries classified in the first and second cluster is given at the end of appendix- A and also those countries that are not classified in any cluster due to missing observation on one or more variables. If we concentrate on South-

Asian countries, we can see that Afghanistan, Bangladesh, India and Pakistan classified in first cluster and only Sri Lanka classified in second cluster.

Continuous Variable: Importance by Variable

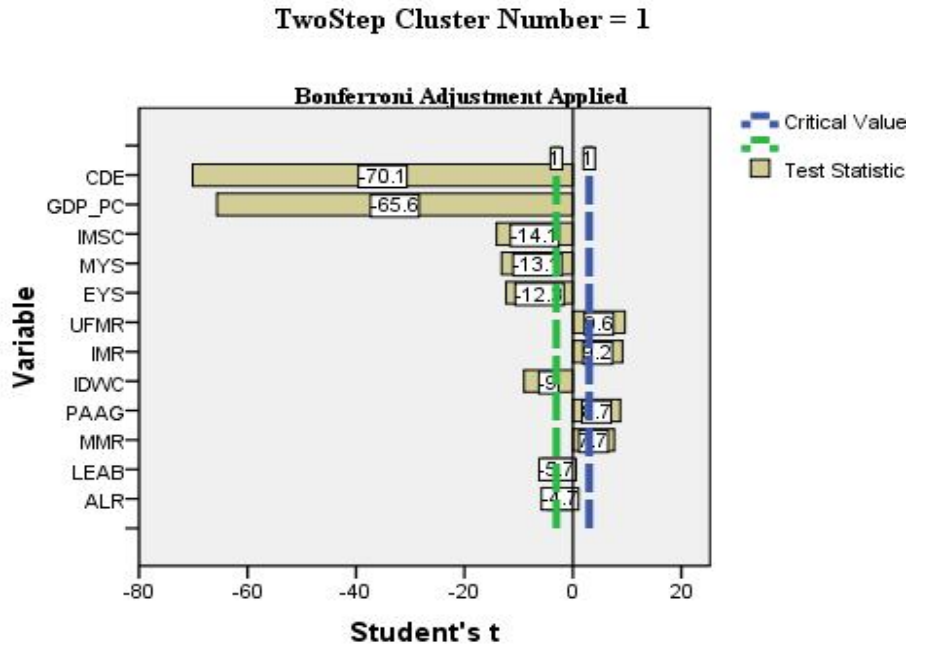


Figure 13

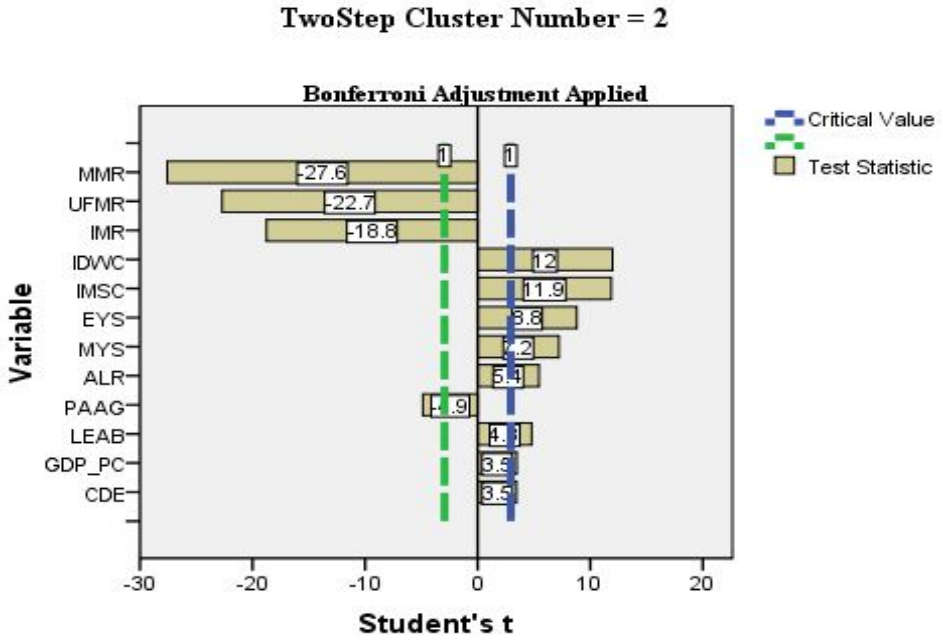


Figure 14

3.3. Kohonen Self-Organizing Feature Map:

Kohonen self-organizing feature map network utilized for both clustering and classification problems. When we have just input variables then it utilized for clustering and we label the clusters by inspecting each unit. While when we have both input and output variables, this network utilized for clustering and also for classification. The output variable is used for labeling the clusters automatically. Here we utilize output variable form Two-Step cluster analysis membership.

The error training graph shows in figure 15. It shows that both error decreases at the end of epochs, the selection error decrease from 3.02 to 0.56 and training error 1.0 to 0.38. From the figure 16 the topology map shows output layer in which units are placed into two-dimension lattice and inter-related neurons are close together in the layer. In the topology map each neuron represented by a square and labeled by the class label in the data set. For example the first neuron at the position (0, 0) has 9 countries and they are all related to good standard of living. Likewise the neuron at the position (0, 1) also has 9 countries and related to good standard of living. In the same way, it can be seen that 6 neurons labeled by GSL, thus the countries placed in these neurons are related to good standard of living. Similarly, next 4 neurons labeled by PSL, so the countries placed in these neurons are related to poor standard of living. Furthermore, the square box shows the level of activation, the blacker square box shows less activation level in that neuron and at the same time it is winner neuron.

In addition to the topology map, the network illustration figure 17 also displays the visual indication of the network. Here an addition feature is the coloring of the neurons, displaying the red color as positive activation level and green color negative activation level. The light red color depicts low activation level for that neuron. As the neuron placed at the edge of the figure have low activation level for the first case. It can be seen clearly from Table C-2, which display the information about the neurons activation level for fist case, the neuron at the position (0, 5) has less activation level as compare to other neurons.

Figure 15: Error Training Graph

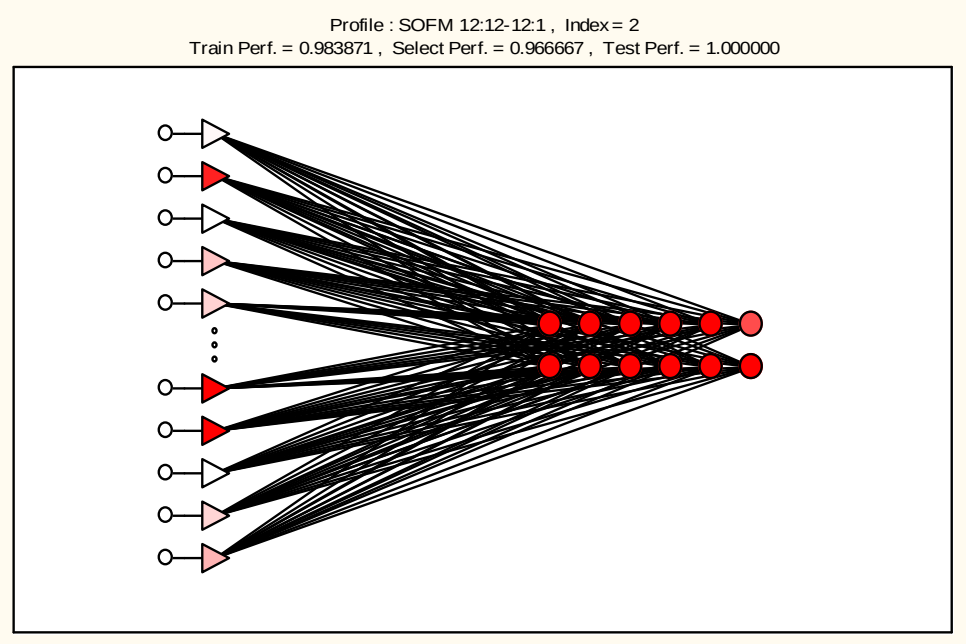


Figure 17: Network Illustration

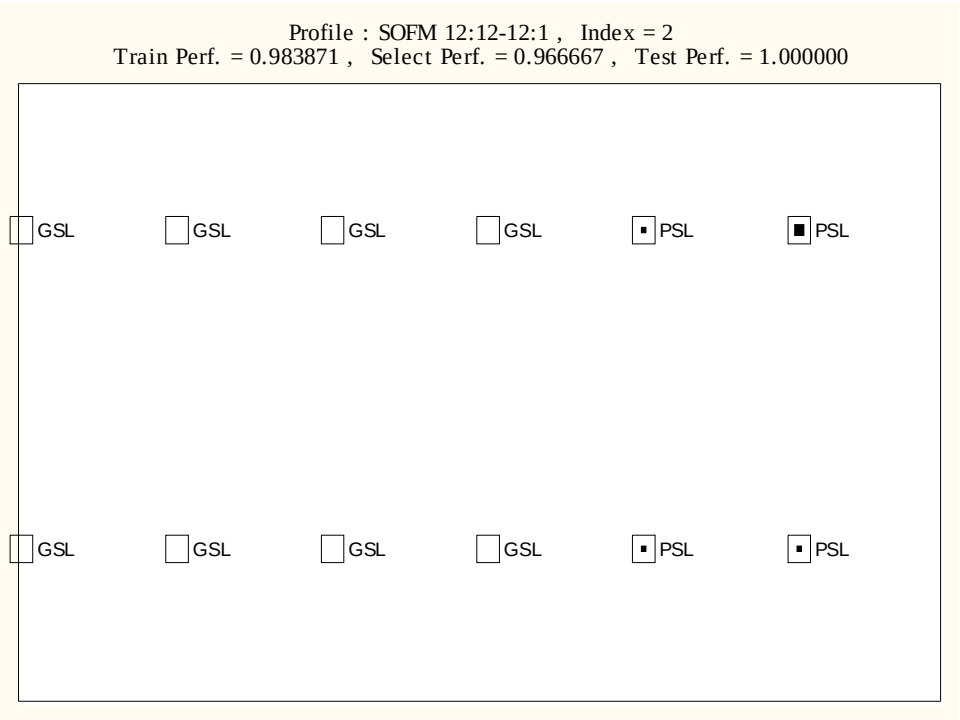


Figure 16: Topological Map

Model Summary table 6 displays the information of overall model performance. The profile (SOFM 12:12-12:1) of the network displays SOFM as the type of the network with 12 input variables and one output variable, and two layers; input layer and output layer, having both 12 units. Further the performance of the network with respect to training, selection and testing are 0.983871, 0.966667 and 1.0000 respectively. The error function displays; training, selection and testing error values 0.378164, 0.559921 and 0.543987 respectively. The performance of the network increases and error function decreases at the end of epochs. The training/member is the depiction of the training algorithm, it display (KO1000) "1000 epochs of Kohonen algorithm.

Table 6: Model Summary

Profile	**SOFM 12:12-12:1**
Train Performance	0.983871
Select Performance	0.966667
Test Performance	1.000000
Train Error	0.378164
Select Error	0.559921
Test Error	0.543987
Training/Members	KO1000

Table 7: Sensitivity Analysis

Variable	**Ratio**	**Rank**	**Variable**	**Ratio**	**Rank**
GDP_PC	1.059134	7	UFMR	1.123760	2
PAAG	1.02663	10	IMR	1.103372	3
ALR	0.97816	12	MMR	1.047355	9
EYS	1.064953	6	CDE	1.058287	8
MYS	1.101045	4	IDWC	1.068151	5
LEAB	1.01744	11	IMSC	1.128355	1

As in the competitive characteristic of Kohonen algorithm, each output node competes to other output nodes for declaring winner node. The neurons win frequency Table 8 display information about the total no. of times each neuron wins. As shown in the table, the neuron at the position (0, 0) 7 times wins, the neuron at the position (1, 0) has highest win frequency which determine that large number of countries are classified in that neuron. Further the neuron at the position (0, 3) has lowest win frequency which determine that less number of countries are classified in that cluster.

Table 8: Neurons Win Frequencies

	0	1	2	3	4	5
0	7.00000	9.000000	14.00000	6.000000	10.00000	17.00000
1	18.00000	9.000000	8.00000	8.000000	8.00000	8.00000

The importance of the input variables, in clustering the cases have been carried through sensitivity analysis Table 7. It shows that improved sanitation coverage is most important variable; under-five mortality rate is second one important variable, then infant mortality rate and so forth. The Classification table 9 presents the overall summary of the classification performance. The total no. of 43 countries out of 122 is from PSL (poor standard of living) and 79 countries out of 122 are from GSL (good standard of living) in the output data set. The model predicts that 42 countries are classified in the first category and 78 countries are classified in the second cluster. Thus there is 97.67% countries were correctly and 2.33% were misclassified in first category. There is 0% unknown cases, which demonstrate that learning algorithm successively performed. Furthermore, the confusion matrix table 10 displays the same information as presented above. The only one country misclassified in good standard of living countries and also only one country misclassified in poor standard of living countries.

Table 9: Classification

	COUNTRY.PSL	COUNTRY.GSL
Total	43.00000	79.00000
Correct	42.00000	78.00000
Wrong	1.00000	1.00000
Unknown	0.00000	0.00000
Correct (%)	97.67442	98.73418
Wrong (%)	2.32558	1.26582
Unknown (%)	0.00000	0.00000

PSL; Poor Standard of Living GSL; Good Standard of Living

Table 10: Confusion Matrix

	PSL	GSL
PSL	42.00000	1.00000
GSL	1.00000	78.00000

At the end in the Appendix-B, Table B-1 contains information about observed and predicted category of each country with respect to its neuron, where it is located. For example, Afghanistan country observed and predicted in the same category PSL (poor standard of living) and located in the fifth neuron which is at the position (0, 5) in the topology map. It also provides information about which country is misclassified. Nicaragua country is misclassified in GSL category and Norway country is misclassified in PSL category.

4. Conclusion

The relationship between socio-economic indicators conclude that the higher indicators values which direct the countries toward decent standard of living have inverse relationship with those indicators that higher values direct the countries toward poor standard of living and vice versa. For example, as higher value of adult literacy rate and lower values of mortality related indicators leads a country toward decent standard of living, has negative relationship.

The results of the Two-Step cluster analysis conclude that, the carbon dioxide emission per capita and GDP per capita are playing most important role in the formation of first cluster. While maternal mortality rate, under-five mortality rate and infant mortality rate is playing most important role in the formation of the second cluster. Additionally the countries which are classified in the first cluster have poor living standard, because they have higher indicator values that determine the state being mortal (infant mortality rate, under-five mortality rate and maternal mortality rate) and have rapid population growth rate, whereas have lower per capita GDP, education level and degrade the environmental quality. While the countries that are classified in the second cluster are enjoying decent standard of living because they have higher per capita GDP, life expectancy, literacy rate, years of schooling and have healthy environment, whereas have lower maternal mortality rate, under-five mortality rate and infant mortality rate indicators values. Moreover, all variables are playing significant role in the classification of the countries. Whereas, SOM provide that which variable is relatively most important for the formation of both cluster. Thus improved sanitation coverage, under five year mortality rate and infant mortality rate is playing most important role as compare to other variables.

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APPENDIX-A

Countries Classified in First Cluster (Poor Living Standard)

Afghanistan	Côte d'Ivoire	Mauritania	Sudan
Angola	Ethiopia	Mozambique	Tanzania
Bangladesh	Ghana	Myanmar	Togo
Benin	Guinea	Nepal	Uganda
Burkina Faso	Haiti	Niger	Yemen
Burundi	India	Nigeria	Zambia
Cambodia	Kenya	Pakistan	Zimbabwe
Cameroon	Lao PDR	Papua New Guinea	
Central African	Liberia	Rwanda	
Chad	Madagascar	Senegal	
Congo	Malawi	Sierra Leone	
Congo, Dem. Rep	Mali	Somalia	

Two-Step Cluster Analysis
Countries doesn't Classified in any Cluster
(Due to Missing Observations)

Eritrea	Romania
Italy	Saudi Arabia
Korea, Rep	Serbia
New Zealand	

Countries Classified in Second Cluster (Good Living Standard)

Albania	Denmark	Kazakhstan	South Africa
Algeria	Dominican, Rep	Kyrgyzstan	Spain
Argentina	Ecuador	Lebanon	Sri Lanka
Armenia	Egypt	Libyan Arab	Sweden
Australia	El Salvador	Malaysia	Switzerland
Austria	Finland	Mexico	Syrian Arab
Azerbaijan	France	Moldova	Tajikistan
Belarus	Georgia	Morocco	Thailand
Belgium	Germany	Netherlands	Tunisia
Bolivia	Greece	Nicaragua	Turkey
Bosnia and Herzegovina	Guatemala	Norway	Turkmenistan
Brazil	Honduras	Panama	Ukraine
Bulgaria	Hungary	Paraguay	United Arab Emirates
Canada	Indonesia	Peru	United Kingdom
Chile	Iran, Islamic, Rep	Philippines	United States
China	Iraq	Poland	Uruguay
Colombia	Ireland	Portugal	Uzbekistan
Costa Rica	Israel	Russian Fed	Venezuela RB
Croatia	Japan	Singapore	Viet Nam
Czech Republic	Jordan	Slovakia	

APPENDIX-B

Kohonen Self-Organizing Feature

Table B-1: Observed and Predicted Countries Categories with Winner

Countries	Observed	Predicted	Winner	Countries	Observed	Predicted	Winner
Afghanistan	PSL	PSL	5.00000	Côte d'Ivoi	PSL	PSL	5.00000
Albania	GSL	GSL	8.00000	Croatia	GSL	GSL	1.00000
Algeria	GSL	GSL	2.00000	Czech Repub	GSL	GSL	6.00000
Angola	PSL	PSL	5.00000	Denmark	GSL	GSL	6.00000
Argentina	GSL	GSL	7.00000	Dominican R	GSL	GSL	2.00000
Armenia	GSL	GSL	8.00000	Ecuador	GSL	GSL	2.00000
Australia	GSL	GSL	6.00000	Egypt	GSL	GSL	2.00000
Austria	GSL	GSL	6.00000	El Salvador	GSL	GSL	8.00000
Azerbaijan	GSL	GSL	3.00000	Eritrea	PSL	PSL	5.00000
Bangladesh	PSL	PSL	10.00000	Ethiopia	GSL	GSL	6.00000
Belarus	GSL	GSL	1.00000	Finland	GSL	GSL	6.00000
Belgium	GSL	GSL	6.00000	France	GSL	GSL	8.00000
Benin	PSL	PSL	5.00000	Georgia	GSL	GSL	6.00000
Bolivia(Plu	GSL	GSL	3.00000	Germany	PSL	PSL	10.00000
Bosnia and	GSL	GSL	1.00000	Ghana	GSL	GSL	6.00000
Brazil	GSL	GSL	2.00000	Greece	GSL	GSL	9.00000
Bulgaria	GSL	GSL	1.00000	Guatemala	PSL	PSL	5.00000
Burkina Fas	PSL	PSL	5.00000	Guinea	PSL	PSL	4.00000
Burundi	PSL	PSL	5.00000	Haiti	GSL	GSL	9.00000
Cambodia	PSL	PSL	4.00000	Honduras	GSL	GSL	1.00000
Cameroon	PSL	PSL	11.00000	Hungary	PSL	PSL	10.00000
Canada	GSL	GSL	6.00000	India	GSL	GSL	9.00000
Central Afri	PSL	PSL	5.00000	Indonesia	GSL	GSL	2.00000
Chad	PSL	PSL	5.00000	Iran (Islam	GSL	GSL	9.00000
Chile	GSL	GSL	7.00000	Iraq	GSL	GSL	6.00000
China	GSL	GSL	3.00000	Ireland	GSL	GSL	6.00000
Colombia	GSL	GSL	2.00000	Israel	GSL	GSL	6.00000
Congo	PSL	PSL	11.00000	Italy	GSL	GSL	2.00000

Congo (Demo	PSL	PSL	5.00000	Japan	GSL	GSL	0.00000
Costa Rica	GSL	GSL	7.00000	Jordan	PSL	PSL	4.00000
Kazakhstan	GSL	GSL	7.00000	Rwanda	PSL	PSL	5.00000
Kenya	PSL	PSL	4.00000	Saudi Arabia	GSL	GSL	0.00000
Korea (Repu	GSL	GSL	2.00000	Senegal	GSL	GSL	0.00000
Kyrgyzstan	PSL	PSL	5.00000	Serbia	GSL	GSL	8.00000
Lao People'	GSL	GSL	7.00000	Sierra Leon	PSL	PSL	4.00000
Lebanon	PSL	PSL	4.00000	Singapore	GSL	GSL	0.00000
Liberia	PSL	PSL	11.00000	Slovakia	GSL	GSL	6.00000
Libyan Arab	GSL	GSL	0.00000	Somalia	GSL	GSL	2.00000
Madagascar	PSL	PSL	11.00000	South Africa	GSL	GSL	8.00000
Malawi	PSL	PSL	5.00000	Spain	PSL	PSL	4.00000
Malaysia	GSL	GSL	7.00000	Sri Lanka	GSL	GSL	2.00000
Mali	GSL	GSL	8.00000	Sudan	PSL	PSL	4.00000
Mauritania	GSL	GSL	9.00000	Sweden	GSL	GSL	2.00000
Mexico	PSL	PSL	11.00000	Switzerland	GSL	GSL	2.00000
Moldova (Re	PSL	PSL	10.00000	Syrian Arab	GSL	GSL	7.00000
Morocco	PSL	PSL	10.00000	Tajikistan	PSL	PSL	11.00000
Mozambique	GSL	GSL	6.00000	Tanzania	GSL	GSL	1.00000
Myanmar	GSL	GSL	9.00000	Thailand	GSL	GSL	6.00000
Nepal	PSL	PSL	11.00000	Togo	GSL	GSL	6.00000
Netherlands	PSL	PSL	5.00000	Tunisia	GSL	GSL	6.00000
New Zealand	GSL	GSL	0.00000	Turkey	GSL	GSL	7.00000
Nicaragua	PSL	GSL	9.00000	Turkmenistan	GSL	GSL	8.00000
Niger	GSL	GSL	3.00000	Uganda	GSL	GSL	2.00000
Nigeria	PSL	PSL	4.00000	Ukraine	GSL	GSL	9.00000
Norway	GSL	PSL	10.00000	United Arab	PSL	PSL	10.00000
Pakistan	GSL	GSL	3.00000	United King	PSL	PSL	5.00000

Panama	GSL	GSL	3.00000	United Stat	PSL	PSL	10.00000
Papua New G	GSL	GSL	1.00000	Uruguay	PSL	PSL	5.00000
Paraguay	GSL	GSL	7.00000	Uzbekistan	GSL	GSL	8.00000
Peru	GSL	GSL	1.00000	Venezuela	GSL	GSL	2.00000
Philippines	PSL	PSL	11.00000	Viet Nam	PSL	PSL	5.00000
Poland	PSL	PSL	4.00000	Yemen	GSL	GSL	7.00000
Portugal	PSL	PSL	5.00000	Zambia	GSL	GSL	8.00000
Romania	GSL	GSL	0.00000	Zimbabwe	GSL	GSL	6.00000
Russian Fed	GSL	GSL	1.00000				