Developmental Performance Ranking of SAARC Nations: An Application of TOPSIS Method of Multi-Criteria Decision Making

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Abstract

To be developed, nations are trying to cope up with the fast-changing economy and technology of the world. But the development of a nation does not depend only on these two factors rather several other indicators are essential to a country's development. The present study deals with the progress of the SAARC (South Asian Association for Regional Cooperation) countries towards development through social, economic and environmental stability. This study aims at analyzing the comparative developmental performance of the SAARC nations in accordance with the Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs). In this study, we have prioritized the 8 SAARC nations based on 4 indicators (economic, demographic, health and environment indicators) and 20 variables using the multi-criteria decision-making method (MCDM). The result showed that Sri Lanka has prioritized 1st followed by Bhutan. India has been ranked 4th and Afghanistan was least prioritized.

Clasificación del Desempeño del Desarrollo de las Naciones de SAARC: Una Aplicación del Método TOPSIS de Toma de Decisiones de Criterios Múltiples

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Resumen

Para desarrollarse, las naciones están tratando de hacer frente la rapidez con la que cambian la economía y la tecnología en el mundo. Pero el desarrollo de una nación no depende solo de estos dos factores, sino de varios otros indicadores esenciales para el desarrollo de un país. El presente estudio aborda el progreso de los países de la SAARC (Asociación de Asia Meridional para la Cooperación Regional) hacia el desarrollo a través de la estabilidad social, económica y ambiental. El objetivo es analizar el desempeño comparativo del desarrollo de las naciones SAARC de acuerdo con los Objetivos de Desarrollo del Milenio (ODM) y los Objetivos de Desarrollo Sostenible (ODS). Hemos priorizado las 8 naciones de la SAARC en base a 4 indicadores (económicos, demográficos, de salud y ambientales) y 20 variables utilizando el método de toma de decisiones con criterios múltiples (MCDM). El resultado mostró que Sri Lanka ha priorizado primero seguido por Bután. India ocupó el cuarto lugar y Afganistán recibió menos prioridad.

Palabras clave: desarrollo sostenible, naciones SAARC, toma de decisiones multi-criterio, TOPSIS, priorización

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T he present age is the age of globalization, co-operation and developing international relations. To withstand in this fast-changing as well as the growing world, every developing and underdeveloped countries want to attain the status of the developed nation. So, do the South Asian Association for Regional Cooperation (SAARC) nations comprising of eight nations i.e., Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka, desire the same. SAARC nations are concerned with economic and human capital i.e., an essential requirement by any nation to change its status from being developing to developed; these are used as a resource to support the economic and social development of nations. The focus of SAARC nations is not only on the development, but they are more focused on sustainable development; sustainable development is a development that meets the needs of the current generations without compromising the needs of future generations. Governments and societies of this organization (SAARC) seek economic and social growth but at the same time, it is also concerned about its impact on natural and social environments. These countries are concerned about developing their nation but also about the inequality, the possibilities of new forms of exclusions as the technology expands, the quality of life and health of children, the elderly and individuals and groups confronting social and economic disadvantages (Healy & Côté, 2001). These nations are experiencing extensive development due to recent policies and trends in recent decades. To achieve social and economic sustainable development, we need to recognize the resources and opportunities for their exploitation (Andrade et al., 2015).

The strength and development of any nation today is not measured only in terms of military and defense capacity but also lies in terms of how a nation is able to promote trade relations, investments and economic integration within the region and globally as well (Tønnesson, 2005).From the very beginning of the formation of SAARC, there have been tremendous improvements in the member nations owing to the realization of regional cooperation and development and recognizing the sense of enhancing the regional economic, social and cultural development. At the same time advocating the revival of the SAARC organization by granting the practical implementation of plans and policies and turning this weak region into the

potentially developed region (Shaheen, 2013). Government and policymakers often face difficulties in making complex decisions that will help in the growth of a nation. These difficulties arise mainly due to a lot of factors or indicators required in making decisions as well as their interdependencies with each other, creating trouble for decision-makers to understand the problem (Zavadskas et al., 2016). The extent of factors and their interactions causes complexity in making decisions for policy and planning makers (Witlox, 2005). The ranking of India is 131 among 188 nations according to the 2016 Human Development Report released by the United Nations Development Programme (UNDP) (3rd among SAARC nations). Sri Lanka (73) and Maldives (105) are ahead of India and Bhutan (132), Bangladesh (139), Nepal (144), Pakistan (147) and Afghanistan (169) got places after India (Jāhāna, 2016). HDI ranking is based on only 3 indicators: Health (life expectancy at birth), Education (mean years of schooling and expected years of schooling) and income (Gross National Income per capita in PPP$). But there can be numerous other parameters (demographic, economic, health and social, etc.) on which we can rank these nations, but a country ranked first on one indicator may fall at last position at the other indicators. So, dealing with all parameters simultaneously is a difficult task. Surmounting this difficulty, the above problem can be considered a problem of multi-criteria decision making (MCDM).

MCDM refers to a set of methods which deal with searching for alternatives in the presence of multiple, usually conflicting, criteria (Jiang et al., 2017). For a given series of alternatives and decision criteria, MCDM aims to give ranking, preference, and sorting of alternatives from least preferred to most preferred. The technique for Order Performance by Similarity to Ideal Solution (TOPSIS) is one of the methods of MCDM to prioritize the alternatives. It was originally developed by Hwang and Yoon in 1981 (Hwang & Yoon, 1981) and further developed by Yoon in 1987 (Yoon, 1987).

TOPSIS is a method that is based on the concept that the chosen alternative is the shortest distance from the positive ideal solution (PIS) and the longest distance from the negative ideal solution (NIS). The advantages of TOPSIS are that it is a simple, rationally, comprehensible concept, good computational efficiency and the ability to compute the relative importance

of each alternative in the simple mathematical form (Yeh, 2002). The motivation behind working on SAARC nations is that SAARC countries are home to 23 percent of the world population which are very much dissimilar in terms of their demographic sizes and stages of socio-economic development. The SAARC region shares the second largest concentration of the poor population after Sub-Saharan Africa (Hanushek & Wößmann, 2007).

In the present study, we have taken certain parameters that govern the sustainable development of the nation. The economic, demographic, health, employment, and environmental indicators vary from place to place. So, prioritizing the nations is based on these indicators using the technique of TOPSIS, multi-criteria decision making.

Scientific Literature Review

The three pillars of HDI calculations are life expectancy, education, and per capita income. Based on these averages, we measure a country's level of social welfare. But these averages provide us limited information about distribution within countries. Human development is not based on only these three factors rather it should be all-round development. Corresponding to the HDR, Human development is realized most essentially by having a long and healthy life, being educated, and having a decent standard of living and these can be achieved by political freedom and guaranteed human rights involving several factors which are considered in our parameters such as access to safe drinking water, electricity, improves sanitation facilities, etc. Here the question arises is that themeasure of human development is based on only the three factors considered in HDI.

The World Commission on Environment and in 1987 laid down the notion of sustainable development (inter- and intra-generational environmental and social justice) on the international agenda (Brundtland, 1987). Despite the works of different organizations in this field, international inter-governmental meetings and authoritative declarations, the global social, economic and environmental indicators are found to be stagnant in the role of human development. The sustainable development worldwide can be achieved if we focus on the health, self-realization, access to minimum

necessary materials, clean and diverse environment, education, etc.Hence, a broad display of newfangled substitutes of HDI has unrolled embracing a wide range of indicators such as Michael Porter's Social Progress Index (Porter et al., 2014) towards further particular alternatives, for instance, Helliwell et al. (2016) Ranking of Happiness or the New Economics Foundation's Happy Planet Index (Comim, 2016). There was a time when Morris's (1978) Physical Quality of Life Index was considered as a stern alternative to the HDI.

The existing measure of economic and social welfare is GNI per capita in HDI which ignores the distribution of income among individuals (Marcuss & Kane, 2007; McCulla & Smith, 2007). Dissemination of income among individuals augments personal and social wellbeing which GNI per capita fails to assess (Kerry et al., 2012). Various goals of developments such as cultural differences are flouted by GNI per capita (Henderson, 1996), superintending the aftermaths of mounting social-economic-political-ecological disparities. HDI excludes the environment, overlooking the environmental costs, natural resources diminution rates, which is an essential factor in human as well as a nation's growth (Giannetti et al., 2015). HDI does not take into account the green GDP that targets to apprehend the real stance of the natural resources of the country. Most nations in the race of development have utterly snubbed the economic aspects of the misuse of the environment. Including the environmental factors will measure the country's preparation for sustainable development. Another important aspect lacked by HDI is unemployment. Creating and initiating strategies for expressive and dynamic work for young generations is one of the important targets of the Millennium Development Goals (Taner et al., 2011) and can be further considered as a fundamental human right. Employment institutes the indispensable tool for harmony, food security, and human development. Escalating employment levels nurtures economic growth and pave paths for accomplishing sustainable development. Therefore, in our study, we have tried to propose the key parameters for the new and natural vision of sustainable human development, which is going to be in accordance with the international strategies of sustainable development and millennium development goals.

Materials and Methods

The present study is the Ranking of SAARC countries based on several indicators. The study area is for the countries Afghanistan, Bhutan, Bangladesh, India, Maldives, Nepal, Pakistan, and Sri Lanka. The data was taken from the World Bank database of the year 2016 for imports and exports of goods and services, GDP growth rate, unemployment % of labor force and age dependency ratio; 2015 for improving sanitation facilities, improved water sources, forest area, life expectancy at birth for both males and females, maternal mortality ratio, infant mortality rate, adult literacy rate, fertility rate, crude birth and death rates, and urban population; 2014 for health expenditure. Here, we have selected 20 parameters for ranking these countries which are responsible for the growth and development of a country. These parameters can be classified in Economic, demographic, health and environmental indicators.

The first indicator included in our study isan economic indicator that contains four variables, namely, imports and exports of goods and services (OECD, 2018a), GDP growth (OECD, 2018b) and total unemployment (OECD, 2018e). Importing and exporting assist in the growth of the national economies and magnify the global market. Expanding exports create employment opportunities and being a component of aggregate demand, it creates demand in the economy as well as plays a crucial role in deciding the current deficit. GDP growthis the total of gross value added by all the producers residing in an economy in addition to any product taxes and exclusion of any subsidies not included in the value of the products. The growth of an economy is measured by the change of its output and the real income of its residents (OECD, 2018b).The countries having low rates of unemployment can have disguised of substantial poverty whereas the countries having a high level of economic development but low rates of poverty can have high rates of unemployment. There will be a less or ineffective contribution to the growth and development of a nation if there is a presence of unemployed or underemployed youths. [SDG Indicator 8.5.2]

The second indicator is the demographic indicator which has six variables viz. Adult literacy rate (World Bank, 2015), total fertility rate, crude birth (OECD, 2018a) and death (Guest, 1974) rates, urban population

and age dependency ratio (Bongaarts, 2001). A high literacy rate indicates the ability of an education system to provide a large population with opportunities to acquire literacy skills and can also be used as a proxy indicator to measure the effectiveness of an education system (World Bank, 2015). Developing nations have high fertility rate as it adheres to traditional religious beliefs, lack of knowledge of contraceptives and access to it, owing to lower level of female education, desire of children for their labors and as a support in old age whereas in developed nations having lower fertility rates often correlated with prosperous wealth, quality education, high degree of urbanization and other factors. To being developed, every developing nation tries to reduce its fertility rate. The birth rate is an important issue of concern for policymakers and the government of a country. It varies with nations to increase or decrease the birth rate e.g. countries like Italy and Malaysia seek to increase their birth rates while China seeks to decrease their birth rate (One-Child policy). Policies to increase the crude birth rate are called pro-natalist policies and policies to reduce the crude birth rate are called anti-natalist policies. So, for any nation, the crude birth rate is an important character in the development of the nation. The crude death rate can be considered as a good indicator of the general health status of a country. Crude Death Rate helps in deciding the health policies of a nation. So, statistics on death are crucial for the growth of any developing nation (Statistical Office United Nations, 1991). The global significance of urbanization can be seen through the demographic transition from rural to urban, and movement from an agriculture-based economy to mass industry, technology, and service in search of more favorable resolutions of social and environmental problems. There are more job opportunities, health care facilities, and other modern services at urbanized centers. Urbanization also provides opportunities for social mobilization and women's empowerment (UNPD, 2014). The age composition of a country's population partly indicates the development pattern of the country and has different impacts on the environment and resources owing to the different age structures. Therefore, to analyze the resource use and formulate future policy and planning goals, the age structure of a population is of great use (World Bank, 2017).

The third indicator is health indicator which has five variables that are the infant mortality rate (Reidpath & Allotey, 2003), the under-five mortality rate (UN IGME, 2017), life expectancy at birth (OECD, 2018c), total health expenditure (WHO, n.d.) and Maternal Mortality Ratio. IMR is an important indicator to know the health status of a country. Since there are less data on incidence and prevalence of diseases, the mortality rates for different age groups (infants, under five, etc.) are of great importance in identifying the vulnerable populations and can also be used to compare socioeconomic developments across the countries (UNICEF, 2017). Under-five mortality rates are a leading indicator that shows child health as well as the overall development of a nation. This indicator can be used to identify the susceptible population as the data on the incidence and prevalence of diseases can be unavailable and it can also be used to compare the socio-economic development of the countries (UNICEF, 2017). An increase in life expectancy at birth can be credited to the increase in the standard of living, improved education facilities, improved health facilities and gain in other socio-economic factors. The creation of institutions and defining the action plan to promote, restore and maintain the health status of the population is of key importance (Shreshta, 2000). To reduce the incidence and prevalence of diseases and to further reduce the mortality and morbidity, there is a need for strengthening health system through financing, service delivery, workforce, governance and information which in turn will lead to a better development of nation (WHO et al., 2015). The effective capacity of the health system of a nation can be identified by this indicator as it signifies the inadequate nutrition and general health of women as well as the lack of fulfillment of their reproductive rights.

The fourth indicator is an environment that includes four variables given as Forest area, Improved sanitation facilities (WHO & UNICEF, 2017), Improved water source (WHO & UNICEF, 2017) and Access to electricity. There has been a tremendous increase regarding the focus on the conservation of biodiversity owing to the increasing threats to biodiversity in the name of development. Destruction of forests and exploitation of its resources to meet the need of the population has become a vital concern for conserving the flora and fauna. Information on forest areas helps many international as well as government agencies in formulating plans and

policies concerning the development of the nation. Sanitation is fundamental to human development. Several international organizations use hygienic sanitation facilities as a measure of progress to fight against poverty, disease, and death. Proper sanitation access is considered as the right of humans. Inadequacies in sanitation facilities cause major diseases and have a significant adverse effect on human health. Water is a life-supporting element for humans, animals, and plants. Meagerness in water sources causes major diseases (diarrhea, cholera, etc.) world-wide. Global access to a safe water source can help in reducing the waterborne disease and illnesses and lead to improved health, poverty reduction and socio-economic development. Economic growth cannot be achieved without electricity. It is impossible for the functioning of the factories, shops, growing crops, etc. without access to any form of energy. Electricity is an indispensable form of energy for human development.

TOPSIS Model

This is a widely used method in solving real-life problems (Yang & Hung, 2007) allowing the decision-makers to incorporate complete information on given criteria and provide us optimal solutions or alternative ranking. This method consists of searching among the given alternatives that are closest to the ideal solution and farthest from the non-ideal solution at the same time (Marković, 2016). TOPSIS results depend on the assignment of the weights to the variables by the decision-makers. A set of weights W= {w_1, w_2, …, w_n} is assigned to the parameters such that $\sum_{j=1}^{n} w_j = 1$.

TOPSIS algorithm

Step 1: The first step in processing the TOPSIS method is the construction of the decision matrix (DM) consisting of m alternatives and n criteria.

Where A_i's are the alternatives and C_j's are the criteria or variables based on which we will be finding our ideal solutions and X_{ij}'s are the interactions of the alternatives and the criteria.

$$DM = \begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{array}{ccccc} C_1 & C_2 & \cdots & C_n \\ \begin{bmatrix} X_{11} & X_{12} & & X_{1n} \\ X_{21} & X_{22} & & X_{2n} \\ & & & \\ X_{m1} & X_{m2} & & X_{mn} \end{bmatrix} \end{array} \tag{1}$$

Step 2: Now, we will normalize the decision matrix to make the dimension of the variable free allowing comparisons across the criteria. Since the various criteria in the decision matrix are measured in the different units, the scores in the decision matrix need to be normalized. Each entry in the normalized matrix R is obtained by the formula given below:

For maximum type criteria,

$$R = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{m} X_{ij}^2}} \tag{2}$$

For minimum type criteria,

$$R = 1 - \frac{X_{ij}}{\sqrt{\sum_{i=1}^{m} X_{ij}^2}} \tag{3}$$

Here, equation (2) is for the parameters which have a positive impact on the development of a nation owing to their higher values and equation (3) is for those parameters which have a negative impact on the development of a nation owing to their higher values. So that assigning the proper weights to the parameters according to their importance is feasible in calculating their prioritization (Marković, 2016).

R matrix is given as:

$$R = \begin{bmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots \\ r_{m1} & \cdots & r_{mn} \end{bmatrix} \tag{4}$$

Step 3: To obtain the weighted normalized matrix, we multiply the j_{th} column of R by w_j, normalized decision matrix V is given as follows:

$$V = \begin{bmatrix} v_{11} & \cdots & v_{1n} \\ \vdots & \ddots & \vdots \\ v_{m1} & \cdots & v_{mn} \end{bmatrix} = \begin{bmatrix} r_{11}w_1 & \cdots & r_{1n}w_n \\ \vdots & \ddots & \vdots \\ r_{m1}w_1 & \cdots & r_{mn}w_n \end{bmatrix}$$

(5)

Step 4: Now, we will obtain the positive ideal solution and negative ideal solution denoted by S_+ and S_- respectively.

S₋ = [{max (v_{ij}|i=1, 2, …, m) |j∈J₋}, {min (v_{ij}|i=1, 2,.., m)|j∈J₊}]
    = {S_{-j}, j= 1, 2, …, n} [ideal alternative coordinates]   (6)

S₊ = [{min (v_{ij}|i=1, 2, …, m) |j∈J₋}, {max (v_{ij}|i=1, 2, …, m) |j∈J₊}]
= {S_{+j}, j= 1, 2, …, n} [non-ideal alternative coordinates]   (7)

    Where,
J₊ = {j = 1, 2, …, n|j associated with the criteria having a positive impact}
J₋ = {j = 1, 2, …, n|j associated with the criteria having a negative impact}

Step 5: Now, we will calculate the distance D_{i+} of each alternative A_i from the ideal solution by the given formula:

$$D_i^+ = \sqrt{\sum_{j=1}^{n}(v_{ij} - S_j^+)^2}$$

(8)

i = 1, 2, …, m, the distance of the i_{th} alternative form the ideal point. We will calculate the distance D_{i-} of each alternative A_i from the non-ideal solution by the given formula:

$$D_i^- = \sqrt{\sum_{j=1}^{n}(v_{ij} - S_j^-)^2}$$

(9)

i = 1, 2, …, m, the distance of the i_{th} alternative form the non-ideal point.

Step 6: Now, we will calculate the relative similarity of the alternatives from the ideal and non-ideal point using the given formula:

$$C_i = \frac{D_i^-}{D_i^- + D_i^+}, \ 0 \leq C_i \leq 1, \ i = 1, 2, \ldots, m \tag{10}$$

If $C_i = 1$, then $A_i = S_+$ and if $C_i = 0$, then $A_i = S_-$, therefore A_i is closer to S_+ if C_i is closer to 1.

Step 7: Now, we will be setting up the rank according to the bigger C_i, this means that the bigger C_i would be the better alternative.

Results and Discussions

In our study, we have considered several factors that are broadly classified into four major indicators (economic, demographic, health and environment indicators) which are further classified into several important indicators that play an important role in human development. Here, we have a total of 20 variables to measure the growth of a human. Hence, we used the TOPSIS method mentioned in the materials and methods to deal with these 20 variables simultaneously and our decision matrix for the variables is given in Table 1. After making the decision matrix, we will now have normalized the decision matrix using the equation (2) for the maximum type criteria which have a positive impact on the development of a nation owing to the higher values (e.g. Exports of Goods and Services, GDP Growth Rate, Access to Electricity, Improved Sanitation, Water Facilities, Forest Area, Life Expectancy at Birth Males and Females and Urban Population percentage) and equation (3) for the minimum type criteria which have negative impact on the development of nation owing to the higher values (e.g. MMR, IMR, Under Five Mortality Ratio, TFR, Health Expenditure, CBR, CDR and Imports of Goods and Services) given in the materials and methods. A normalized matrix is given in Table 2. After considering the relative importance of each variable, the weights to these variables were allotted such that the variables which are crucial in the growth and development of a nation were allotted higher weights and rest were allotted relatively low weights. The weights assigned to these variables are given in Table 3. Using

equation (5) in the materials and methods section, we constructed the weighted normalized decision matrix is given in Table 4.

Using the equation (6) and (7) from the material and methods section, we obtained the positive and negative ideal solution, given in Table 5. Using equation (8) and (9) in the materials and method section, we obtained the distance of each alternative from the positive and negative ideal solution is given in Table 6. Now, we obtained the relative similarity of the alternatives from the ideal and non-ideal point using the equation (10) given in the materials and method section based on which we ranked the countries is given in Table 7.

The result was found to be efficient using this technique. Ranking of the countries has been found in the following manner: Sri Lanka (1_{st}), Bhutan (2_{nd}), Maldives (3_{rd}), India (4_{th}), Bangladesh (5_{th}), Nepal (6_{th}), Pakistan (7_{th}) and Afghanistan (8_{th}). From the decision matrix, we can observe the evidence in support of the result obtained. Since TOPSIS is an MCDM technique which considers several factors simultaneously for prioritization of alternatives, so here we can observe that Sri Lanka is performing better than other SAARC nations in several parameters such as Unemployment % of total labor force, Improved sanitation facilities (% of population with access), Maternal mortality ratio, Infant mortality rate, Life expectancy at birth (both males and females), Age dependency ratio (% of working-age population), Crude birth and death rates. Sri Lanka has also been found performing above average in other parameters among the SAARC nations.

India has been ranked (4_{th}) and it can be justified by comparing the variables with the top prioritized countries. The empirical evidence in support of the result is as follows: India's Exports of goods and services are 19.9% of GDP which is lower than all the three top prioritized countries Bhutan (32.9), Maldives (91.4) and Sri Lanka (21). India has higher Unemployment % of the total labor force of 3.5 which is greater than Bhutan (2.5). India has lower (a) access to electricity (% of Population) of 79.2 than Bhutan (100), Maldives (100) and Sri Lanka (92.2); (b) improved sanitation facilities (% of population) of 40 than Bhutan (50), Maldives (98) and Sri Lanka (95); (c) life expectancy at birth both females and males of 70 and 67 respectively than Maldives (78,76), Sri Lanka (78,72) and Sri Lanka (70,70); (d) adult literacy rate (population 15+ years both sexes%) of 72 than

Maldives (99) and Sri Lanka (93); (e) urban population % of 33 than Bhutan (39) and Maldives (46); these factors have a positive impact on the development of a nation and owing to higher values show higher growth of a nation. India has higher (a) MMR of 174 than Bhutan (148), Maldives (68) and Sri Lanka (30); (b) IMR of 38 than Bhutan (27), Maldives (7) and Sri Lanka (8); (c) under-five mortality ratio of (48) than Bhutan (33), Maldives (9) and Sri Lanka (10); (d) total fertility rate of (2.4) than Bhutan (2), Maldives (2.1) and Sri Lanka (2.1); (e) age dependency ratio (% of working-age population) of 52 than Bhutan (47), Maldives (47) and Sri Lanka (51); (f) CBR of 20 than Bhutan (17) and Sri Lanka (16); (g) CDR of 7 than Bhutan (6) and Maldives (4); these are the factors which imparts negative impact on the growth of the nation's owing to their higher values. The result also shows that Sri Lanka is moving in the right direction towards attaining the Sustainable Development Goals.

Conclusions

This study measured the knowledge level of awareness regarding the development of nations concerning the factors associated with the economic development, accessibility to the health services, and demographic approach of the countries, employment enrollment factor, and proportion of forest land. Thus, the development of nations with the factors thereof means keeping with the pace of the fast-changing world and maintaining the social stability of nations and considering the factors associated with the environment.

In recent times multi-criteria decision-making problem (MCDM) has found the TOPSIS algorithm which is widely used to prioritize the multi attributes in making decisions and help us in making an optimum decision based on several factors or variables.

Here, the TOPSIS algorithm helped us in prioritizing the SAARC nations based on the five indicators and twenty-two variables. This study showed us that Sri Lanka is performing well towards its development followed by Bhutan. India has been found in 4th position followed by Bangladesh and posts to the Maldives. In our study, we observed that Bhutan is two places above India in contrary to the HDI ranking where Bhutan's ranking is below

India. This result is attributed to the large forest cover in Bhutan and lower IMR, TFR, MMR than India and a greater ratio of access to electricity, improved sanitation facilities and improved drinking water as compared to India. Therefore, we can say that Bhutan is better in proratingtheir resources following the sustainable development and millennium development goals than India. The result is more analogous to the Human Development Ranking (HDI) published on 21st March 2017 with the following rankings of the considered countries in the study: Sri Lanka (73), Maldives (105), India (131), Bhutan (132), Bangladesh (139), Nepal (144), Pakistan (147) and Afghanistan (169). The ranking of the SAARC countries is shown in table 8.

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Annexes

Table 1.
Decision Matrix

Countries	Imports of goods and services (% of GDP)	Exports of goods and services (% of GDP)	GDP growth rate (annual %)	Unemployment % of total labor force	Access to electricity % of population	Improved sanitation facilities (% of population with access)	Improved water source (% of population with access)	Forest area (% of land area)	Life expectancy at birth (females)	Life expectancy at birth (males)	MMR (per 100000 live births)	IMR (per 1000 live births)	Under 5 mortality rate (per 1000 live births)	Health expenditure total (%of GDP)	Adult literacy rate population 15+ years both sexes (%)	TFR (births per woman)	Age dependency ratio (%of working-age population)	CBR	CDR	Urban population (%)
Afghanistan	49	6.9	2.2	8.5	89.5	32	55	2.1	62	60	396	66	91	8.2	38	4.7	85	33	8	27
Bangladesh	21.3	16.6	7.1	4.1	62.4	61	87	11	73	71	176	31	38	2.8	61	2.1	51	19	5	35
Bhutan	52.1	29.4	6.2	2.4	100	50	100	72.3	70	70	148	27	33	3.6	64	2	46	17	6	39
India	20.6	19.2	7.1	3.5	79.2	40	94	23.8	70	67	174	38	48	4.7	72	2.4	52	20	7	33
Maldives	89	93.8	4.1	3.2	100	98	99	3.3	78	76	68	7	9	13.7	99	2.1	47	21	4	47
Nepal	39.4	10.7	0.6	3.2	84.9	46	92	25.4	71	69	258	29	36	5.8	65	2.2	60	20	6	19
Pakistan	15.8	8.7	5.7	5.9	97.5	64	91	1.9	67	65	178	66	81	2.6	56	3.5	65	29	7	39
Sri Lanka	29.1	21.4	4.4	5	92.2	95	96	33	78	72	30	8	10	3.5	93	2.1	51	16	7	18

Table 2.
Normalized Matrix

Countries	Imports of goods and services (% of GDP)	Exports of goods and services (% of GDP)	GDP growth rate (annual %)	Unemployment % of total labor force	Access to electricity % of population	Improved sanitation facilities (% of population with access)	Improved water source (% of population with access)	Forest area (% of land area)	Life expectancy at birth (females)	Life expectancy at birth (males)	MMR (per 100000 live births)	IMR (per 1000 live births)	Under 5 mortality rate (per 1000 live births)	Health expenditure total (%of GDP)	Adult literacy rate population 15+ years both sexes (%)	TFR (births per woman)	Age dependency ratio (%of working- age population)	CBR	CDR	Urban population (%)
Afghanistan	0.6193	0.0658	0.1507	0.3790	0.3555	0.1744	0.2154	0.0240	0.3074	0.3079	0.3246	0.4166	0.3744	0.4380	0.1894	0.4039	0.4854	0.4832	0.5556	0.2849
Bangladesh	0.8345	0.1583	0.4863	0.7005	0.2478	0.3324	0.3407	0.1256	0.3620	0.3643	0.6998	0.7260	0.7387	0.1496	0.3040	0.7337	0.6912	0.7024	0.7222	0.3694
Bhutan	0.5952	0.2803	0.4247	0.8247	0.3972	0.2724	0.3917	0.8257	0.3471	0.3592	0.7476	0.7614	0.7731	0.1923	0.3190	0.7463	0.7215	0.7338	0.6667	0.4116
India	0.8399	0.1830	0.4863	0.7443	0.3146	0.2179	0.3682	0.2718	0.3471	0.3438	0.7032	0.6641	0.6700	0.2511	0.3589	0.6956	0.6852	0.6868	0.6111	0.3483
Maldives	0.3085	0.8942	0.2808	0.7662	0.3972	0.5340	0.3877	0.0377	0.3868	0.3900	0.8840	0.9381	0.9381	0.7318	0.4934	0.7337	0.7154	0.6711	0.7778	0.4960
Nepal	0.6939	0.1020	0.0411	0.7662	0.3372	0.2506	0.3603	0.2901	0.3521	0.3541	0.5599	0.7437	0.7525	0.3098	0.3240	0.7210	0.6367	0.6868	0.6667	0.2005
Pakistan	0.8772	0.0829	0.3904	0.5690	0.3872	0.3487	0.3564	0.0217	0.3322	0.3335	0.6964	0.4166	0.4431	0.1389	0.2791	0.5561	0.6065	0.5458	0.6111	0.4116
Sri Lanka	0.7739	0.2040	0.3014	0.6347	0.3662	0.5176	0.3760	0.3769	0.3868	0.3695	0.9488	0.9293	0.9312	0.1870	0.4635	0.7337	0.6912	0.7494	0.6111	0.1900

Table 3.
Weight assigned to the parameters

Countries	Imports of goods and services (% of GDP)	Exports of goods and services (% of GDP)	GDP growth rate (annual %)	Unemployment % of total labor force	Access to electricity % of population	Improved sanitation facilities (% of population with access)	Improved water source (% of population with access)	Forest area (% of land area)	Life expectancy at birth (females)	Life expectancy at birth (males)	MMR (per 100000 live births)	IMR (per 1000 live births)	Under 5 mortality rate (per 1000 live births)	Health expenditure total (%of GDP)	Adult literacy rate population 15+ years both sexes (%)	TFR (births per woman)	Age dependency ratio (%of working- age population)	CBR	CDR	Urban population (%)
Weights	0.03	0.04	0.05	0.03	0.04	0.07	0.07	0.06	0.06	0.06	0.07	0.06	0.06	0.04	0.06	0.05	0.06	0.03	0.03	0.03

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Table 4.
Weighted Normalized Decision Matrix

Countries	Imports of goods and services (% of GDP)	Exports of goods and services (% of GDP)	GDP growth rate (annual %)	Unemployment % of total labor force	Access to electricity % of population	Improved sanitation facilities (% of population with access)	Improved water source (% of population with access)	Forest area (% of land area)	Life expectancy at birth (females)	Life expectancy at birth (males)	MMR (per 100000 live births)	IMR (per 1000 live births)	Under 5 mortality rate (per 1000 live births)	Health expenditure total (%of GDP)	Adult literacy rate population 15+ years both sexes (%)	TFR (births per woman)	Age dependency ratio (%of working- age population)	CBR	CDR	Urban population (%)
Afghanistan	0.0186	0.0026	0.0075	0.0114	0.0142	0.0122	0.0151	0.0014	0.0184	0.0185	0.0227	0.0250	0.0225	0.0175	0.0114	0.0202	0.0291	0.0145	0.0167	0.0085
Bangladesh	0.0250	0.0063	0.0243	0.0210	0.0099	0.0233	0.0239	0.0075	0.0217	0.0219	0.0490	0.0436	0.0443	0.0060	0.0182	0.0367	0.0415	0.0211	0.0217	0.0111
Bhutan	0.0179	0.0112	0.0212	0.0247	0.0159	0.0191	0.0274	0.0495	0.0208	0.0216	0.0523	0.0457	0.0464	0.0077	0.0191	0.0373	0.0433	0.0220	0.0200	0.0123
India	0.0252	0.0073	0.0243	0.0223	0.0126	0.0153	0.0258	0.0163	0.0208	0.0206	0.0492	0.0398	0.0402	0.0100	0.0215	0.0348	0.0411	0.0206	0.0183	0.0104
Maldives	0.0093	0.0358	0.0140	0.0230	0.0159	0.0374	0.0271	0.0023	0.0232	0.0234	0.0619	0.0563	0.0563	0.0293	0.0296	0.0367	0.0429	0.0201	0.0233	0.0149
Nepal	0.0208	0.0041	0.0021	0.0230	0.0135	0.0175	0.0252	0.0174	0.0211	0.0212	0.0392	0.0446	0.0451	0.0124	0.0194	0.0360	0.0382	0.0206	0.0200	0.0060
Pakistan	0.0263	0.0033	0.0195	0.0171	0.0155	0.0244	0.0249	0.0013	0.0199	0.0200	0.0487	0.0250	0.0266	0.0056	0.0167	0.0278	0.0364	0.0164	0.0183	0.0123
Sri Lanka	0.0232	0.0082	0.0151	0.0190	0.0146	0.0362	0.0263	0.0226	0.0232	0.0222	0.0664	0.0558	0.0559	0.0075	0.0278	0.0367	0.0415	0.0225	0.0183	0.0057

Table 5.
Positive and Negative Ideal Solution

Countries	Imports of goods and services (% of GDP)	Exports of goods and services (% of GDP)	GDP growth rate (annual %)	Unemployment % of total labor force	Access to electricity % of population	Improved sanitation facilities (% of population with access)	Improved water source (% of population with access)	Forest area (% of land area)	Life expectancy at birth (females)	Life expectancy at birth (males)	MMR (per 100000 live births)	IMR (per 1000 live births)	Under 5 mortality rate (per 1000 live births)	Health expenditure total (%of GDP)	Adult literacy rate population 15+ years both sexes (%)	TFR (births per woman)	Age dependency ratio (%of working- age population)	CBR	CDR	Urban population (%)
S_j^+	0.0263	0.0358	0.0243	0.0247	0.0159	0.0374	0.0274	0.0495	0.0232	0.0234	0.0664	0.0563	0.0563	0.0293	0.0296	0.0373	0.0433	0.0225	0.0233	0.0149
S_j^-	0.0093	0.0026	0.0021	0.0114	0.0099	0.0122	0.0151	0.0013	0.0184	0.0185	0.0227	0.0250	0.0225	0.0056	0.0114	0.0202	0.0291	0.0145	0.0167	0.0057

Table 6.
Distance from Positive and Negative Ideal Solution

Countries	D_i^+	D_i^-
Afghanistan	0.0996	0.0169
Bangladesh	0.0648	0.0565
Bhutan	0.0451	0.0763
India	0.0613	0.0551
Maldives	0.0516	0.0861
Nepal	0.0670	0.0485
Pakistan	0.0823	0.0424
Sri Lanka	0.0470	0.0800

Table 7.
Prioritization of Countries

Countries	C_i	Ranking
Afghanistan	0.1454	8
Bangladesh	0.4657	5
Bhutan	0.6287	2
India	0.4735	4
Maldives	0.6253	3
Nepal	0.4200	6
Pakistan	0.3400	7
Sri Lanka	0.6299	1

Table 8.
Ranking of SAARC Nations

Countries	C_i	Ranking
Sri Lanka	0.6299	1
Bhutan	0.6287	2
Maldives	0.6253	3
India	0.4735	4
Bangladesh	0.4657	5
Nepal	0.4200	6
Pakistan	0.3400	7
Afghanistan	0.1454	8

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