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Performance Reflections on Quality Education in Respect of SDGs: A Re-Assessment of Indian States and UTs Using TOPSIS Approach

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Abstract - **The success of Millennium Development Goals (MDGs) has led to the initiation of Sustainable Development Goals by the United Nations, earmarking a time frame of 2016–2030 for its achievement. The Sustainable Development Goals framework consists of 17 goals and 169 targets within the three broader dimensions of economic, social and environmental development. The performance evaluation of Indian states and union territories, available in SDG India Index Baseline Report, 2018, has been recently concluded by NITI Aayog. Focusing on goal 4that puts thrust on quality education, NITI Aayog has considered 7 criteria capturing targets 4.1 besides 4.c and 36 alternatives (Indian states and union territories) within a multi criteria decision making environment where criteria weights are assumed to be equal, performance calculated on the basis of simple arithmetic average theory and missing value cases not considered in their computation. This simplistic approach partially captures the effect of complex interplay between the multiple criterions. The purpose of this paper is to re-evaluate the performance of Indian states and union territories with respect to goal 4of Sustainable Development Goals, as estimated by NITI Aayog. It also aims to provide a more holistic picture on performance ranking by incorporating varying weights of criteria, as obtained from Shannon's entropy, and replacing arithmetic average theory with a more rigorous mathematical model within the domain of multi criteria decision making. In this study Technique for Order Preference by Similarity to Ideal Solution have been used to generate an index for ranking alternatives and all missing values have been figured from expectation maximization algorithm. As expected, rank reversal phenomenon has been observed and a very low level of convergence between ranks obtained from the proposed approach and that of NITI Aayog emerges.**
Keywords: **Sustainable Development Goals, Technique for Order Preference by Similarity to Ideal Solution, NITI Aayog, Shannon's Entropy Weight, Rank Convergence**

I. INTRODUCTION

The Sustainable Development Goals (SDGs) are viewed as an extension of Millennium Development Goals (MDGs) and adopted by the United Nations at the fifty fifth General Assembly in the year 2000. The meeting is also designated as the Millennium Summit which recommended a roadmap for world development in the next 15 years (2000–2015). It had eight goals and twenty one targets dealing primarily to eliminate poverty and hunger and focused on various issues such as gender, shelter, disease, education and climatic change. At the UN Rio+20 Conference, the member states met to create the document– 'The Future We Want' (United Nations, 2012). They developed 17 goals on the momentum of MDG by adding sustainability parameter based on three dimensions of development; namely economic, social and environmental. The same was proposed to be implemented in the post 2015 era. In September 2015, at its Sustainable Development Summit, the United Nations adopted the 2015-2030 agenda for global transformation. The Sustainable Development Goals (SDG) framework, that consists of 17 goals, 169 targets and 306 National Development Indicators, undertakes to provide systematic solutions to the obstacles identified while implementing the MDGs like inequality, sustainability, institutional resourcefulness, implementation efficacy, environmental deterioration, etc. (UN 2014). The SDGs are 'action oriented, global in nature and universally applicable' (UN, 2013b), and as described by Ban Ki-moon, former Secretary General of the UN, it is the 'to do list for planet and people' (UN, 2015a).The second most populous country in the world, India, is committed in making significant strides towards the attainment of SDGs. NITI Aayog is mandated with the job of developing an evaluation framework on the progress of SDGs in India. For this purpose a comprehensive mapping of SDG targets have been done involving Central Ministries, States and Union Territories (UT's), Civil Society Organization, Business and Academia (NITI Aayog, SDG India Index Baseline Report, 2018). In the light of 17 SDGs, NITI Aayog estimated the progress through a single measurable index which provides an assessment of the performance of Indian states and UT's. SDG India Index Baseline Report of NITI Aayog forms the basis of the present research, even though other reports and research studies were consulted in order to have a comprehensive understanding on the subject. The other reports referred in this study include Voluntary National Review Report (NITI Aayog, 2017) on the implementation of sustainable development goals; Sustainable Development Goals: Agenda 2030 (A Civil Society Report, 2017) and UN reports of various years. Demonstration of the action points for attainment of 17 SDGs and 169 associated targets are detailed in the report named Integrated and Coordinated Implementation of and Follow-Up to the Outcomes of the Major United Nations Conferences and Summits in the Economic, Social and Related Fields (General Assembly of the United Nations, 2015). With regard to individual research works, the concept of sustainability has been characterized through systems approach as the maximization of goals across three systems involving environmental, economic and social systems (Barbier, 1987;

Barbier & Markandya, 2012; Costanza *et al.*, 2016). This approach is attributed to Barbier (1987) who first identified the three systems as basic to any process of development. Focusing on universal education, an interesting article contends that localized understanding of lifelong learning has to be developed for achieving sustainability in promoting the inclusive education goal (Regmi, 2015).

This paper focuses on SDG 4 which mandates ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all. The targets under this goal cover learning outcomes, preprimary education, secondary, tertiary and vocational education. In the ensuing research we re-produce the aggregative measure of performance of Indian states and UTs after recognizing the gap in the performance measuring methods developed by NITI Aayog (2018). UNESCO (2016) guidelines for 2030 agenda identifies three underlying principles as follows: firstly, education is a fundamental human right and an enabling right; secondly, education is a public good and thirdly, gender equality is inextricably linked to the right to education for all. According to them, quality in education described as a composite of learning, quality of learning environment, the inputs, and quality of learning contents, the curriculum, the quality of teaching processes, the teacher, the teaching process and quality of learning assessment. Following the SDG India Index Baseline Report 2018 of NITI Aayog, that measures India's performance towards the attainment of SDG 4, seven national level indicators have been identified, which cover two SDG targets out of ten. These indicators have been selected by NITI Aayog on the basis of availability of data at national level and to provide the comparison across the Indian states and UT's. Table I captures these seven indicators, their national target values with further detailing on the abbreviations used in this study and the nature of the criteria, whether they are of benefit (max) of cost (min) type.

TABLE I SDG GLOBAL TARGETS AND THEIR INDICATOR DETAILS

SDG Global Target	Indicators Selected for SDG India Index	National Target Value	Abbreviations Used in study	Max / Min Criteria
4.1. By 2030 ensure that all girls and boys complete free equitable and quality primary and secondary education leading to relevant and effective learning outcome.	1. Adjusted net enrolment ratio at elementary(Class 1-8) and secondary(class 9-10) school	100	ANERES	Max
	2. Percentage of correct responses on learning outcomes on language, Mathematics and EVS for class 5 Students.	67.89	PCRC5	Max
	3. Percentage correct responses on learning outcomes on language, Mathematics and EVS for class 8 Students	57.17	PCRCB	Max
	4. Percentage of children in the age group of 6-13 who are out of school	0.28	PCOUS	Min
	5. Average annual dropout rate at secondary level	10	AADOSL	Min
4.c .By 2030 substantially increase the supply of qualified teachers including through international cooperation for teacher training in developing countries, especially least developed countries and small island developing states.	6. Percentage of school teachers professionally qualified	100	PSTPQ	Max
	7. Percentage of elementary and secondary school with Pupil Teacher Ratio less than /equal to 30.	100	PPTL30	Max

Source: UN (2015) and Author's computation

Target 4.1 captures effective learning outcome, a more elaborative version, whose aim is to provide access to lifelong learning opportunities across all the gender, region, income levels and most importantly social category. It holds true for all levels of education like elementary, primary, secondary, tertiary, technical and vocational. For target 4.1., five indicators have been particularly defined broadly focusing on enrolment ratio, learning outcome at elementary and junior high level and finally on the retention or the drop out measurement. Target 4.c. explores the criteria of increasing the supply of qualified teachers. The declaration adopted in SDG 4 clearly refer that all students at all levels from pre-primary to higher educational level should be taught by properly qualified, professionally trained, well-motivated teacher with high mentoring capability. Broadly, the two main targets of SDG 4 capture learning outcomes with special thrust on inclusive, lifelong learning opportunity and learning outcomes that can be achieved only through fostering quality education through dedicated teacher.

This study is a humble initiative in developing a modified index for measuring the performance of Indian States and UT's towards attainment of SDG 4. The index developed by NITI Aayog that ranks Indian States and UT's considers a multi criteria decision making approach with the assumption of equal priority of criteria i.e. equal weights assigned to individual criterions. Also null values were assumed for the missing data, and they were not included in the priority estimation. Further the simple arithmetic average theory has been deployed to arrive at the score for alternatives. This approach being oversimplified captures the partial effect of the complex interplay of criteria that transpires concurrently. It is this gap which creates further scope for modifying and capturing a more realistic situation by developing a comprehensive ranking index based on an alternative MCDM approach. There are many MCDM methods that include SAW, ELECTRE, PROMETHEE, TOPSIS, VIKOR, AHP, ANP, MACBETH, and DEA to name a few. Of these the one proposed by Hwang & Yoon (1981) minimizes the distance to the ideal alternative and maximize the distance to the negative ideal solution and is termed as Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). This method owing to its intuitive nature and relative ease of computation finds huge application across varied disciplines (Behzadian, Otaghsara, Yazdani & Ignatius, 2012) including that of supply chain management, logistics, design, engineering and manufacturing system, business and marketing management, health, safety and environment management, energy management, human resource management, chemical engineering, water resource management along with other areas too. Such wide application of TOPSIS across multiple disciplines and its mathematical robustness inspired the researchers to consider it in the present study which aims at a holistic evaluation of performance. The computational process of TOPSIS also assigns weights to individual criteria to determine how relevant each criteria is in its contribution to the overall performance evaluation. The researchers also contemplate a change in the alternative ranking, and a low level of similarity between the outputs of the present research and that of NITI Aayog. Table II summarizes the differences in the grand narrative of the two approaches and thus justifies the need of this extension work using a more sophisticated mathematical approach.

TABLE II COMPARISON OF METHODS USED BY NITI AAYOG AND THE PROPOSED METHOD

Characterstics	Method used by NITI Aayog	Proposed Method (TOPSIS)
Evaluation Objective	Priority order of alternatives	Priority order of alternatives
Number of Alternatives	Any finite number	Any finite number
Number of Criteria	Any finite number	Any finite number
Classification of Criteria	Min - Max criteria concept applied	Min - Max criteria concept applied
Comparability of Criteria Data	Statistical normalization	Statistical Normalization
Weights of Criteria	Considered equal	Considered different. Evaluated objectively using entropic consideration
Mathematical Principle	Arithmetic average theory	Euclidian distance approach
Missing Data Treatment	Not included in priority computation	Missing data computation based on expectation maximization algorithm
Core Process	Composite score calculated as an arithmetic mean of criteria scores	Separation of each alternative from the best (PIS) and worst (NIS) solutions and then evaluating relativeness closeness
Choice Evaluation	Highest score is the best choice	Highest relative closeness is the best choice

Source: Author’s computation based on NITI Aayog SDG India Index Baseline Report 2018

The remainder of the paper is structured as follows. Section II elaborates the details of research methodology including that of the proposed TOPSIS approach. Section III captures the exhaustive findings and analysis while section IV concludes.

II. RESEARCH METHODOLOGY

The ensuing research is descriptive in nature and is based on cross sectional study design. Here, secondary data for a particular time frame is used. Government of India data base as reported in the SDG India Index Baseline Report (2018) that is open to access have been referred in this study. The data pertains to 29 states and 7 union territories in India and 7 criteria within the Goal 4 of SDGs have been considered. After collating the data, it was scanned to identify missing value cases. Two such cases were identified and missing replacement was made using the expectation maximization algorithm. Further, test of multi collinearity was conducted to check if any of the chosen criteria are redundant. Finally, this data was processed in R software. For evaluating the rank of alternatives i.e. Indian states and union territories, an MCDM approach, TOPSIS, is used, details of which is presented in section 3.I. Also, the convergence of outputs between ranks derived from these two approaches has been evaluated. For this we used the rank correlation method of Kendall’s Tau as many states and union territories indexed by NITI Aayog had tied ranks.

A. Proposed Approach

The Technique for order performance by similarity to ideal solution (TOPSIS), one of the known classical MCDM methods, was first developed by Hwang and Yoon (1981) and later used by large number of researchers across diverse disciplines (Shidpour, Shahrokhi & Bernard, 2013; Pinter & P. sunder, 2013; Park, Park, Kwun & Tan, 2011; Liu, 2009). It is based upon the concept that the chosen alternative should have the shortest distance from the positive ideal solution and farthest distance from the negative ideal solution. This method is highly intuitive, practical and an effective one. In this method (TOPSIS), the performance and the weights of each criterion are given as exact (precise) values. A review of the TOPSIS approach and its algorithm is presented in section 3.I.i.

1. TOPSIS Algorithm

The best decision alternative may be evaluated using TOPSIS through a series of steps:

Step 1: Normalization of Decision Matrix

$n_{ij} = x_{ij} \Big/ \sqrt{\sum_{j=1}^{m} x_{ij}^2}$; j = 1,2,…….m & i = 1,2,…….n

Step 2: Weighted normalized decision matrix. The weighted normalized values are calculated as

$v_{ij} = w_i n_{ij}$, j = 1,2,…….m; i = 1,2,…….n &

w_i = Weight of the i^th^ attribute or criterion and$\sum_{i=1}^{n} w_i = 1$, details of which is reviewed in 3.I.ii.

Step 3: Determination of Positive and Negative Ideal solution

$A^+ = \{v_1^+, \dots, v_n^+\} = \{ \left(\substack{max \\ j} v_{ij} \middle| i \in I\right), \left(\substack{min \\ j} v_{ij} \middle| i \in J\right) \}$

$A^- = \{v_1^-, \dots, v_n^-\} = \{ \left(\substack{min \\ j} v_{ij} \middle| i \in I\right), \left(\substack{max \\ j} v_{ij} \middle| i \in J\right) \}$

Where I is associated with the benefit criteria, and J is associated with the loss criteria.

Step 4: Calculation of separation measures, using the n-dimensional Euclidean distance.

The separation of each alternative from the positive and negative ideal solutions are given by

$d_j^+ = \left\{\sum_{i=1}^{n}\left(v_{ij} - v_i^+\right)^2\right\}^{\frac{1}{2}}$, j = 1,…m and $d_j^- = \left\{\sum_{i=1}^{n}\left(v_{ij} - v_i^-\right)^2\right\}^{\frac{1}{2}}$, j = 1,…m

Step 5: Calculation of Relative Closeness (Index) to Ideal Solution. The relative closeness of the alternative A_j with respect to A^+ is defined as

$$R_j = \frac{d_j^-}{\left(d_j^+ + d_j^-\right)}, \text{ j = 1,…m}$$

Since $d_j^- \geq 0$ and $d_j^+ \geq 0$, then clearly, $R_j \in [0, 1]$

Step 6: Ranking the preference order. For ranking using relative closeness (index) value, the larger the value better is the alternative as it is relatively closer to the ideal solution. Thus, the alternatives are ranked in decreasing order.

2. Choice of Weights

In an MCDM environment, weights of criteria reflect their relative importance in the overall decision making process. Because the evaluation of criteria entails diverse opinions and meanings, we cannot assume that each evaluation criterion is of equal importance (Chen, Tzeng, & Ding, 2003). There are two approaches to calculating weights, the subjective and objective methods. The subjective methods determine weight based on the preference or judgments of decision makers.

The objective methods use mathematical models to determine weights without any consideration of the decision maker's preferences. Of the various objective weighting measures that have been proposed by researchers, Shannon's entropy concept (Shannon & Weaver, 1947) is well suited for weight evaluation. Shannon entropy is a measure of uncertainty in information formulated in terms of probability theory. It is a highly established and popular method of weight determination in a multi-criteria environment and involves a stepwise computation as shown next.

Step i. Normalization of the data matrix as$p_{ij} = \frac{x_{ij}}{\sum_{j=1}^{m} x_{ij}}$, j = 1, 2, ….., m &i = 1,2,…., n

Raw data normalizing is done to rationalize the disparate units of measurement of criteria.

Step ii. Entropy E_i is calculated as $E_i = -h_0 \sum_{j=1}^{m} p_{ij} . \ln p_{ij}$

i.e. $E_i = -h_0 \sum_{j=1}^{m} \frac{x_{ij}}{\sum_{j=1}^{m} x_{ij}} \ln \frac{x_{ij}}{\sum_{j=1}^{m} x_{ij}}$, i = 1,2, …,n and

h_0 is the entropy constant and is defined as $h_0 = (\ln m)^{-1}$

Step iii. Defining $d_i$as $d_i = 1 - E_i$ and

Step iv. Defining Shannon's Entropy Weight W_i as $W_i = \frac{d_i}{\sum_{1=1}^{n} d_i}$

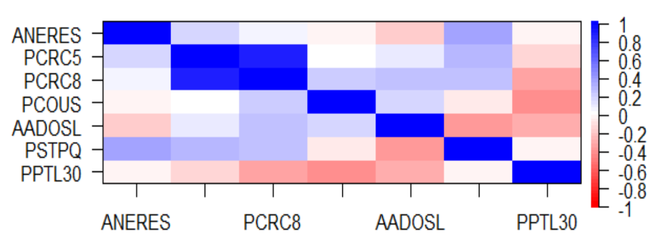
III. ANALYSIS AND FINDINGS

The analysis was initiated with finding the correlation between the seven criteria followed by test of multicollinearity. The correlation and VIF outputs are shown in Table III and correlation plot in Fig.1. It is evident that though the correlation between PCRC8 and PCR5 is on the higher side (0.86), no multicollinearity was found among the criteria as VIF for all of them are found to be < 10. Thus all criteria are retained for further analysis. Since the criteria had different units of measurement it was essential to eliminate the effect of varying units and make them unit free. Thus statistical normalization was done and its results captured in Table IV.

TABLE III CORRELATION AND VIF

	ANERE	PCRC5	PCRC8	PCOUS	AADOS	PSTPQ	PPTL3
ANERES	1						
PCRC5	0.17	1					
PCRC8	0.06	0.86	1				
PCOUS	-0.03	-0.02	0.19	1			
AADOSL	-0.19	0.1	0.22	0.15	1		
PSTPQ	0.35	0.29	0.23	-0.09	-0.4	1	
PPTL30	-0.02	-0.14	-0.37	-0.43	-0.3	-0.04	1
VIF	1.20	5.40	6.07	1.34	1.45	1.51	1.57

Source: Author's computation



Source: Author's computation

Fig. 1 correlation PLOT

TABLE IV NORMALIZED DECISION MATRIX

STATES/ UT	ANERES	PCRC5	PCRC8	PCOUS	AADOSL	PSTPQ	PPTL30
AP	0.1358	0.1966	0.1896	0.0568	0.1408	0.2006	0.1731
ARP	0.1690	0.1260	0.1360	0.1821	0.1534	0.1044	0.1789
ASS	0.1725	0.1865	0.1887	0.1796	0.2425	0.0821	0.1517
BIH	0.1648	0.1684	0.1767	0.3087	0.2321	0.1103	0.0438
CHAT	0.1648	0.1563	0.1674	0.2339	0.1905	0.1502	0.1669
GOA	0.1935	0.1482	0.1563	0.1353	0.0999	0.1987	0.1818
GUJ	0.1604	0.1754	0.2007	0.1210	0.2244	0.2043	0.1419
HAR	0.1602	0.1542	0.1646	0.0655	0.1424	0.1949	0.1510
HP	0.1987	0.1673	0.1665	0.0131	0.0544	0.1958	0.1937
J&K	0.1224	0.1643	0.1406	0.1272	0.1549	0.1153	0.1934
JHAR	0.1454	0.1825	0.2026	0.1260	0.2151	0.1452	0.1007
KAR	0.1830	0.2077	0.2016	0.0929	0.2346	0.1960	0.1531
KER	0.1963	0.1986	0.1859	0.0511	0.1104	0.1999	0.1840
MP	0.1492	0.1613	0.1683	0.2358	0.2220	0.1579	0.1430
MAHA	0.1731	0.1704	0.1711	0.0505	0.1154	0.2024	0.1516
MAN	0.1887	0.1774	0.1656	0.1073	0.1289	0.0885	0.1875
MEG	0.1463	0.1371	0.1452	0.1809	0.1839	0.0623	0.1749
MIZ	0.1703	0.1472	0.1360	0.0374	0.1961	0.1235	0.1897
NAG	0.1203	0.1502	0.1397	0.0561	0.1634	0.0673	0.1931
ODI	0.1759	0.1633	0.1683	0.3805	0.2649	0.1657	0.1625
PUN	0.1680	0.1452	0.1452	0.1422	0.0794	0.1868	0.1732
RAJ	0.1551	0.2057	0.2303	0.3131	0.1208	0.1922	0.1497
SIK	0.0973	0.1381	0.1452	0.0362	0.1424	0.0989	0.1994
TN	0.1986	0.1603	0.1489	0.0412	0.0726	0.1995	0.1669
TEL	0.1766	0.1684	0.1554	0.1353	0.1392	0.1996	0.1566
TRI	0.2026	0.1663	0.1582	0.0493	0.2547	0.0820	0.1914
UP	0.1470	0.1532	0.1637	0.2433	0.0916	0.1585	0.1127
UK	0.1651	0.1855	0.1794	0.3162	0.0932	0.1781	0.1770
WB	0.1546	0.1593	0.1600	0.1528	0.1595	0.1074	0.1503
A&N	0.1658	0.1573	0.1443	0.1322	0.0885	0.2021	0.2003
CHD	0.1684	0.2026	0.1961	0.0274	0.1551	0.2021	0.1651
DNH	0.1643	0.1875	0.1924	0.0929	0.1503	0.1898	0.1775
DD	0.1434	0.1412	0.1424	0.0798	0.2892	0.1890	0.1594
DEL	0.1988	0.1462	0.1452	0.1965	0.1058	0.2044	0.0935
LAK	0.1753	0.1431	0.1332	0.2289	0.0606	0.1973	0.2013
PUD	0.1701	0.1552	0.1267	0.0112	0.1093	0.2042	0.1916

Source: Author's computation

In the next step the weights or the relative importance of each criteria have been evaluated using Shannon's entropic approach. Table V exhibits the weight of criteria (relative importance) expressed in percentage. It has been found that PCOUS has the highest importance (57.18%) followed by AADOSL (18.76) and PSTPQ (11.52%). All other criteria have relative importance below 6%. Out of the 7 criteria considered in the study, it is one criteria (PCOUS) that has emerged to be overwhelmingly dominant over the others. In fact the second most important criteria are almost 40% less important to the most important one. Using these weights, the weighted normalized decision matrix was evaluated subsequently and the same is presented in Table VI.

TABLE V SHANNON'S WEIGHT OF CRITERIA

CRITERIA	SHANNON WEIGHTS (%)
ANERES	2.48
PCRC5	1.84
PCRC8	2.46
PCOUS	57.18
AADOSL	18.76
PSTPQ	11.52
PPTL30	5.77
TOTAL	100.00

Source: Author's computation

Based on the benefit and cost criteria, the Euclidean distance and the relative closeness were computed following the formula as in Step 3, 4 and 5. Also, the rank (TOPSIS Rank) of states and union territories were estimated from the relative closeness, also called the relative closeness index. Table VII captures the relative closeness and the TOPSIS Rank. It was then compared with the score and rank derived from the research output of NITI Aayog. Since many states and union territories had similar ranks i.e. tied ranks, the modified ranks had to be evaluated. All of them are captured in Table VIII.

TABLE VI WEIGHTED NORMALIZED DECISION MATRIX

STATES/ UT	ANERES	PCRC5	PCRC8	PCOUS	AADOSL	PSTPQ	PPTL30
AP	0.0034	0.0036	0.0047	0.0325	0.0264	0.0231	0.0100
ARP	0.0042	0.0023	0.0033	0.1041	0.0288	0.0120	0.0103
ASS	0.0043	0.0034	0.0046	0.1027	0.0455	0.0095	0.0088
BIH	0.0041	0.0031	0.0043	0.1765	0.0435	0.0127	0.0025
CHAT	0.0041	0.0029	0.0041	0.1337	0.0357	0.0173	0.0096
GOA	0.0048	0.0027	0.0038	0.0774	0.0187	0.0229	0.0105
GUJ	0.0040	0.0032	0.0049	0.0692	0.0421	0.0235	0.0082
HAR	0.0040	0.0028	0.0040	0.0374	0.0267	0.0224	0.0087
HP	0.0049	0.0031	0.0041	0.0075	0.0102	0.0225	0.0112
J&K	0.0030	0.0030	0.0035	0.0728	0.0291	0.0133	0.0112
JHAR	0.0036	0.0034	0.0050	0.0720	0.0404	0.0167	0.0058
KAR	0.0045	0.0038	0.0050	0.0531	0.0440	0.0226	0.0088
KER	0.0049	0.0036	0.0046	0.0292	0.0207	0.0230	0.0106
MP	0.0037	0.0030	0.0041	0.1348	0.0416	0.0182	0.0083
MAHA	0.0043	0.0031	0.0042	0.0289	0.0216	0.0233	0.0088
MAN	0.0047	0.0033	0.0041	0.0613	0.0242	0.0102	0.0108
MEG	0.0036	0.0025	0.0036	0.1034	0.0345	0.0072	0.0101
MIZ	0.0042	0.0027	0.0033	0.0214	0.0368	0.0142	0.0110
NAG	0.0030	0.0028	0.0034	0.0321	0.0307	0.0078	0.0111
ODI	0.0044	0.0030	0.0041	0.2175	0.0497	0.0191	0.0094
PUN	0.0042	0.0027	0.0036	0.0813	0.0149	0.0215	0.0100
RAJ	0.0038	0.0038	0.0057	0.1790	0.0227	0.0221	0.0086
SIK	0.0024	0.0025	0.0036	0.0207	0.0267	0.0114	0.0115
TN	0.0049	0.0029	0.0037	0.0235	0.0136	0.0230	0.0096
TEL	0.0044	0.0031	0.0038	0.0774	0.0261	0.0230	0.0090
TRI	0.0050	0.0031	0.0039	0.0282	0.0478	0.0094	0.0110
UP	0.0036	0.0028	0.0040	0.1391	0.0172	0.0183	0.0065
UK	0.0041	0.0034	0.0044	0.1808	0.0175	0.0205	0.0102
WB	0.0038	0.0029	0.0039	0.0874	0.0299	0.0124	0.0087
A&N	0.0041	0.0029	0.0035	0.0756	0.0166	0.0233	0.0116
CHD	0.0042	0.0037	0.0048	0.0157	0.0291	0.0233	0.0095
DNH	0.0041	0.0034	0.0047	0.0531	0.0282	0.0219	0.0102
DD	0.0036	0.0026	0.0035	0.0456	0.0543	0.0218	0.0092
DEL	0.0049	0.0027	0.0036	0.1123	0.0199	0.0235	0.0054
LAK	0.0043	0.0026	0.0033	0.1309	0.0114	0.0227	0.0116
PUD	0.0042	0.0029	0.0031	0.0064	0.0205	0.0235	0.0111

Source: Author's computation

TABLE VII RELATIVE CLOSENESS & TOPSIS RANK

STATES/ UT	Relative Closeness	TOPSIS Rank	STATES/ UT	Relative Closeness	TOPSIS Rank
AP	0.8593	9	NAG	0.8365	11
ARP	0.5379	25	ODI	0.0639	36
ASS	0.5270	27	PUN	0.6552	23
BIH	0.1975	35	RAJ	0.2326	34
CHAT	0.4001	30	SIK	0.8875	5
GOA	0.6707	20	TN	0.9183	3
GUJ	0.6801	18	TEL	0.6642	22
HAR	0.8381	10	TRI	0.8059	12
HP	0.9894	1	UP	0.3969	31
J&K	0.6786	19	UK	0.2371	33
JHAR	0.6681	21	WB	0.6119	24
KAR	0.7414	15	A&N	0.6804	17
KER	0.8841	6	CHD	0.9060	4
MP	0.3900	32	DNH	0.7694	13
MAHA	0.8832	7	DD	0.7449	14
MAN	0.7323	16	DEL	0.5123	28
MEG	0.5338	26	LAK	0.4414	29
MIZ	0.8603	8	PUD	0.9526	2

Source: Author's computation

TABLE VIII SCORE, RANK & MODIFIED RANK OF NITI AAYOG

STATES/ UT	NITI Score	NITI Rank	Modified NITI Rank	STATES/ UT	NITI Score	NITI Rank	Modified NITI Rank
AP	77	4	4.5	NAG	45	33	33
ARP	44	34	34	ODI	46	31	31.5
ASS	54	23	23.5	PUN	63	18	18
BIH	36	36	36	RAJ	73	9	9
CHAT	53	25	25.5	SIK	47	30	30
GOA	71	10	10	TN	75	7	7
GUJ	67	14	14	TEL	66	15	15
HAR	65	16	16.5	TRI	56	22	22
HP	82	3	3	UP	53	26	25.5
J&K	51	27	27.5	UK	68	13	13
JHAR	58	20	20.5	WB	51	28	27.5
KAR	76	6	6	A&N	69	11	11.5
KER	87	1	1	CHD	85	2	2
MP	49	29	29	DNH	77	5	4.5
MAHA	74	35	8	DD	46	32	31.5
MAN	65	8	16.5	DEL	58	21	20.5
MEG	38	17	35	LAK	62	19	19
MIZ	54	24	23.5	PUD	69	12	11.5

Source: Author's computation

Finally, a comparison between the modified ranks of the study by NITI Aayog and TOPSIS ranks were made (as shown in Table IX) and similarity between the ranks calculated. For this Kendall's Tau, which measures the rank correlation (even with tied ranks) was calculated. Here, a hypothesis is made as:

H_0: There is high similarity or association between TOPSIS rank and modified NITI rank.

H_1: There is low similarity or association between TOPSIS rank and modified NITI rank.

Such hypothesis testing was considered relevant since a significant modification was made in the approach towards calculation of the ranks and the researchers contemplated low similarity between the two outputs. The sample estimates yields Kendall's rank correlation tau; z = 3.1351 with a p-value = 0.001718 and tau = 0.3674. Thus, H_0 was rejected and H_1 accepted. Thus, it could be concluded that modification in the approach has been effective as very low similarity is found between TOPSIS rank and that derived by NITI Aayog.

TABLE IX COMPARISON BETWEEN MODIFIED RANK OF NITI AAYOG & TOPSIS

STATES/ UT	Modified NITI Rank	TOPSIS Rank	STATES/ UT	Modified NITI Rank	TOPSIS Rank
AP	4.5	9	NAG	33	11
ARP	34	25	ODI	31.5	36
ASS	23.5	27	PUN	18	23
BIH	36	35	RAJ	9	34
CHAT	25.5	30	SIK	30	5
GOA	10	20	TN	7	3
GUJ	14	18	TEL	15	22
HAR	16.5	10	TRI	22	12
HP	3	1	UP	25.5	31
J&K	27.5	19	UK	13	33
JHAR	20.5	21	WB	27.5	24
KAR	6	15	A&N	11.5	17
KER	1	6	CHD	2	4
MP	29	32	DNH	4.5	13
MAHA	8	7	DD	31.5	14
MAN	16.5	16	DEL	20.5	28
MEG	35	26	LAK	19	29
MIZ	23.5	8	PUD	11.5	2

Source: Author's computation

IV. CONCLUSION

Further to the initiation of Sustainable Development Goals (SDGs) in 2016 by the United Nations after successful outcome of MDGs (2000-2015), Indian government has remains committed towards achieving the stipulated targets as one could also see during the MDG era. In the quest for understanding where government focus and intervention is required that would not only help in resource allocation but also help in initiating programs aimed at achievement of SDG targets, performance of Indian states and union territories was conducted by NITI Aayog. With respect to goal 4 that emphasizes on quality education, NITI Aayog has considered 7 criteria capturing targets 4.1 and 4.c along with 36 alternatives (Indian states and union territories) within a multi criteria decision making (MCDM) environment. However, their analysis is based on the assumption of equal criteria weights. They also used simple arithmetic average theory in calculating the scores of alternatives. Further missing value cases were not considered in their computation. The present research work takes care of all these simplifications and re-evaluates performance of Indian states and union territories with respect to goal 4 of SDGs, as estimated by NITI Aayog. The ensuing study uses entropic considerations of Shannon for criteria weight determination and TOPSIS for calculating an index that is used to rank alternatives. Also all missing values have been estimated using expectation maximization algorithm.

The paper concludes occurrence of rank reversal phenomenon and a very low level of convergence (similarity) between ranks obtained from the proposed approach and that of NITI Aayog. It may also be concluded that the varying weights of criteria, which in actual life scenario is a reality, has an impact on the performance measurement of Indian states and union territories. It emerges from the study that the government should prioritize focus on the top three important criteria which account for 88% of the total criteria importance and its includes percentage of children in the age group of 6-13 who are out of school (PCOUS, 57.81%), average annual drop-out rate at secondary level (AADOSL, 18.76%) and percentage of school teachers professionally qualified (PSTPQ, 11.52%). The researchers contemplate that if proper action plans are implemented on these three criteria, achievement of goal 4 in Indian context would be a certainty for the entire nation. Finally, NITI Aayog has classified the 36 Indian states and union territories into three groups. The first 17 is named front runners, the next 11 as performers and last 8 as aspirants. The former includes KER, CHD, HP, AP, DNH, KAR, TN, MAHA, RAJ, GOA, A&N, PUD, UK, GUJ, TEL, HAR and MAN. Performers includes PUN, LAK, JHAR, DEL, TRI, ASS, MIZ, CHAT, UP, J&K and WB while aspirants include MP, SIK, ODI, DD, NAG, ARP, MEG and BIH. Keeping the classification name, count and order of alternatives same as that of NITI Aayog, the present study concludes that owing to the rank reversal phenomenon, a change in of list of states and union territories have evolved for all the three categories. As per reversed ranks, front runners now include HP, PUD, TN, CHD, SIK, KER, MAHA, MIZ, AP, HAR, NAG, TRI, DNH, DD, KAR, MAN, A&N and 12 states and union territories are common to that of the list of NITI Aayog. The 11 performers include GUJ, J&K, GOA, JHAR, TEL, PUN, WB, ARP, MEG, ASS and DEL with 6 common states. The aspirant consists of LAK, CHAT, UP, MP, UK, RAJ, BIH and ODI, having just one common state.

The present research also has certain limitations. The deployed process of TOPSIS is one of the distance based methods and introduces two reference points but does not consider the relative importance of the distances from these points. The present study may be further extended by considering more targets under the same goal if the problem of data availability is sorted out. Also, some other MCDM methods, either distance based or its likes may be also be deployed. The weights may be re-calculated with other methods including those used for subjective weight determination. Such modifications in ranking approach may lead to more robust findings and is intended at outlining the scope for further research work.

REFERENCES

[1] Barbier, E.B. (1987). The concept of sustainable economic development. *Environmental Conservation,* 14:101–110. Retrieved from https://www.cambridge.org/core/journals/environmental-conservation/article/concept-ofsustainable-economic-development/

[2] Barbier, E.B. & Markandya, A. (2012). *A New Blueprint for a Green Economy*. London, UK: Taylor & Francis.

[3] Behzadian, M., Otaghsara, S.K., Yazdani, M, & Ignatius, J. (2012). A state-of the-art survey of TOPSIS applications, *Expert Systems with Applications*. *39*, 13051–13069.

[4] Chen, M.F., Tzeng, G.H., & Ding, C.G. (2003). Fuzzy MCDM approach to select service provider. Paper presented at the *IEEE International Conference on fuzzy systems*, *1*, 572-577. Retrieved from https://doi.org/10.1109/FUZZ.2003.1209427.

[5] A Civil Society report. (2017). *Sustainable Development Goals: Agenda 2030*. Retrieved from http://www.indiaenvironment portal.org.in/files/file /Civil-society-Report-on-SDGs.pdf.

[6] Costanza, R., Daly, L., Fioramonti, L., Giovannini, E., Kubiszewskia, I., Mortensen, L. F. & Wilkinson, R. (2016). Modelling and measuring sustainable wellbeing in connection with the UN Sustainable development Goals. *Ecological Economies*, *130*, 350-3555. Retrieved from http://www.sciencedirect.com/science/ article/pii/S0921800915303359

[7] Hwang, C.L. & Yoon, K. (1981). *Multiple Attribute Decision Making*. New York, USA: *Springer-Verlag.*

[8] Liu, P. (2009). Multi-attribute decision-making method research based on interval vague set and TOPSIS method. *Technological and Economic Development of Economy*, *15*(3), 453–463.

[9] NITI Aayog. (2017). *Voluntary National Review Report.* Retrieved from http:// www.niti.gov.in/content/voluntary-national-review-report

[10] NITI Aayog. (2018). *SDG India Index Baseline Report.* Retrieved from http:// www.niti.gov.in/content/sdg-india-index-baseline report 2018.

[11] Park, J.H., Park, I.Y., Kwun, Y.C., & Tan, X. (2011). Extension of the TOPSIS method for decision making problems under interval-valued in tuitionistic fuzzy environment. *Applied Mathematical Modelling*, *35*, 2544–2556.

[12] Pinter, U. & Pšunder, I. (2013). Evaluating construction project success with use of the M-TOPSIS method. *Journal of Civil Engineering and Management*, *19,* 16–23.

[13] Regmi, K.P. (2015). Can lifelong learning be the post-2015 agenda for the Least Developed Countries? *International Journal of Lifelong Education*, *34*(5), 551–568.

[14] Shannon, C.E., & Weaver, W. (1947). The mathematical theory of communication. *Illinois, USA: Urbana-The University of Illinois Press.*

[15] Shidpour, H., Shahrokhi, M., & Bernard, A. (2013). A multi-objective programming approach, integrated into the TOPSIS method, in order to optimize product design; in three-dimensional concurrent engineering. *Computers & Industrial Engineering, 64*, 875–885.

[16] United Nations. (2015). Integrated and Coordinated Implementation of and Follow-Up to the Outcomes of the Major United Nations Conferences and Summits in the Economic, Social and Related Fields. *General Assembly Report*. Retrieved from http://www. un.org/en/ga/62/plenary/followupconf/bkg.shtml

[17] United Nations. (2012). the future we want. *Outcome document of the Conference on Sustainable Development*. Retrieved from https://sust development.un.org/content/documents/733FutureWeWant.pdf

[18] UN. (2013b). Open Working Group proposal for Sustainable Development Goals. Retrieved from https://sustainable development.un.org/content/documents/1579SDGs%20Proposal.pdf.

[19] UN. (2014). Resolution adopted by the General Assembly. Retrieved from http://unstats.un.org/unsd/dnss/gp/FP-New-E.pdf.

[20] UN. (2015a). Agenda 2030 'to-do list for people and planet'. Retrieved from http://www.un.org/press/en/2015/sgsm17111. doc.htm.

[21] UNESCO. (2016). Unpacking sustainable development goal 4 education 2030 guide. Retrieved from http://unesdoc.unesco. org/images/0024/002463/246300E.pdf.