Statistics and Applications {ISSN 2452-7395 (online)}
Volume 18, No. 1, 2020 (New Series), pp 55-62

Weighted Sustainable Development Goal Index

A. K. Nigam[1] and Manoj Kumar Pant[2]

[1]*Consultant Advisor, IASDS*
[2]*Additional Chief Executive Officer, Centre for Public Policy and Good Governance, Department of Planning, Government of Uttarakhand*

Received: 13 March 2020; Revised: 26 March 2020; Accepted: 30 March 2020

Abstract

Sustainable Development Goal (SDG) India Index, developed by NITI AAYOG in 2018, is to oversee the progress of the nation and the states on the achievements of Sustainable Development Goals (SDG). The document presents SDG Indices of different major goals. A major limitation of these SDG indices is their unweighted form because these are developed using arithmetic mean as average even in the presence of extreme values. The purpose of the present work is essentially to propose weights to develop weighted index numbers for SDGs. We follow the methodology on developing weights for different SDG indicators developed recently by Nigam (2019). The utility of the proposed methodology is demonstrated by applying it to SDG data on poverty.

Key words: Sustainable development goals, Weighted SDG index, Relative gap, Choice of weights.

1. Introduction

The Sustainable Development Goals (SDGs) are a set of 17 global goals set by the United Nations General Assembly in 2015 for the year 2030. The SDGs are part of Resolution 70/1 of the United Nations General Assembly, the 2030 Agenda. The SDGs are: No Poverty (End poverty in all its forms everywhere), Zero Hunger (End hunger, achieve food security and improved nutrition and promote sustainable agriculture), Good Health and Well-being (Ensure healthy lives and promote well-being for all at all ages), Quality Education (Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all), Gender Equality(Achieve gender equality and empower all women and girls), Clean Water and Sanitation (Ensure availability and sustainable management of water and sanitation for all), Affordable and Clean Energy (Ensure access to affordable, reliable, sustainable and modern energy for all), Decent Work and Economic Growth (Promote sustained, inclusive and sustainable economic growth, fill and productive employment and decent work for all), Industry, Innovation, and Infrastructure (Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation), Reducing Inequality (Reduce inequality within and among countries), Sustainable Cities and Communities (Make cities and human settlements inclusive, safe, resilient and sustainable), Responsible Consumption and Production (Ensure sustainable consumption and production patterns), Climate Action (Take urgent action to combat climate change and its impacts), Life Below Water, Life On Land (Protect, restore and promote

Corresponding Author: A.K. Nigam
Email: dr_aknigam@yahoo.com

sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and halt and reverse land degradation and halt biodiversity loss), Peace, Justice and Strong Institutions (Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels), and Partnerships for the Goals (Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development).

The goals are broad based and interdependent. Each of the 17 SDGs has a list of targets that are measured with indicators. Given the importance accorded by the Government of India to achieving SDGs, NITI Aayog decided to come out with the progress through a single measurable index that would serve as an advocacy tool and trigger action at the State level. With this purpose, SDG India Index report was launched by NITI Aayog in December 2018.

The SDG India Index is an aggregate measure which can be understood and used by everyone - planners, policymakers, academicians, businesses, civil society and the general public. It has been designed to provide an aggregate assessment of the performance of all Indian States and UTs, and to help leaders and change makers evaluate their performance on social, economic and environmental parameters. It aims to measure India and its States' progress towards the SDGs for 2030.

There are already several index numbers in related areas, like food insecurity by M.S. Swaminathan Research Foundation (MSSRF), global hunger index (GHI) by IFPRI, Yale's environmental performance index, sustainable environmental performance index by DES Uttarakhand and IIFM, SDG indices by NITI Aayog and some related work by Nigam (2018a, b).

Work on GHI and SDG indices by NITI Aayog follows MSSRF methodology and hence suffers from all those limitations as in food insecurity indices by MSSRF. A major limitation is the unweighted form of these indices and also use of arithmetic mean as average even in the presence of extreme values.

The present work aims at proposing weights to develop weighted index numbers for SDGs. The methodology followed on developing weights for different SDG indicators is essentially the one developed recently by Nigam (2019). We demonstrate the utility of the proposed methodology by applying it to data on poverty SDG.

2. Niti Aayog Methodology

Just as a preliminary and for the sake of completeness, it is essential to describe briefly the SDG India Index. For details one may refer to SDG Index India Report, 2018 by Niti Aayog.

To make data comparable across indicators, State-wise data values of each of the Priority Indicators were rescaled from its raw form into a score ranging from 0 to 100, with 0 denoting lowest performer and 100 indicating that the target has been achieved.

For indicators where increasing value means better performance (*e.g.* forest area coverage), score was computed as follows:

$$x' = \frac{x - min\,(x)}{T(x) - min\,(x)} \times 100 \quad (1)$$

where, x = raw data value, $min(x)$ = minimum observed value of the indicator in the dataset, $T(x)$ = national target value of the indicator, x' = normalized value after rescaling.

For indicators where increasing value means worse performance (*e.g*. Poverty rate), score was computed as follows:

$$x' = \left[1 - \frac{x - T(x)}{max(x) - T(x)}\right] \times 100 \quad (2)$$

where, x = raw data value, $max(x)$ = maximum observed value of the indicator in the dataset, $T(x)$ = national target value of the indicator, x' = normalized value after rescaling.

In instances where States and Union Territories (UTs) performed better than the target, their Index Score has been capped at 100.

SDG Index Score: For each of the Goals under SDGs (except Goals 12, 13, 14 and 17), SDG India Index Score was computed for each State/UT. This was calculated as the arithmetic mean of the normalised values of all the Priority Indicators within the Goal. In calculating the average, equal weights were assigned to each indicator and the arithmetic mean was rounded off to the nearest whole number. The Goal scores for the respective states are computed using

$$I_{ij}\left(N_{ij}, I_{ijk}\right) = \sum_{k=1}^{N_{ij}} \frac{1}{N_{ij}} \times I_{ijk} \quad (3)$$

where, I_{ij} = Goal score for State i under SDG j, N_{ij} = Number of non-null indicators for State I under SDG j, I_{ijk} = Normalised value for State i of indicator k under SDG j.

The Goal Score I_{ij} for State i under SDG j was then rounded off to the nearest whole number to give the SDG Index Score. Based on the SDG India Index, States and UTs were classified into 4 categories under each of the SDGs (except Goals 12, 13, 14 and 17):

- Achiever – when SDG India Index score is equal to 100
- Front Runner – when SDG India Index score is less than 100 but greater than or equal to 65
- Performer – when SDG India Index score is less than 65 but greater than or equal to 50
- Aspirant – when SDG India Index score is less than 50

Composite SDG India Index Score: Every State's and UT's composite SDG India Index score was finally computed to quantify the overall progress of the States and UTs towards the SDGs. This was calculated as the arithmetic mean of the Goal scores across 13 out of the 17 Goals. This was done by assigning equal weight to every Goal score and the arithmetic mean was rounded off to the nearest whole number.

$$I_i\left(N_i, N_{ij}, I_{ijk}\right) = \frac{1}{N_i}\sum_{j=1}^{N_i} I_{ij} \times \left(N_{ij}, I_{ijk}\right) \quad (4)$$

where, I_i = Composite SDG index score of State i, N_i = Number of Goal scores for which State i has nonnull data, I_{ij} = Goal score for State i under SDG j.

The arithmetic mean of Goal scores are then rounded off to the nearest whole number to give the composite SDG India Index score for each State/UT. The States/UTs are again classified into the four categories (as described above): Achiever, Front Runner, Performer and Aspirant.

3. Proposed Methodology

When all the commodities are not of equal importance, we assign weight to each commodity relative to its importance and the index number computed from these weights is called a weighted index number. If the base year quantities are used as weights, then it also called the base year weighted index. Generally, planners and policymakers are entrusted to monitor the progress of those indicators which are more beneficial for the people. Therefore, identification of such indicators with their weights might be useful for measuring the real progress. For assigning the weights to different indicators, many methods can be adopted which depend upon the availability of time series data (Regression Method), Group Exercises (Analytical Hierarchy Process) and so on. Here we have proposed gap between target and current progress of base year as the weight. It is not easy to assign weights to respective indicators by regression and other related methods as the availability of time series data is a big challenge. We have adopted a new method where we take the base year data of target and achievement and assign the weights as their gap. More the gap, less the weight is the simple phenomenon of this gap-based weight assignment methodology. In contrast, NITI AAYOG SDG India Index methodology provides the index score with equal weight to all indicators.

Let w_{jk}, be the weight assigned to the kth indicator in the jth goal, there being p goals and n_j indicators in the jth goal, $j = 1,\ldots,p$, $k = 1,\ldots, n_j$. It may be noted that the total number of weights is the sum of n_j over j.

We first describe how to work out the weights for the SDG index.

Step 1. Compute the gap between current/baseline figure (raw data) and the target. If the target has already been achieved, fix the weight as 100. If the target is yet to be achieved compute the relative gap. Relative gap is the ratio of the gap and the current value. The weight is then the inverse of the relative gap. Using the inverse as the weight ensures that poor performing indicators (with larger relative gap) are assigned lower weight and contribute little to the overall index score.

Step 2. The next step is to normalize the weights and make them vary between 0 and 1. The normalized weights are obtained as the ratio of the inverse of relative gap and the total of inverse of relative gaps.

Step 3. The overall index number of the indicators, which are yet to achieve their targets, is the product of weights and the current values of indicators.

Step 4. The overall weighted SDG index number is given by the arithmetic mean of 100 and the index number of the indicators which are yet to achieve their targets (as computed in Step 3).

The above method can easily be extended to include minor variants of the case discussed above.

4. Example

Consider the all India SDG raw data on poverty as given in Niti Aayog's SDG Index. Table 1 gives raw data, unweighted and weighted SDG indices of Indian States on poverty. First five columns starting from third column give raw data, and the next five columns give their normalized values using formulae (1) and (2). These also give unweighted SDG indices and their average (arithmetic mean) gives the unweighted SDG index (SDG 1 in Table 1) as reported in the India SDG index, 2018. The next column gives the rank of states labeled as rank (1). The following column gives weighted SDG indices, weights based upon the gap and target values as per the proposed methodology in steps 1-5, and their average gives the weighted SDG index (SDG 2 in Table 1). The last column gives the rank of states labeled as rank (2).

A comparison between ranks (1) and (2) show that the ranks of states are changed with no definite pattern. Nevertheless, the ranks (2) are more logical and realistic. An examination of the two ranks reveals that Tamil Nadu which ranked 1 in the unweighted category with the index score 68 is also top ranked with score 99 in the weighted index category. On the other hand, Haryana which ranked 25 in the unweighted category with the score 25, has rank 1 in the weighted category with a score of 99. Uttarakhand's weighted index is also ranked on top though it ranked 7 in the unweighted category. As a matter of fact, besides Haryana and Uttarakhand, Gujarat, Mizoram and Daman & Diu are also on the top with identical scores of 99.

The above comparison opens up the debate on how the ranks of SDG 2 are changing in a haphazard manner *vis-a-vis* SDG 1. The issue was a point of thorough discussion on first author's Special lecture on Hunger and Related SDGs in a 2-days Workshop on SDGs at Hyderabad (23-24 January 2020). The Workshop was organized by Ministry of Statistics and Programme Implementation (MoSPI), Government of India, with the objective of Capacity Building of Senior Indian Statistical Services officers of Deputy Director General and above level. The discussion led to a recommendation that it needs a full-fledged research study of around 2 - years duration to find answers to different types of questions bothering us. The authors are already working on it and the results obtained will be reported in a separate communication in the future.

Yet another problem that needs to be examined is in the normalization of Priority Indicators, which were rescaled from its raw form into a score ranging from 0 to 100, with 0 denoting lowest performer and 100 indicating that the target has been achieved. If we consider the Percentage of population living below the national poverty line, the first indicator of the goal Poverty given in the first column of Raw data in Table 1, we note that for all raw data values 9.2, 5.09, 8.06, and few others the Index Score is 100. This seems illogical and requires rescaling modification. Similar is the scenario in case of Index Scores 0. It requires again substantial efforts to modify formulae (1) and (2).

5. Choice of Other Weights

Besides gaps between current/baseline value, there can be other choices of weights. We may pick up inverse of the number of observations used to compute the value for a given indicator. Another choice could be the coefficient of variation for each indicator value. If we choose more than one weight, then the overall weight can be taken as the geometric mean of all the weights.

While computing weighted index numbers usually geometric mean is preferred against arithmetic mean or harmonic mean. In most cases, we may have weights with extreme values and this makes geometric mean superior to arithmetic mean. The easier interpretability of geometric mean makes it a better choice than harmonic mean. While computing weighted index numbers usually geometric mean is preferred against arithmetic mean or harmonic mean.

Biggest hurdle in choosing more than one weight is the non-availability of data on these weights. However, it is advisable to use as many weights as possible to derive a good weighted index.

Acknowledgements

We thank the reviewer and the editors for their suggestions that helped considerably improve the contents.

References

Nigam, A. K. (2018a). Improving global hunger index. *Agricultural Research*, **7**, e-print (2019) **8**, 132-139.

Nigam, A. K. (2018b). Global hunger index – Revisited. *Journal of the Indian Society of Agricultural Statistics*, **72**, 225–230.

Nigam, A. K. (2019). *Weighted SDG Index*. Unpublished Manuscript. Also, part of the Key Note Address on Zero Hunger at a National Seminar on Statistics and SDGs, organized at Statistics Department, Lucknow University.

Nigam, A. K. (2020). *Hunger and Related SDGs*. Workshop for capacity building of Senior ISS officers of DDG and above level on SDGs 23-24 January 2020 organized at Hyderabad.

SDG India Index. Baseline Report (2018). Niti Aayog.

Table 1: Unweighted and Weighted SDG Indices of Indian States

Sl No	State	% popln. living below National Poverty line	% house - holds with any usual member covered by any health scheme or health insurance	Persons provided employ- ment as % of persons who demanded employ- ment under MG- NREGA	% of the popln. (out of total eligible popln.) receiving social protection benefits maternity benefits	Number of homeless house-holds per 10,000 house-holds	% of popln. living below National Poverty line	% of house- holds with any usual member covered by any health scheme or health insurance	Persons provided employ- ment as a percentage of persons who demanded employ- ment under MG- NREGA	Propor- tion of the popln. (out of total eligible popln.) receiving social protec- tion benefits mater- nity benefits %	Number of home- less house- holds per 10,000 house- holds	SDG 1 Index score	Rank (1)	SDG 2 Index score	Rank (2)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
		Raw Data					Index Score								
1	AnP	9.2	74.6	87.77	17.4	15.34	100	74	72	16	72	67	**5**	86	**24**
2	ArP	34.67	58.3	85.56	20.5	0.23	18	57	67	19	100	52	**22**	79	**31**
3	AS	31.98	10.4	87.1	66.1	3.42	27	7	71	66	94	53	**21**	94	**10**
4	BI	33.74	12.3	75.63	53.9	3.13	21	9	44	53	94	45	**30**	94	**10**
5	CH	39.93	68.5	77.25	66.2	15.77	0	67	48	66	71	50	**25**	83	**28**
6	Goa	5.09	15.9	98.15	7.4	1.62	100	13	96	6	97	62	**9**	98	**6**
7	GU	16.63	23.1	80.92	8.9	14.06	80	20	57	8	74	48	**27**	86	**24**
8	Hy	11.16	12.2	80.16	13.5	14.52	99	9	55	12	73	50	**25**	99	**1**
9	HP	8.06	25.8	91.12	13.1	9.37	100	23	80	12	83	60	**12**	89	**18**
10	J&K	10.35	4.2	88.79	54	12.33	100	1	74	53	77	61	**10**	86	**24**
11	JR	36.96	13.3	70.34	41.6	4.38	10	10	32	41	92	37	**35**	93	**12**
12	UK	11.26	19.5	90.1	49.4	8.88	99	17	77	49	84	65	**7**	99	**1**
13	KN	20.91	28.1	84.26	19.9	8.45	66	26	64	19	85	52	**22**	87	**21**
14	KL	7.05	47.7	87.98	20.4	3.4	100	46	73	19	49	66	**6**	80	**29**
15	MP	31.65	17.7	79.68	61.1	21.42	29	15	54	61	61	44	**31**	77	**32**
16	MH	17.35	15	86.4	8.7	17.18	78	12	69	7	68	47	**29**	86	**24**
17	MN	36.89	3.6	96.46	26.2	2.95	10	0	92	25	95	44	**31**	96	**9**
18	ML	11.87	34.6	97.3	28	4.24	97	32	94	27	92	68	**4**	97	**8**
19	MZ	20.4	45.4	99.94	47.5	0.62	67	43	100	47	99	71	**2**	99	**1**
20	NL	18.88	6.1	98.91	29.7	3.03	73	3	98	29	94	59	**13**	98	**6**
21	OR	32.59	47.7	84.76	72.6	7.11	25	46	65	72	87	59	**13**	88	**19**
22	PB	8.26	21.2	81.63	19.1	6.59	100	18	58	18	88	56	**19**	90	**15**
23	RJ	14.71	18.7	85.07	56.1	16.51	87	16	66	55	70	59	**13**	88	**19**
24	SK	8.19	30.3	94.16	29.4	11.75	100	28	87	28	78	64	**8**	90	**15**
25	TN	11.28	64.1	98.83	29.5	4.56	99	63	97	28	92	76	**1**	99	**1**
26	TG	Null	66.4	77.06	12.2	8.92	Null	65	48	11	84	52	**22**	87	**21**
27	TR	14.05	58.1	94.38	32.6	5.34	89	57	87	32	90	71	**2**	93	**12**

28	UP	29.43	6.1	84.3	48.7	5.36	36	3	64	48	90	48	**27**	90	**15**
29	WB	19.98	33.4	87.63	28.7	8.28	69	31	72	28	85	57	**17**	87	**21**
30	AN	1	5.7	92.46	1.4	0.97	100	2	83	0	98	57	**17**	51	**36**
31	CD	21.81	21.3	Null	13.7	19.7	63	19	Null	12	64	39	**34**	80	**29**
32	DN	39.31	30.8	Null	2.6	24.94	2	28	Null	1	54	21	**37**	73	**33**
33	DD	9.86	17	Null	19.3	0.67	100	14	Null	18	99	58	**16**	99	**1**
34	DL	9.91	16.4	Null	7.9	54.52	100	13	Null	7	0	30	**36**	56	**35**
35	LK	2.77	3.4	56.13	17.5	0	100	0	0	16	100	43	**33**	58	**34**
36	PD	9.69	32.8	93.78	21.4	3.97	100	30	63	20	93	61	**10**	93	**12**
	IN	**21.92**	**28.7**	**84.75**	**36.4**	**10.39**	**62**	**26**	**65**	**35**	**81**	**54**	**20**	**70**	
	Target	**10.95**	**100**	**100**	**100**	**0**	**100**	**100**	**100**	**100**	**100**	**100**			

Note: AnP – Andhra Pradesh; ArP – Arunachal Pradesh; AS – Assam; BI – Bihar; CH – Chhattisgarh; GU – Gujarat; HY – Haryana; HP – Himachal Pradesh; J&K – Jammu and Kashmir; JR – Jarkhand; UK – Uttarakhand; KN – Karnataka; KL – Kerala; MP – Madya Pradesh; MH – Maharashtra; MN – Manipur; ML – Meghalaya; MZ – Mizoram; NL – Nagaland; OR – Orissa; PB – Punjab; RJ – Rajasthan; SK – Sikkim; TN – Tamil Nadu; TG – Telangana; TR – Tripura; UP – Uttar Pradesh; WB – West Bengal; AN – Andaman and Nicobar Islands; CD – Chandigarh; DN – Dadra and Nagar Haveli; DD – Daman and Diu; DL – Delhi; LK – Lakshadweep; PD – Pondicherry; IN - India