Environmental and Social Sustainability Index (ESSI)

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by

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in
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This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science in Industrial and Systems Engineering.

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"Delete the negative; accentuate the positive."

Donna Karan

Environmental and Social Sustainability Index (ESSI)

Amna FAISAL

Abstract

Globalization and sustainable development are becoming important subjects for scientists, technologists, policy makers as well as ordinary citizens of the globe. This study analyzes the sustainability from the perspective of not just the environment and the ecosystem but also from the social aspects of all inhabitants. Previous indexe (EPI) measured the performance of different countries based on the environment and the ecosystem by following MDGs and social progress parameters, separately. However, there are strong dependencies of parameters used in that index as a measure of sustainability, however few other emerging factors were not included. Another index (SPI) is being consulted that measures the social progress.In this work, the proposed Environmental and Social Sustainability Index (ESSI) includes all relevant parameters of sustainability that measures the performance of countries primarily based on SDGs by using the data from United Nations and other international organizations. The ESSI takes into account the most critical environmental and the ecosystem vitality indicators as well as key social progress factors to reach an integrated model on sustainability. Moreover, it includes the comparison of results between Yale University EPI and this proposed index ESSI. Finally, these countries are being divided according to categories used by United Nations to compensate the shortcoming of Yale University EPI i.e. comparison between highly developed and least developed countries.

Keywords: ESSI (Environmental and Social Sustainability Index), MDG's (Millennium Development Goals), SDG's (Sustainable Development Goals), Yale University EPI, SPI(Social Progress Index).

Çevresel ve Sosyal Sürdürülebilirlik Endeksi (ESSI)

Amna Faisal

Öz

Küreselleşme ve sürdürülebilir kalkı, kalkınma, bilim adamları, teknoloji uzmanları, politika yapıcılar ve dünyanın sıradan vatandaşları için önemli konular haline gelmektedir . Bu araştırma sürdürülebilirliği sadece çevre ve ekosistem değil, aynı zamanda tüm sakinlerin sosyal yönlerinden de incelemektedir. Daha önceki gelişmiş endeksler, MGD'leri takip ederek ve EPI ve sosyal ilerleme SPI parametrelerini ayrı ayrı inceleyerek, farklı ülkelerin çevre ve ekosisteme dayaı performanslarını ölçtüler. Bununla birlikte, bu endekslerde kullanılan parametrelerin sürdürülebilirlik ölçüsü olarak güçlü bağımlılıkları ve az sayıda ortaya çıkan faktör dahil edilmemiştir. Bu araştırmada, önerilen Çevresel ve Sosyal Sürdürülebilirlik Endeksi (ESSI), Birleşmiş Milletler ve diğer uluslararası kuruluşların verilerini kullanarak, öncelikli olarak SDG'lere dayanan ülkelerin performansını ölçen tüm ilgili sürdürülebilirlik parametrelerini içermektedir. ESSI, en kritik çevresel ve ekosistem canlılık göstergelerinin yanı sıra sürdürülebilirlik üzerine entegre bir modele ulaşmak için kilit sosyal ilerleme faktörlerini de dikkate almaktadır. Ayrıca, Yale Üniversitesi EPI ve bu önerilen endeks ESSI araşındaki sonuçların karşılaştırılmasını içerir. Son olarak, bu ülkeler Birleşmiş Milletler tarafından Yale Üniversitesi EPI'sinin eksikliğini telafi etmek için kullanılan kategorilere, yani gelişmiş ve en az gelişmiş ülkeler arasındaki karşılaştırmaya göre bölünmektedir.

Anahtar Sözcükler: MDG'ler (Binyıl Kalkınma Hedefleri), SDG'ler (Sürdürülebilir Kalkınma Hedefleri), Yale Üniversitesi EPI (Çevresel Performans Endeksi), SPI (Sosyal İlerleme Endeksi).

I Would Like To Dedicate My Work To My Dearly Loved Parents, My Gorgeous Husband, My Compassionate Brother And My Little Angels (My Daughters) For Having Their Support And Encouragement Throughout This Journey Of My Masters.

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Moreover, my parents plays an important role in this journey. Since childhood, they keep encouraging me for whatever I want to do like many other parents, but my decision of doing Masters from abroad, after having two kids was difficult for me as well as for my family. But then again my parents are the ones who become my backbone as they left their country and came here to take care of my kids and to support me during this time of my thesis.

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Abbreviations

UN	United Nations
MSW	Municipality Solid Waste
SPI	Social Progress Imperative
WHO	World Health Organization
FAO	Food Agriculture Organization
MDGs	Millennium Development Goals
SDGs	Sustainable Development Goals
EPI	Environmental Performance Index
ESSI	Environmental And Social Sustainability Index
UNCTAD	United Nations Conference On Trade And Development
OECD	Organisation For Economic Cooperation And Development
UNESCO	United Nations Educational Scientific And Cultural Organization

Chapter 1

Introduction

1.1 Introduction

Sustainability has much widespread boundaries now, as compared to past. In modern era, it is not just related to environment and ecosystem but after the launch of SDG's (Sustainable Development Goals) in 2015, it got a new implication as balanced combination of environment health, ecosystem vitality and social order. Still it has different inferences for different societies. For instance, some emphasize on environment, others on ecosystem and rest of them on social order, health, globalization etc. However, it includes all these factors with more or less weights to maintain the overall sustainability of inhabitants. Henceforward, sustainability includes health of the land, water and air including the living organism on them. Sustainability is a journey towards a future in which human beings should have harmony with natural world and its habitats in terms of using them without damaging or destructing it. Shortly, sustainability seems to protect our natural environment, human and ecological health, while driving innovation and not compromising our way of life[8].

Social equity and sustainability of community are also very important aspects of sustainability in terms of socialism. Equity is important in terms of opportunities, conditions and justice for meeting present and future needs altogether. Exclusionary or discriminatory practices in economic, political or social participation results in racism and antipathy. Conclusively it generates scarcity which may have less access of municipal services and amenities for residents of one area compared to another area. This can be referred as

geographical division also called as horizontal equity. The other aspect is sustainability of community that is reproduction and maintenance of home community to a satisfactory level of performance. Social capital and solidarity construct networks, mutuality and association resulting in good behaviors and sustainable societies[9]. Hence community stability is very important factor to be considered while measuring the performance of countries to check their rank in sustainability along environmental well being and biome vitality among other nations.

This index is a proposed model to collect all the factors of sustainability with different weightings to rank the 180 countries around the globe. One of the eminent index related to environmental health and ecosystem vitality is Environmental performance index (EPI) launched by Yale University[10]. Therefore, this research is about the idea of merging EPI with other pillars of sustainability by adding some social factors taken from Social progress imperative (SPI). SPI is a measure of enough food, shelter, education, opportunities, health and wellness, personal safety, communication and environmental wellness[11]. Some additional factors related to environmental health and ecosystem vitality are also included in ESSI that were missing in Yale University EPI.

1.2   United Nations Sustainable Development Goals (SDGs):

United Nations launched eight MDG's in 2000 that were valid up to 2015. However, after 2015, UN announced 17 new goals (SDGs) having targets for sustainability accompanying all pillars. It includes 17 Global Goals, 169 targets and 230 indicators that apply to all countries, with the aim of achieving them by the year 2030[12].

The SDGs are quite interrelated to MDGs. In other words, SDGs are the advanced version of MDGs. United Nations assigns separate symbol for each goal of MD and SD. We have used those symbols in Fig (1.1 and 1.2)[13–15] to show the conversion of MDGs to SDGs. This conversion revolves around four major areas; dignity, people welfare, planet protection and partnership. Our index has the agenda to focus on all SDGs by aiming all targets through a range of indicators to measure sustainability scores of countries all over the globe. Some new zones were introduced in SDGs covering perspectives of justice and prosperity. Fig2.2 [15], shows SDGs that were not included in MDGs.
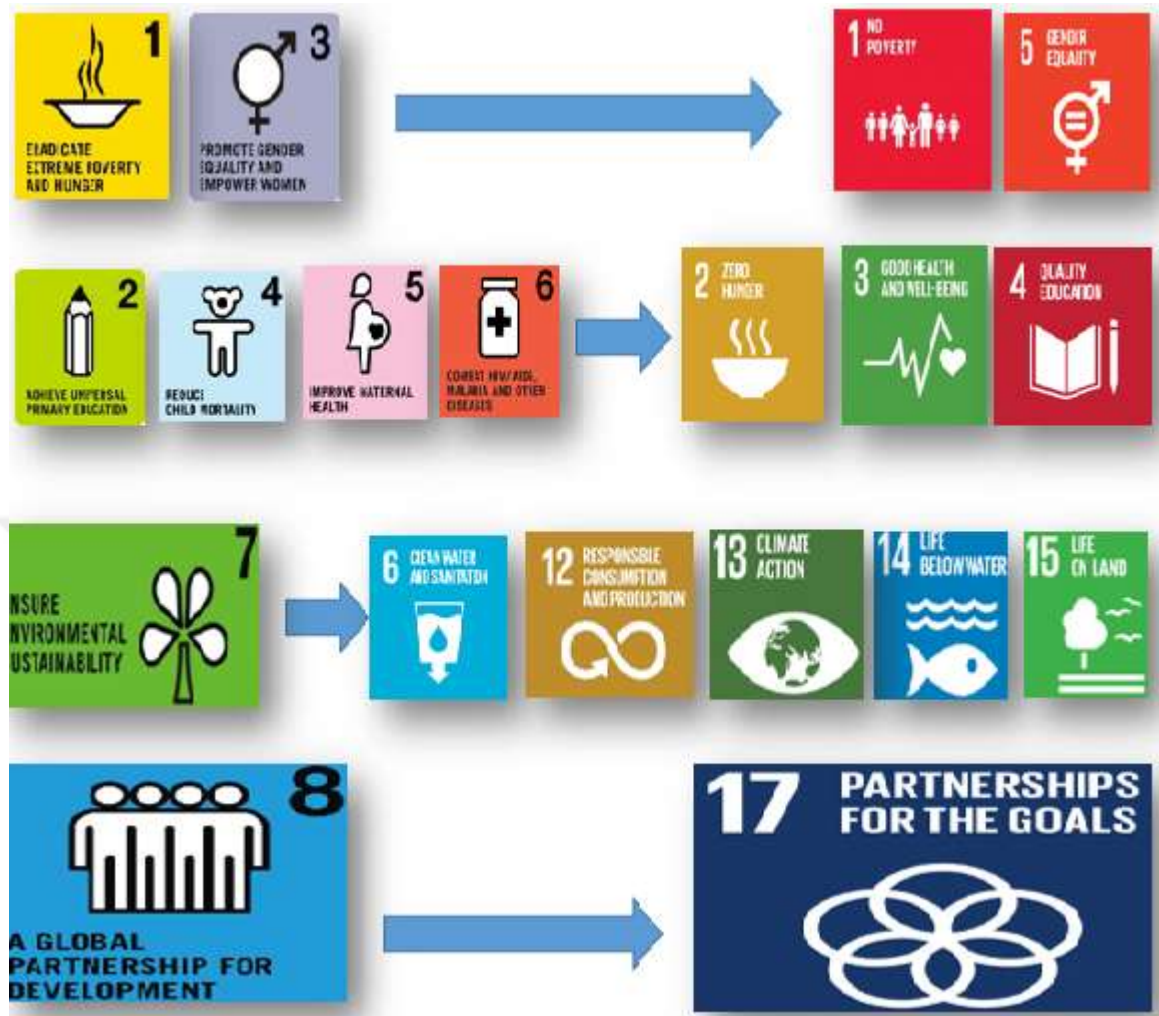
FIGURE 1.1: Conversion of MDGs to SDGs.

FIGURE 1.2: SDGs that are not part of MDGs .

1.3   ESSI And SDGs Alignment

All the indicators used in this present index have the alliance with SDGs. Main factors of this index are environmental health, ecosystem vitality, nutrition and basic medical care, electricity, access to knowledge, opportunities and death rate of all countries. "Environmental health and ecosystem vitality" are aligned with SDGs 6,12,13,14 and 15. "Nutrition and basic medical care" is associated with SDG 2 and 3. "Quality and access to electricity" covers SDG 9 and 11."Access to knowledge" is related to SDG 4. The section "opportunities" cover SDG 1, 4, 5, 7, 8, 9, 10, 16 and 17 while "death rate" is under SDG 3.

Chapter 2

Background and Previous Sustainability Indexes

2.1   Yale University's EPI And Policy Objectives

Yale University is working on EPI since 2000 and they have launched more than 10 versions of this index. In Environmental Performance Index (EPI), 2018, they ranked 180 countries on 24 performance indicators according to 10 issues on policy categories of environmental health and ecosystem vitality. It provides a gauge to measure the performance of these countries on basis of each others performance as well as their own previous performances. Therefore, it results in a scorecard with numbers that shows ranking which indicate the overall performance of that country. That is how, it declares the high performers and laggards. It also provides a baseline for others to be leaders in sustainability. In their index, Yale University just focuses on MDG No.7 that is "ensure environmental sustainability". They do not consider SDGs. Table 2.1 describes the EPI with its indicators and their abbreviations by which they measured them and allocate the weight by importance of factors, literature review and expert opinion. It is clear from Table 2.1 that EPI revolves around MDG No.7 [13].

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TABLE 2.1: Yale University EPI with policy objectives, issue categories and indicators including their weights.[1]

Policy Objective			Issue Category			Indicator		
Title	TLA	W	Title	TLA	W	Title	TLA	W(%)
Environmental Health	HLT	40%	Air Quality	AIR	65%	Household Solid Fuels	HAD	40%
						PM2.5 Exposure	PME	30%
						PM2.5 Exceedance	PMW	30%
			Water & Sanitation	H2O	30%	Drinking Water	UWD	50%
						Sanitary	USD	50%
			Heavy Metals	HMT	5%	Lead Exposure	PBD	100%
Ecosystem Vitality	ECO	60%	Biodiversity & Habitat	BDH	25%	Marine Protected Areas	MPA	20%
						Biome Protection (National)	TBN	20%
						Biome Protection (Global)	TBG	20%
						Species Protection Index	SPI	20%
						Representing Index	PAR	10%
						Species Habitat Index	SHI	10%
			Forests	FOR	10%	Tree Loss	TCL	100%

Policy Objective			Issue Category			Indicator		
Title	TLA	Weight	Title	TLA	Weight	Title	TLA	Weight
			Fisheries	FSH	10%	Fish Stock Status	FSS	50%
						Regional Marine Trophic Index	MTR	50%
			Climate & Energy	CCE	30%	CO2 Emissions â Total	DCT	50%
						CO2 Emissions â Power	DPT	20%
						Methane Emissions	DMT	20%
						N2O Emissions	DNT	5%
						Black Carbon Emissions	DBT	5%
			Air Pollution	APE	10%	SO2 Emissions	DST	50%
						NOX Emissions	DXT	50%
			Water Resources	WRS	10%	Wastewater Treatment	WWT	100%
			Agriculture	AGR	5%	Sustainable Nitrogen Management	SNM	100%

2.2   Strengths And Weaknesses Of Yale EPI

Yale University used best available data from international research entities, such as the Institute for Health Metrics and Evaluation, the World Resources Institute, and the Sea Around Us Project at the University of British Columbia, as well as international organizations such as the World Bank and the UN Food and Agriculture Organization that makes EPI trustworthy. Nevertheless, there are serious data gaps such as many countries do not have true data or some of them are not willing to share their database, which limits the capability of EPI to show fair results, and particularly it changes the performance of index on a number of important issues. Hence, availability of enough and reliable data on agriculture, water resources, waste management, and threats to biodiversity and sustainability can strengthen the EPI[16].

Moreover, in each version they are improving but in latest version they claim that they are aligned with internationally agreed SDGs by using quantitative approach to evaluate policy performance and that, SDGs are baseline for evaluation. Since after going through whole index, many factors seems missing in index that are core points of SDGs. Secondly the leaders in EPI are developed countries and developing countries like African countries are low performers, whose problems are beyond their abilities to sustain environmental, human and societal health. Hence, " environmental performance is an issue of governance - only well-functioning governments are able to manage the environment for the benefit of all"[17].

The fact is astonishing, as EPI does not include any governance factor that is even part of SDGs under Goal 16. They just have nine major issues (health, air quality, water and sanitation, water resources, agriculture, forests, fisheries, biodiversity and habitat, climate and energy). Countries score between 0 and 100 in each area and then EPI can conclude that how close that country from baseline. One other absence in EPI is measurement of carbon intensity. There is no worldwide-approved objective for CO_2 reduction, which results in false rating. Over-polluters (Britain, Denmark, and USA) give the impression as "over-achievers" while those that discharge small amount are relegated. EPI focuses on capacity to address a problem and not the scale of the problem in each country or the background of that problem which may be the cause of that problem which results in developing countries at bottom and developed nations on top. One example is of waste water treatment. EPI targets 100 percent waste water treatment, so

developed countries have those facilities while least developed do not, which results in declaring them as laggards. So irrespective of efforts and capacities of any country, it will be unfair to grade them because they will not be awarded for their exertions. Therefore, EPI conveys a message that Organization for Economic Co-operation and Development (OECD) countries are superlative and African countries are destructive for sphere. This problem can be overcome by adding some opportunity, growth, governance and economic related factors in EPI[18].

Chapter 3

Environmental And Social Sustainability Index

3.1 Environmental And Social Sustainability Index

In ESSI, we are trying to strengthen the EPI by overcoming the entire dearth related to sustainability. A new categorical ranking is introduces in this proposed index under the guideline of United Nations. Over and done with that grouping, performance of each country has been measured within its own group so that developed countries do not be compared with developed ones.

The 60 percent of ESSI has been generated from EPI as without healthy environment, maintaining a prosperous life is a terrible task. Climate change pollution (air, water, solid), ecosystem, species loss, all are important issues for human health. Thus without considering these aspects, societies well-being is impossible to achieve. If there is a struggle to survive, to maintain a better society is difficult. Nevertheless, social norms have their own importance, which cannot left behind unattended[19]. In ESSI most important indicators for measuring social sustainability are death rates, undernourishment, tolerance for immigrants and medical care.

3.2   ESSI Policy Categories

This index is a proposed model to follow the SDG's by covering the below mentioned policy categories in Table 3.1. The main purpose of this index is to observe the effects of climate change, pollution, environment and society on different countries by figuring out routine of people on them and their activities. We used a hierarchical framework to construct ESSI. Three main categories are divided into 8 factors, which further split the index into 42 indicators to measure environmental and social sustainability of each country within the group of 180 countries. The constraint for assigning an indicator for each factor of every policy category is that, it should measure at least one angle of environment, ecosystem or social performance. Careful consideration is required for selection of indicators for environmental health and biome vitality, as these both are very close to each other. This is the first version of ESSI and all indicators are included in the light of SDGs keeping in mind the limitation of data collection. However in the future, more indicators related to SDGs can be added into these 3 main policy categories of ESSI.

TABLE 3.1: Basic policy categories of ESSI.

Environmental Performance	Ecosystem Vitality	Social Order

3.3   Overall Goals Of This Index

Thus, before going forward towards our index we also have to consider some questions before dealing with the data and its interpretation.

- What is the aim (goal) of Index with reference of sustainability?

- What are we trying to achieve?

- Who is beneficiary from this index?

The main purpose of this index is to merge environment and ecosystem with social aspects to follow SDGs. Therefore, we can rank the countries on their overall performance of above-mentioned policy categories for sustainability. Ultimately, we want to create a

report card to record their performances between each other as well as for the previous years. Some countries that were not very good in environmental sustainability but they were focusing on other factors that have equal importance as environment, were categorized as low ranked. This index is can help them to improve their ranking. The factors that would be considered in this index are

- Hygienic drinking water and safe sanitation.

- Improved outdoor and indoor air quality.

- Solid waste.

- Burden of disease

- Biome vitality

- Better standards of education

- To achieve gender equality

- Tolerance for immigrants

- Noise pollution

- Nutrition and basic medical care

- Death rate

- Access to electricity

- The end of poverty and hunger

3.4 Factors With Indicators And Their Weight In ESSI

In ESSI, there are three main policy categories; Environmental performance, Ecosystem grade and Social order of any country. Environment and Ecosystem is then classified into three factors; Environmental health, Ecosystem vitality and other emerging factors. For the first two factors, EPI is being checked in and we took the data as it is, because of authentic statistics of Yale University. Table 3.2 shows policy categories of ESSI, their factors and indicators accompanied by assigned weight.

TABLE 3.2: Policy categories, Factors, indicators and their abbreviations of ESSI.

Policy category	Factors	Abb	Indicator	Abb
Environmental Health& Ecosystem Vitality	Environmental Health	EnH	Household Solid Fuels	HAD
			PM2.5 Exposure	PME
			PM2.5 Exceedance	PMW
			Drinking Water	UWD
			Sanitation	USD
			Lead Exposure	PBD
	Ecosystem Vitality	EcV	Marine Protected Areas	MPA
			Biome Protection (Natinal)	TBN
			Biome Protection (Global)	TBG
			Species Protection Index	SPI
			Representativeness Index	PAR
			Species Habitat Index	SHI
			Tree Cover Loss	TCL
			Fish Stock Status	FSS
			Regional Marine Trophic Index	MTR
			CO2 Emissions â Total	DCT
			CO2 Emissions â Power	DPT
			Methane Emissions	DMT
			N2O Emissions	DNT
			Black Carbon Emissions	DBT
			SO2 Emissions	DST
			NOX Emissions	DXT
			Wastewater Treatment	WWT
			Sustainable Nitrogen Management	SNM
Emerging Factors (10%)	Noise Pollution and Solid Waste	EFE	Noise(50%)	NOS
			Solid waste management& recycling(50%)	SWM

Policy category	Factors	Abb	Indicator	Abb
Social Order(30%)	Nutrition and Basic Medical Care (20%)	NBM	Undernourishment (20%)	UNN
			Depth of food deficit (20%)	DFC
			Maternal mortality rate (20%)	MMR
			Child mortality rate (20%)	CMR
			Deaths from infectious diseases (20%)	DID
	Electricity (15%)	ELC	Access (50%)	ATE
			Quality (50%)	QOE
	Access to Knowledge (15%)	ATK	Adult literacy rate (40%)	ALR
			Primary and secondary school enrollment (30%)	PSE
			Gender parity in education (30%)	GPE
	Opportunity (20%)	OPP	Availability of affordable housing (40%)	AAH
			Tolerance for immigrants (40%)	TFI
			Globally ranked universities (20%)	GRU
	Death Rate (20%)	DeR	Traffic deaths (25%)	TDR
			Suicide rate (25%)	SDR
			Premature deaths from non-communicable diseases (25%)	PDD
			Life expectancy at 60 (25%)	LER

Chapter 4

Methodology And Data Collection

4.1   EPI And ESSI

Environment and Ecosystem performance is measured by environmental health, ecosystem vitality, noise pollution and solid waste. Despite of EPI's shortcomings, we decided to use that as baseline for 1st two categories of ESSI due to its strength of data collection. Nevertheless, for other two factors, data is collected from resources mentioned in Table 4.1. In EPI environmental health and ecosystem vitality were given weights as 40%& 60% respectively as mentioned in Table 2.1, but in ESSI this ratio has been changed to 50%, 50% stated in Table 4.1. In EPI Environment and Ecosystem has been dealt as the total of 100%but in ESSI, 70% is assigned for them, from which 60% is for Environment and Ecosystem while 10%is for noise and solid waste. For social order, remaining 30% has been assigned for whole category and then, further division has been done as described in Table 3.2.

4.2   Data Collection

As mentioned above, data taken from EPI was not altered and used as it was. Nevertheless, factors related to social order were measured very keenly by exploring the SPI. We look behind the sources mentioned by SPI and assigned our own weight to each indicator to get final score. Table4.1 shows indicators related to Environment and Biome with associated source and gauging unit.

4.2.1 Environment And Biome

TABLE 4.1: Indicators related to Environment and Biome with associated source and gauging unit.[1–3]

Indicator		Measurement	Source
Environmental health		Air quality, sanitation, wastewater treatment, drinking water etc.	https://epi.envirocenter.yale .edu/epi-topline
Ecosystem vitality		Marine BIOME protection, wastewater treatment, carbon emissions, Tree protection, Fish Stock, Methane Emissions etc.	https://epi.envirocenter.yale .edu/epi-topline
[l]Emerging factors related to environmental Health & Ecosystem Vitality but not included in EPI	Noise	# Of Vehicles per 1000 people* behavior of people.	http://www.nationmaster.com /country- info/stats/Transport/Road
	Solid waste	Solid Waste Generation Per Capita (kg/capita/-day)	www.worldbank.org

Table 4.2, 4.3 and 4.4 below shows each indicator with associated source and gauging unit.

4.2.2 Nutrition And Basic Medical Care

If a child is not fed with proper nutrition in the first 1,000 days of life; pregnancy to childâs second birthday, can results in rigorous and irreversible lifetime health and social challenges. SDGs cannot be obtained without investing in satisfactory and sustained resources of nutrition[20].

TABLE 4.2: Indicators related to Nutrition and Basic Medical Care with associated source and gauging unit.[4, 5]

Indicator	Measurement	Source
Undernourishment (Kcal)	(%of pop.)	Food and Agriculture Organization of the United Nations.
Depth of food deficit (Kilocalories per person per day) \	(%of pop.)	Food and Agriculture Organization of the United Nation.
Maternal mortality rate (deaths/100,000 live births)	Maternal deaths within 42 days of pregnancy termination.	World Health Organization.
Child mortality rate (deaths/100,000 live births)	Death of children and infants under the age of five years old.	UN Inter-agency Group for Child Mortality Estimation.
Deaths from infectious diseases (deaths/100,000)	Mortality rate caused by infectious diseases.	Institute for Health Metrics and Evaluation.

4.2.3   Electricity

Access and quality of electricity are equally important for gaining sustainable development.

TABLE 4.3: Indicators related to Electricity with associated source and gauging unit.[5]

Indicator	Measurement	Source
Access (% of pop.)	Population with access to electricity.	Sustainable Energy for All
Quality(1=low, 7=high)	Interruptions and their duration.	World Economic Forum Global Competitiveness Report

4.2.4 Access to Knowledge

For gaining sustainable development, quality education is the base for the whole idea. According to UN, above 265 million children are not going to school from which 22% are of primary age. Unfortunately, % ages that are going to school are not provided with enough knowledge[21].

TABLE 4.4: Indicators related to Access to Knowledge with associated source and gauging unit[5].

Indicator	Measurement	Source
Adult literacy rate (%of pop. aged 15+)	Dividing Number of literates aged 15 years, and over, by their population in the form of %age.	UN Educational, Scientific, and Cultural Organization Institute for Statistics
Primary and secondary school enrollment (%of children)	Enrolled âofficial school age childrenâ expressed as a percentage of the total population of official school age.	UN Educational, Scientific, and Cultural Organization Institute for Statistics
Gender parity in secondary enrollment (girls/boys)	Total females by total enrolled males in a given stage of education.	UN Educational, Scientific, and Cultural Organization Institute for Statistics

4.2.5 Opportunity

Cèdric van Styvendael, the President of Housing Europe states " Investing in affordable housing is investing in sustainable development". It is among the key risks for implementing SDGs at a large scale[22].

Table 4.5 and 4.6 below shows each indicator of factor "Opportunity" and "death rate"with associated source and gauging unit and data has been collected from sources.

TABLE 4.5: Indicators related to Opportunity with associated source and gauging unit[4, 5].

Indicator	Measurement	Source
Availability of affordable housing (%age of pop)	The percentage of respondents satisfied or dissatisfied with the availability of good, affordable housing?	Gallup World Poll.
Tolerance for immigrants (%age of pop)	Percentage of respondents answers, whether the city or area where they live a good place or not to live for immigrants?â	Gallup World Poll.
Globally ranked universities (points)	The number of universities ranked on any of the international university rankings, measured on a scale from 0 to 10.	Times Higher Education World University Rankings, QS World University Rankings, &Academic Ranking of World Universities.

4.2.6 Death Rate

TABLE 4.6: Indicators related to Death Rate with associated source and gauging unit[4, 5].

Indicator	Measurement	Source
Traffic deaths (deaths/100,000)	Estimated road traffic fatal injury deaths per 100,000 population.	World Health Organization.
Suicide rate (deaths/100,000)	Mortality rate due to self-detriment.	Institute for Health Metrics and Evaluation..
Premature deaths from non-communicable diseases (deaths/100,000)	Mortality rate due to cardiovascular, cancers, diabetes, and chronic respiratory diseases among populations aged 30-70 yr.	Institute for Health Metrics and Evaluation.
d) Life expectancy at 60 (years)	The average number of years that a person of 60 years old could expect to live in the country of his living.	World Health Organization.

Chapter 5

Factors Explanation and Index Formulation

5.1 Environmental Performance

All the ESSI factors, their indicators and their weightages are described in Chapter 3 and Chapter 4. In this chapter they are explaining their contribution in ESSI and how they are aligned with SDGs.

5.1.1 Environmental Health

Indoor and outdoor environmental health is equally important but due to usage of vast resources to attain the required comfort level, environment is in real danger. Global warming is a result of these artificial heating methods. Vast usage of air conditioning results in access amount of CO2 discharge and climate change which results in danger for the forthcoming era [23]. Air pollution is above the WHO limit in the area where more than 92% of world's inhabitants lives. Diseases caused by air pollution are among major causes of deaths. It includes lung cancer, heart diseases and chronic respiratory disease. Babyhood pneumonia is also air pollution consequential disease. Fine particulate matter (pm) penetrates into blood and cause respiratory diseases. In efficient cooking techniques and non-standardized fuel results into indoor air pollution. Methane and black carbon are called short-lived climate pollutants (SLCPs) which results in climate change[24]. Hence, SDGs 6 and 13 are targeted in this factor to cover environmental situation trend. We have used indicators and data for this factor as described by the Yale University.

5.1.2 Ecosystem Vitality

Ecosystem vitality measures ecosystem safety and source management. Ecosystem involves plants and animals including their interaction with non-living organism like water, soil, sun, weather, climate, earth and environment. This relationship has a mutual impact on every entity of this system[25]. Human's actions always had an enormous effect on earth's atmosphere as well as on ecosystem that makes the whole trajectory as a cycle. Humans change ecosystem and ecosystem influence humans as a reverse effect. So a drastic change is needed in human behavior make this relationship healthy and life supportive. "Ecosystem stewardship" is a framework, dedicated to promote ecological sustainability. Three strategies have been introduced under this framework as reduction of sensitivity and magnitude of known stresses, focus on proactive policies and avoid unsustainable solutions and traps[26]. This factor covers SDGs; 11, 13, 14 and 15. Indicators and data for this factor is taken from Yale universityâs EPI.

5.1.3 Emerging factors related to Environmental Health & Ecosystem Vitality

Noise pollution and solid waste are two aspects related to above described factors of EPI. Yale University Index does not include any factor associated with these issues. This fact cannot be ignored that solid waste, especially when it is not treated properly is a great danger for air, soil, water and species on them. For instance, leachate from dumps permeates in soil and pollutes underground water. Wandering species assault the garbage at waysides and jumble that on the whole way. Most dangerous is when solid waste is burned without knowing the exact procedure, it affects the air quality. One other thing is bad odor from this type of waste. With the damage of environment, solid waste is equally hazardous for health too. It origins numerous infections in human as Bacillary Dysentery, Diarrhea and Amoebic Dysentery, Plague, Salmonellosis, Trichinosis, Endemic Typhus, Cholera, Jaundice, Hepatitis, Gastro Enteric Diseases etc.[27].

Noise is a sound, which is not liked by human ear. Environmental noise involves all uninvited sounds in our communities except workplace sounds. It is a great threat to environment and health. Noise pollution is becoming worst day by day and its magnitude is snowballing dramatically because of population increase, urbanization and usage of increasingly powerful and numerous vehicles. Increased number of highways, rails and air traffic is another cause. The health cannot leftward ignore as noise pollution has

undeviating and aggregate adversarial effects on it. It shrinks professional, domestic, communal and learning environments resulting in economic and social loses. It disturbs sleep, concentration, recreation and communication[28].

For noise pollution, there is no data available for the countries all over the globe by any of the renowned sources like UN, WHO, World Bank etc. So we decided to consider just one aspect of noise; traffic noise that is most hazardous for environmental sustainability and health of species on it[29]. We collected data for number of cars for each country as cars/1000 person. However, the question arises about the driving behavior and horn honking culture difference of each society.

In developing and least developed countries, there are workshops that replace car horns with bus horn to create a loud noise. Taxi drivers are also notorious because of horn honking. There are no laws about horn honking which results in much more noise pollution despite of less number of cars[30] . While in developed countries like Spain, UK, USA and other European countries, horn honking, out of pre-announced situations by Govt. will end up a huge fine as a result, people use horns very rarely just in case of emergency situations[31]. UN has classified countries all over the globe into four main countries according to their development [6]. Therefore, we used that category to deal with each group to find out traffic noise for each country. Hence, according to these facts and findings we assigned scores for each category described in Table 5.1.

TABLE 5.1: Groups classified by UN and horn honking behavior score[6].

Gruops classified by UN	Horn honking behaviar score
developed countries	0.2
transitionary phase	0.4
developing countries	1
under developed	1

For Solid waste, data for MSW (Municipality Solid Waste) has been considered and it is measured as Generation Per Capita (kg/capita/day).

5.2   Social order

The social dimensions of sustainability have not received the same treatment as the other two pillars and there are various interpretations regarding what issues should be addressed. The selection of socialmeasures in sustainable development indicator sets

(SDIs) is often a function of power rather than policy coherence, as influential groups are more likely to have their concerns included . These indicators reflect different socio-cultural priorities and as such are often picked for political rather than scientific reasons. For example, preferences for neoliberalism or the European social model will result in different social objectives . Social sustainability is the ability of a social system, such as a country, family, or organization, to function at a defined level of social well being and harmony indefinitely. Problems like war, endemic poverty, widespread injustice, and low education rates are symptoms a system is socially unsustainable[11]. In this part of ESSI, those factors have been included from social pillar of sustainability that have direct alliance with SDGs.

5.2.1   Nutrition And Basic Medical Care

SDGs 2 and 3 are about this factor, however, majority of the SDGs are impossible to attain without proper nutrition. Conclusively, it will not just end up with malnutrition but also influence health, education, water, sanitation and hygiene[20] . Availability of good medical care can progress, uphold and renovate health whereas can minimize negative effects on environment and control options to reinstate and enhance the environment for the benefit of health and welfare of present as well as future generation[32].

5.2.2   Undernourishment

The estimation for prevalence of undernourishment (PoU) can be describes as proportion of population having insufficient consistent food utilization to supply required nutritional power to uphold a regular and vigorous life. It is expressed as a percentage. This indicator is used to evaluate SDG Target 2.1. It is expressed as dietary energy (kcal) with certain energy requirement norms[33].

5.2.3   Depth Of Food Deficit

It is measured by comparing the undernourished personâs average dietetic energy value which they take from food with minimum value of dietetic energy they require to restore body weight and commence low range activities. Higher result means deeper hunger. It can be measured as (Kilocalories per person per day) it is under SDG 2 and to achieve this goal by 2030 requires thoughtful change in the global food and agriculture structure[34].

5.2.4 Maternal Mortality Rate

Maternal mortality is the death within 42 days of pregnancy termination because of impediments of pregnancy, infant birth, and the puerperium in a particular geomorphologic area (country, state, etc.). To get the rate of this value, it is divided by total inhabitantsâ live births for that specific geomorphologic area for a particular time period. This period can be a year, multiplied by 100,000[35]

(Number of inhabitant motherly deaths/Number of inhabitant live births) x 100,000.

It reflects SDG3 having target to reduce the global motherhood death ratio to less than 70 per 100, 000 live births including no country having motherhood death rate more than twice the worldwide average till the end of 2030[36].

5.2.5 Child Mortality Rate

Due to lack of basic vaccination, dietary add-ons and antibiotics, many children all over the globe died each year before touching the age 5, those can be saved by providing above mentioned necessities. Death under age 5 can be calculated as number of deaths under age 5 divided by total population of under 5 children per 10,000 per day[37]. SDG target for child death is to prevent new born premature deaths unto 12 deaths per 1,000 live births and under 5 unto 25 deaths per 1,000 live births[38].

5.2.6 Deaths From Infectious Diseases

It is a bunch of diseases that attacks low-income countries more than high-income states resulting in stealing millions of lives each year. As a whole, they are responsible for more than one in eight deaths worldwide. It can be calculated as age-wise death rate caused by infectious diseases per 100,000 people. Target 3.3 of SDG pays attention on this indicator by addressing that AIDS, TB, Malaria, Tropical diseases, Hepatitis, Water related diseases and other communicable diseases should be over by the end of 2030[39].

5.3 Electricity

5.3.1 Access To Electricity

It can be estimated as proportion of the inhabitants with right to use to electricity. With the increment of worldâs population, technological advancement and economic growth, electricity demand is increasing in a snow ball trend. Hence centralized and decentralized renewable energy sources are needed to fulfill this demand. SDG 7 addresses this issue by ensuring affordable, reliable, modern and sustainable energy with the right access for all. The sustainable energy refers to a concept "well below $2^0 Cpathway''$.

It means that energy should be produced and provided to billions of people while not disturbing the climate and keeping the temperature below $2^0 C$.

It is measured in terms of %age of population having access to electricity[40].

5.3.2 Quality Of electricity

It includes voltage and commercial quality as well as continuity of electricity in terms of information which is to be expected for stability, supply consistency and voltage quality. Frequency and period of disturbance is measured as continuity of electricity. If the daily electricity supply is kept to minimal interruptions in terms of numbers and their length is also minimum, it means a good quality of electricity. SDG 7 addresses widespread admittance of modern power by 2030 as well as involvement of âcarbon-freeâ energy supply should be doubled by 2030. A scale is formulated from 1-7 to measure the quality of electricity where 1 is graded as low and 7 is ranked as high[41].

5.4 Access To Knowledge

SDG4 refers to this section as quality education. Worldwide efforts are going on to cope this phenomenon but still a threshold step is needed to fulfill this deficiency. The reasons behind this insufficiency are inadequately trained staff, deprived circumstances and lack of equity between rural and urban areas[21]. The following indicators are used in ESSI to measure the access to knowledge performance for all countries.

5.4.1 Adult Literacy Rate

It is estimated as the %age of community ages 15 and above that can read and write simultaneously and they have the ability to perform plain mathematics computation with recognizing a tiny straightforward speech regarding their everyday life[42]. World Bank calculated this rate by dividing total number literates above and 15 in any country, with total community of that country and multiplied this result by 100[43]. One of the SDG target is to ensure that whole youth and large %age of adults should achieve literacy and numeracy without gender biasness unto 2030[44].

5.4.2 Primary And Secondary School Enrollment

It is measured as total children registered in primary or secondary level without considering their age, divided by total population having officially matching age of that level (primary or secondary). It is calculated as %age of children[45].

5.4.3 Gender Parity In Education

This section covers SDG 4 where the target is to ensure comprehensive and fair system of education and learning chances for everyone till the end of 2030 including that education should be free. And without gender biasness, opportunities for childhood growth, pre-primary learning and concern should be provided. It is measured as dividing total females by total enrolled males in a given stage of education in a specific area[46].

5.5 Opportunity

There are many factros of social oredr related to sustaonablity but we have choosed some of them according to relation and availabilty of real data.

5.5.1 Availability Of Affordable Housing

SDG 11 points towards this segment. It is among the key risks for implementing SDGs at a large scale. Euro found claims that poor planned housing costs 195 billion Euros for European economies annually and in the developing and under developed countries 40%of income is being spent on home expenditures. The data has been collected as

%age of people who responds to survey with their satisfaction or dissatisfaction with the availability of affordable home[22].

5.5.2 Tolerance For Immigrants

United Nation is working on an ongoing project " The Sustainable Development Goals and Migrants/Migration". UN has launched 3 versions of it added latest version on 23 February 2016. There is no specified SDG for immigrants but UN started this project to have relation of different SDGs with migrants. Immigrants should be provided by basic services as health, education, social protection as well as advanced assistant ship as property rights, related technologies and monetary facilities. It is estimated as %age of population that responds to survey that whether the specified area of their living is a good pace or not for immigrants[47].

5.5.3 Globally Ranked Universities

Target 4.3 of SDGs directed towards the Higher education that aims to ensure equity without gender biasness for inexpensive and excellent technological, occupational and tertiary schooling as well as university education. This target is equally important as other SDGs. The road map for this SDG is Education 2030 Framework for Action (FFA) having policy of admittance, fairness, eminence and significance. UNESCO is playing a very important role and recognizes the attempts of different countries to bring equity and education based on well-built normative gadgets and organization having focus on with a focus on equality and admittance for all[48]. The number of universities ranked on any of the international university rankings, measured on a scale from 0 to 10.

5.6 Death Rate

Higher life expectancy results in lower death rate while increase in other factors like traffic deaths, suicidal attempts and deaths caused by non-communicable diseases results in high mortality rate.

5.6.1   Life Expectancy At 60

It is the expected life of a person at age 60 that he or she could live and assumption is made that other age-specific death levels are constant for specific country and time period. Life table is used to measure the life expectancy keeping sex and age specific mortality rates in consideration. WHO prepared a model life table by considering 180 life tables keeping other parameters limited. SDG 3 mentioned this section as âassure vigorous life and encourage welfare for all ageâ[49].

5.6.2   Premature Deaths From Non-Communicable Diseases

It is the death rate caused by heart diseases, diabetes, tumors and chronic asthma diseases among people of age between 30-70 years. SDG 3.4 addresses this issue as the reduction of one third untimely deaths from this cause by the end of 2030 by avoidance and proper handling. It also discussed cerebral fitness and growth. It is calculated as deaths per 100,000 persons in a specific time period in a specific area[50].

5.6.3   Suicide Rate

It is the death because of self-imposed injury. It is calculated as death per 100,000 people for a specific age group in a specific time period in a specific geographical area.SDG 3.4 is directed towards this section. Where mental health is discussed as condemning suicide is metal stress related diseases[51].

5.6.4   Traffic Deaths

It is the mortality rate due to injuries during traffic accidents. It can be calculated by dividing value of estimation of road traffic injury death by 100,000 people for a specific time period in a specific country. SDG 3.6 and 11.2 is related to this subject in which by 2020, traffic deaths should be halved and imposing the sustainable and safe transportation systems for all with particular attention for susceptible terminals, females, kids, special needs personnel and old citizens[52].

5.7 Index Formulation

The data is collected from resources mentioned in Tables 4.1, 4.2, 4.3, 4.4, 4.5 and 4.6. It is processed according to the weights described in Table 3.2. The index is calculated as the total of 100% and then all countries are being ranked according to their score from 100. Indicators, for which data is processed as in terms of point like in the case of globally ranked universities or quality of electricity, upper and lower values has been assigned to data range but for other cases %age of population has been considered. Each indicator is calculating one aspect of index and while calculating the score, to avoid unfair scoring and to reduce the impact of missing values, the constraint is followed as the country score will not be calculated if more than one value from each factor is missing. The following formula is used to calculate the score for index.

ESSI Score=(0.6*0.5)(EnH+EcV)-(0.5*0.1)(NOS+SWM)-(0.2*0.2*0.3)(UNN+DFC+MMR+CMR+DID)+(0.3*0.15*0.5)(ATE+QOE)+(0.3*0.15*0.4)(ALR)+(0.3*0.15*0.3)(PSE+GPE)+(0.3*0.2*0.4)(AAH+TFI)+(0.3*0.2*0.2)(GRU)-(0.3*0.2*0.25)(TDR+SDR+ PDD) +0.3*0.2*0.25(LER)

Chapter 6

ESSI Score

6.1 ESSI Score Of 180 Countries

After collection and processing of all data, we end up with the final scores of ESSI. Table 6.2 shows the ESSI score. Countries are given colors according to their groups categorized by UN[6]. Table 6.1 specifies group Vs color.

6.2 Discussion

It is clear from results that top 25 countries are developed nations. Switzerland and France are leading among all the 180 countries because of their healthy environment, ecosystem friendly zone and social infrastructure. Transitory and developing states are somewhere between and least developed countries are at the end. There are clusters in the results especially for highly developed and least developed counties. Highly developed countries are occupying top positions while least developed are lying at bottom. The main reason behind this fact is the difference in policies for both groups. All 1st World countries especially European countries use Sustainable Development Goals (SDGs) as the mentor for their environmental and social development. They started a project "

TABLE 6.1: Indicates Category Vs Color assigned[6].

Category	Color assgined
Developed Countries	Red
Transitionary States (Developing to developed)	Green
Highly Developing Countries	Blue
Least Developed countries	Black

TABLE 6.2: ESSI score of 180 countries.

R	Country	Score	R	Country	Score	R	Country	Score
1	Switzerland	83.54	39	Cuba	64.98	77	Kazakhstan	56.99
2	France	82.98	40	Tunisia	64.80	78	Mauritius	56.93
3	Finland	80.83	41	Romania	64.67	79	Mexico	56.90
4	Denmark	80.75	42	Peru	64.42	80	Kyrgyzstan	56.46
5	United Kingdom	79.89	43	Hungary	63.72	81	Cabo Verde	56.05
6	Spain	79.66	44	Uruguay	63.21	82	St. Vincent and the Grenadines	55.91
7	Sweden	79.46	45	Sri Lanka	63.18	83	Bolivia	55.78
8	Malta	79.25	46	Ecuador	62.97	84	Ukraine	55.62
9	Japan	78.85	47	Venezuela	62.95	85	Barbados	55.57
10	Belgium	78.24	48	Panama	62.72	86	Philippines	55.55
11	Luxembourg	77.96	49	Morocco	62.69	87	Antigua and Barbuda	55.33
12	Ireland	77.82	50	Armenia	62.52	88	South Korea	55.32
13	Austria	77.65	51	Montenegro	62.23	89	Argentina	55.29
14	Iceland	77.57	52	Poland	62.14	90	Qatar	55.18
15	Norway	77.44	53	Seychelles	61.84	91	Paraguay	55.04
16	Germany	76.89	54	Russia	61.60	92	Saudi Arabia	54.66
17	Netherlands	76.07	55	Turkmenistan	61.59	93	Tonga	54.43
18	Australia	76.06	56	Jordan	61.49	94	Belize	54.36
19	Greece	75.93	57	Macedonia	61.34	95	Sao Tome and Principe	54.22
20	Canada	75.84	58	Dominican Republic	60.92	96	Moldova	53.92
21	Italy	75.02	59	Belarus	60.92	97	Samoa	53.78
22	New Zealand	74.64	60	Chile	60.80	98	Trinidad and Tobago	53.69
23	Portugal	74.38	61	Turkey	60.64	99	China	53.55
24	United States	73.54	62	Brazil	60.62	100	St. Lucia	53.45
25	Cyprus	71.94	63	Taiwan	60.35	101	Oman	52.98
26	Costa Rica	68.59	64	Azerbaijan	60.22	102	Lebanon	52.82
27	Albania	68.38	65	Serbia	59.51	103	Thailand	52.65
28	Czech Republic	68.01	66	Bahamas, The	59.24	104	Vietnam	52.58
29	Slovenia	67.73	67	Egypt	59.24	105	Bosnia and Herzegovina	51.88
30	Colombia	67.46	68	Iran	59.23	106	United Arab Emirates	51.56
31	Singapore	67.26	69	El Salvador	58.90	107	Honduras	51.39
32	Slovakia	67.19	70	Maldives	58.59	108	Grenada	51.34
33	Israel	67.09	71	Georgia	58.35	109	Uzbekistan	51.28
34	Estonia	66.65	72	Algeria	58.33	110	Mongolia	51.24
35	Lithuania	66.39	73	Nicaragua	57.94	111	Malaysia	51.22
36	Bulgaria	65.91	74	Dominica	57.54	112	Equatorial Guinea	51.11
37	Croatia	65.55	75	Jamaica	57.49	113	Bhutan	49.61
38	Latvia	65.11	76	Guatemala	57.33	114	Suriname	48.15

R	Country	Score	R	Country	Score	R	Country	Score
115	Nigeria	48.00	137	Micronesia	41.01	159	Burkina Faso	33.86
116	Libya	47.82	138	Tanzania	40.63	160	Zambia	33.78
117	Timor-Leste	47.58	139	Laos	40.60	161	Botswana	33.73
118	Tajikistan	46.42	140	Rwanda	39.70	162	Benin	33.69
119	Kuwait	46.29	141	Malawi	38.72	163	Liberia	32.86
120	Indonesia	46.02	142	Mauritania	38.44	164	Solomon Islands	32.54
121	Ghana	45.78	143	Mali	37.99	165	Chad	32.29
122	Namibia	45.10	144	Djibouti	37.75	166	India	30.89
123	Myanmar	45.02	145	Kiribati	37.56	167	Eritrea	30.58
124	Bahrain	44.53	146	Ethiopia	37.22	168	Niger	30.40
125	Sudan	44.19	147	South Africa	36.97	169	Sierra Leone	29.74
126	Gabon	44.18	148	Mozambique	36.88	170	Swaziland	28.48
127	Comoros	44.08	149	Togo	36.42	171	Guinea-Bissau	28.08
128	Brunei Darussalam	44.02	150	Uganda	35.84	172	Madagascar	27.67
129	Kenya	43.69	151	Bangladesh	35.63	173	Zimbabwe	27.62
130	Guyana	43.67	152	Guinea	35.39	174	Papua New Guinea	26.16
131	Cambodia	43.28	153	Nepal	35.17	175	Dem. Republic of Congo	25.27
132	Senegal	43.23	154	CÃ´te d'Ivoire	34.70	176	Haiti	24.56
133	Republic of Congo	42.57	155	Vanuatu	34.26	177	Burundi	23.79
134	Iraq	42.07	156	Cameroon	34.19	178	Afghanistan	23.73
135	Fiji	41.47	157	Angola	34.13	179	Lesotho	18.73
136	Gambia, The	41.19	158	Pakistan	34.06	180	Central African Republic	6.35

Monitoring of the SDGs and the Europe 2020 strategy". European Commission (Eurostat) follows the performance of EU strategies on regular basis in the light of Sustainable Development Indicators (SDI). Three editions 2016, 2017, and 2018 have been published for this project. Ecologic Institute is one of the main entities of this project. They are focusing on these SDGs; Zero Hunger (SDG2), Clean water (SDG6), Energy (SDG7), Climate action (SDG13), Life on land and below water (SDG4&15), and Partnership for goals (SDG17)[53].

Essentially, a monitoring framework is required by a global alliance among government and scientific bodies for developing countries for required implementation and monitoring of SDGs. While selecting the indicators, careful monitoring is required to make the progress beneficial in many ways. In developing nations there is no proper communication and information is fragmented which results in data gaps and fake results. Another important cause of inability of SSGs in developing countries is the absence of policies related to infrastructure, database management system, lack if skilled work force and high-performance computing. Conclusively, it ends at poor decision-making[54].

Most of transitory states are the distributed part of Russia and "Soviet Union "era damaged environment of this zone but after that in 2012 "President Medvedev" issued an agenda containing the policy for environmental development till 2030. It includes many challenges like global climate change as well as local air pollution etc. Therefore, Russia continues its journey towards sustainability from that socket while all other neighboring countries are also on the way to sustainability[55]. Unfortunately, least developed countries are mostly after the second half in this ranking. It has been discussed earlier under the section 4, that least developed and highly developed countries do not have same resources, knowledge, opportunities and laws. Therefore, it will be quite unfair to rank them in a single pipeline. According to UN categories, results have been refined to find out leaders and laggards in their respective groups. Table 13&14 shows results according to particular categories.

6.3   ESSI Score Among Their Own Groups

In this section, focus is on the least developed countries. Table 6.3 shed some light on results. It is the comparison between least developed states despite of comparison between all nations. Mostly they all have same economic, social and environmental conditions. Sao Tome and Principe is topper and Central African Republic rests at last position. Extinction of poverty in LDCs (Least Developing countries) is most challenging goal among SDGs where almost fifty percent population lives below poverty line. UNCTAD (United Nations Conference on Trade and Development) contends that LCDs are battlefield for winning or losing SDGs. Employment creation, economic growth, accelerating structural transformations are vital for achieving SDGs. In " Istanbul Programme of Action", achievement of 7 percent annual growth rate is kept as baseline for LDCs for attaining SDGs. Though exterior forces have solid impressions on the pace and organization in LDCs in terms of GDP growth. However, government of these countries can follow durable policies to reduce the impact of these external forces. They should take steps to lead their countries on their own[56].

Sao Tome and Principe achieves higher rank inâ Human Development Indexâ too with respect to other African countries and has improved other social indicators. Gross primary progress is 100%, life expectancy of 66 years, low child mortality rate, 97% population has access to improved water, and 60 % population has access to electricity. While Central African Republic is a landlocked country with very limited resources. Year 2013

TABLE 6.3: Shows least developed, highly developed and transitory States according to respective categories.

R	Country	Rank	Country	R	Country	R	Country
1	Switzerland	1	Albania	1	Sao Tome	36	Sierra Leone
2	France	2	Armenia		and Principe	37	Guinea-Bissau
3	Finland	3	Montenegro	2	Samoa	38	Madagascar
4	Denmark	4	Russia	3	Equatorial Guinea	39	Congo, Dem. Republic of
5	United Kingdom	5	Turkmenistan	4	Bhutan	40	Haiti
6	Spain	6	Macedonia	5	Timor-Leste	41	Burundi
7	Sweden	7	Belarus	6	Myanmar	42	Afghanistan
8	Malta	8	Azerbaijan	7	Sudan	43	Lesotho
9	Japan	9	Serbia	8	Comoros	44	Cen. African Republic
10	Belgium	10	Georgia	9	Cambodia		
11	Luxembourg	11	Kazakhstan	10	Senegal		
12	Ireland	12	Kyrgyzstan	11	Gambia, The		
13	Austria	13	Ukraine	12	Tanzania		
14	Iceland	14	Moldova	13	Rwanda		
15	Norway	15	Bosnia and Herzegovina	14	Malawi		
16	Germany	16	Uzbekistan	15	Mauritania		
17	Netherlands	17	Tajikistan	16	Mali		
18	Australia			17	Djibouti		
19	Greece			18	Kiribati		
20	Canada			19	Ethiopia		
21	Italy			20	Mozambique		
22	New Zealand			21	Togo		
23	Portugal			22	Uganda		
24	United States			23	Bangladesh		
25	Cyprus			24	Guinea		
26	Czech Republic			25	Nepal		
27	Slovenia			26	Vanuatu		
28	Slovakia			27	Angola		
29	Estonia			28	Burkina Faso		
30	Lithuania			29	Zambia		
31	Bulgaria			30	Benin		
32	Croatia			31	Liberia		
33	Latvia			32	Solomon Islands		
34	Romania			33	Chad		
35	Hungary			34	Eritrea		
36	Poland			35	Niger		

security crisis ragged its social performance that was already very limited. There is a lot of social insecurity until now which lead to displacement of population internally and externally. GDP per capita projections shows that in 2017, almost 75% of total population lives below international poverty line. After 2019, situation can be better according to forecasts. Poverty seems to drop to 73% because of export and production in the field of cotton, diamond and wood [56]. Table 6.4 shows ranking of developing countries among their own category.

TABLE 6.4: Indicates rank and score of developing countries in their own category.

R	Country	R	Country	R	Country	R	Country
1	Costa Rica	22	Egypt	43	Saudi Arabia	64	Namibia
2	Colombia	23	Iran	44	Tonga	65	Bahrain
3	Singapore	24	El Salvador	45	Belize	66	Gabon
4	Israel	25	Maldives	46	Trinidad and Tobago	67	Brunei Darussalam
5	Cuba	26	Algeria	47	China	68	Kenya
6	Tunisia	27	Nicaragua	48	St. Lucia	69	Guyana
7	Peru	28	Dominica	49	Oman	70	Congo, Rep.of
8	Uruguay	29	Jamaica	50	Lebanon	71	Iraq
9	Sri Lanka	30	Guatemala	51	Thailand	72	Fiji
10	Ecuador	31	Mauritius	52	Vietnam	73	Micronesia
11	Venezuela	32	Mexico	53	United Arab Emirates	74	Laos
12	Panama	33	Cabo Verde	54	Honduras	75	South Africa
13	Morocco	34	St. Vincent and the Grenadines	55	Grenada	76	CÃ´te d'Ivoire
14	Seychelles	35	Bolivia	56	Mongolia	77	Cameroon
15	Jordan	36	Barbados	57	Malaysia	78	Pakistan
16	Dominican Republic	37	Philippines	58	Suriname	79	Botswana
17	Chile	38	Antigua and Barbuda	59	Nigeria	80	India
18	Turkey	39	South Korea	60	Libya	81	Swaziland
19	Brazil	40	Argentina	61	Kuwait	82	Zimbabwe
20	Taiwan	41	Qatar	62	Indonesia	83	Papua New Guinea
21	Bahamas	42	Paraguay	63	Ghana		

Chapter 7

EPI And ESSI Score Comparison

In this chapter, a comparison has been done for 180 countries among EPI and ESSI score. The main purpose of this comparison is to highlight the difference among the environmental and social performance of each country. Table 7.1 designates the rank of each country from both indexes according to alphabetical order.

The results are obvious for least developed countries as they have a score change of 10 points in either direction. They occupy the last places in both indexes but swap each other positions. The reason is same as discussed in previous sections; lack of policies, limited resources, outer effects and poverty.

Among the transitory states, Bosnia and Herzegovina jumped in a positive direction and improves its position from 158 (EPI) to 110 (ESSI). Bosnia has been effected enormously by war ended up with the problems as air pollution from metallurgic plants, limited disposing of urban waste, water shortage and destruction of infrastructure. 1992-1995 civil war keeps Bosnia at a very low rank in EPI. However, it started to retain itself with prominent struggle but to make sustainable and healthy environment, World Bank started a project " Local Initiatives (Microfinance) Project II". This project is an initiative to support private-sector led growth by providing funding to small entrepreneurs to expand their businesses and improve social performance by giving loans to low-income people so that can earn by themselves. It improves livelihood of poor by reaching low-income groups to provide long-term profitability[57]. Conclusively, this project helps Bosnia to improve its rank in ESSI.

Botswana is among developing countries and declines its position from 113 (EPI) to 160 (ESSI). In 1966, at the time of independence, Botswana was one of the poorest countries

in world but after the discovery of diamond and good management policies, it acquires upper-middle income status in 1990s. Through its national development framework, it makes big advances in economic growth. However, assets demanding nature of gold mining and external forces created a society with rigidity that results in lack of employment generation. Outcome was an inequality of income among people and poverty level is statically high for a middle-income country. They are trying to follow SDGs through Poverty Eradication Programme (PEP), LetlhafulaProgramme, HIV "Treat All Strategy" and mainly "National Development Plan 11 (2017 â 2023)"[58]. These initiatives can improve its ranking in coming versions of ESSI.

One more country that declines its position in ESSI is Brunei Darussalam. It has followed the MDGs; health, education and environment while for maintaining social sustainability, it is still on the way to consolidate and maintain its achievement to cope with universal challenges, like climate change, food and energy prices. They also have to cope with required targets of education, gender equality, skilled workers and quality of life[59]. Brunei has huge resources of oil comparative to its population and it has very massive dependence on foreigner workers to operate its resources. Brunei has to pay a large amount of its income to those workers that seem to be problematic in future because of economic condition if country. Excess of these workers disturbs their ranking in social sustainability too[60].

Turkey turns out to be one of the improving nations in ESSI compared to EPI. It jumps from 108 (EPI) rank to 61 in ESSI. There are enormous reasons behind this improvement but one of the main reasons is "Series of Project (SOP)" that lend money to (Iller Bank) to provide money to selected municipalities for improving public services all over the country. The project also contains "The Turkey Sustainable Cities Program", which supports environmental, financial, and social sustainability improvement. With this finding, municipalities are responsible for waste water treatment, solid waste management, improved street lighting and energy productivity. This program stands on private-public investment with a target of maximizing finance for development, aligned with social sustainability at national and international level[61]. "Sustainable Development Coordination Commission (SDCC)" is another force behind this improved social performance. It is coordinated by "Ministry of Development'. It has main concern with the implementation of SDGs. Since 2000, Turkey already had a set of indicators by TURKSTAT to measure sustainable development but after SDGs announcement, it has been aligned further. [62].

TABLE 7.1: Indicates rank of 180 countries for both EPI and ESSI[7].

EPI Rank	Country	ESSI Rank	EPI Rank	Country	ESSI Rank
168	Afghanistan	177	146	Comoros	127
40	Albania	32	178	Congo, Dem. Republic of	175
88	Algeria	67	157	Congo, Rep. of	136
170	Angola	152	30	Costa Rica	26
76	Antigua and Barbuda	96	139	CÃ´te d'Ivoire	155
74	Argentina	84	41	Croatia	37
63	Armenia	51	55	Cuba	36
21	Australia	17	24	Cyprus	25
8	Austria	14	33	Czech Republic	28
59	Azerbaijan	62	3	Denmark	4
98	Bahamas, The	80	163	Djibouti	141
96	Bahrain	125	73	Dominica	79
179	Bangladesh	154	46	Dominican Republic	58
93	Barbados	77	87	Ecuador	48
44	Belarus	66	66	Egypt	63
15	Belgium	11	106	El Salvador	68
81	Belize	95	71	Equatorial Guinea	104
167	Benin	159	165	Eritrea	166
131	Bhutan	113	48	Estonia	35
92	Bolivia	81	141	Ethiopia	147
158	Bosnia and Herzegovina	110	107	Fiji	132
113	Botswana	160	10	Finland	3
69	Brazil	56	2	France	2
53	Brunei Darussalam	122	140	Gabon	128
30	Bulgaria	40	156	Gambia, The	135
154	Burkina Faso	162	94	Georgia	75
180	Burundi	178	13	Germany	16
89	Cabo Verde	76	124	Ghana	120
150	Cambodia	134	22	Greece	20
161	Cameroon	157	118	Grenada	111
25	Canada	19	110	Guatemala	74
171	Central African Republic	180	134	Guinea	153
137	Chad	165	143	Guinea-Bissau	171
84	Chile	55	128	Guyana	124
120	China	100	174	Haiti	176
42	Colombia	30	114	Honduras	109

EPI Rank	Country	ESSI Rank	EPI Rank	Country	ESSI Rank
43	Hungary	44	112	Moldova	94
11	Iceland	13	83	Mongolia	107
177	India	167	65	Montenegro	57
133	Indonesia	121	54	Morocco	46
80	Iran	65	135	Mozambique	148
152	Iraq	133	138	Myanmar	129
9	Ireland	12	79	Namibia	123
19	Israel	29	176	Nepal	156
16	Italy	21	18	Netherlands	18
78	Jamaica	72	17	New Zealand	22
20	Japan	9	97	Nicaragua	70
62	Jordan	52	172	Niger	168
101	Kazakhstan	82	100	Nigeria	117
130	Kenya	131	14	Norway	15
95	Kiribati	140	116	Oman	97
61	Kuwait	118	169	Pakistan	158
99	Kyrgyzstan	83	56	Panama	50
153	Laos	137	164	Papua New Guinea	174
37	Latvia	38	105	Paraguay	88
67	Lebanon	101	64	Peru	42
173	Lesotho	179	82	Philippines	89
160	Liberia	164	50	Poland	49
123	Libya	116	26	Portugal	23
29	Lithuania	33	32	Qatar	85
7	Luxembourg	10	45	Romania	41
68	Macedonia	69	52	Russia	61
175	Madagascar	172	148	Rwanda	142
127	Malawi	144	102	Samoa	93
75	Malaysia	108	104	Sao Tome and Principe	92
111	Maldives	64	86	Saudi Arabia	91
147	Mali	145	126	Senegal	130
4	Malta	8	84	Serbia	71
166	Mauritania	143	39	Seychelles	45
90	Mauritius	73	155	Sierra Leone	170
72	Mexico	78	49	Singapore	34
122	Micronesia	138	28	Slovakia	31

EPI Rank	Country	ESSI Rank	EPI Rank	Country	ESSI Rank
34	Slovenia	27	159	Togo	149
151	Solomon Islands	163	57	Tonga	99
142	South Africa	146	35	Trinidad and Tobago	98
60	South Korea	86	58	Tunisia	39
12	Spain	6	108	Turkey	59
70	Sri Lanka	47	38	Turkmenistan	54
91	St. Lucia	102	145	Uganda	151
36	St. Vincent & Grenadines	87	109	Ukraine	90
115	Sudan	126	77	UAE	106
103	Suriname	114	6	United Kingdom	5
162	Swaziland	169	27	United States	24
5	Sweden	7	47	Uruguay	43
1	Switzerland	1	136	Uzbekistan	112
23	Taiwan	60	144	Vanuatu	150
129	Tajikistan	119	51	Venezuela	53
119	Tanzania	139	132	Vietnam	103
121	Thailand	105	117	Zambia	161
125	Timor-Leste	115	149	Zimbabwe	173

Chapter 8

Conclusion

SDGs are carrying out the role as a mentor for all the developed, developing and least developed countries. This is the first version of ESSI, which highlights the performance of 180 countries with respect to SDGs. All the columns of sustainability are important and ESSI measures performance of these countries within boundary of sustainability. It measures this enactment within the limitations of LDCs problems and deficiencies and dominances of developed estates. However, it tries to lower down the firm of environmental sustainability ranking of these countries by adding social factors in it so that all countries can show their capabilities and efforts in every direction of sustainability. All the factors added in ESSI have some importance, purpose and connection with SDGs. However, it has some data deficiencies as false data or insufficient data, same as EPI but improvements can be made by launching next versions of it by loading it with updated data each year. More factors related to environment, ecosystem and social order could be added in ESSI to improve its capability.

The outcomes are clear; developed nations are toppers while least developed are laggards. This study illustrates the reasons behind the high scores of developed states as well as details of developing and least developed countries for gaining low rank. These countries are then classified into UN categories to rank them in their own groups to overcome the limit of different resources, policies and opportunities. A comparison has been carried out for each group to find out leader and laggard in that group. Lastly, ESSI score has been compared to EPI score to find out that if a country performs very well according to EPI, but not as good for social order. How its position will be changed in ESSI as compared to EPI and vice versa for good performers in social sustainability.

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