UNIVERSITY OF GHANA

COMPARATIVE ANALYSIS OF SUSTAINABLE DEVELOPMENT GOALS (SDGs) ACHIEVEMENT AMONG WEST AFRICAN COUNTRIES; APPLICATION OF EXTENDED TOPSIS TECHNIQUE

THIS THESIS IS SUBMITTED TO THE DEPARTMENT OF OPERATIONS AND MANAGEMENT INFORMATION SYSTEMS (OMIS) UNIVERSITY OF GHANA BUSINESS SCHOOL (UGBS) IN PARTIAL FULLFILMENT FOR THE AWARD OF A MASTER OF PHILOSOPHY DEGREE IN OPERATIONS MANAGEMENT

BY

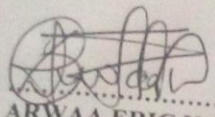
ARWAA KARIBAYENG ERIC

10636335

DATE: AUGUST, 2019

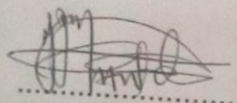
DECLARATION

I solemnly declare that this research work is entirely my own efforts and has not been submitted to this university or any other university either in part or whole for the award of a degree or professional qualification. This work is my own original production, except where explicitly stated otherwise in the text, references and acknowledgement has been duly given.



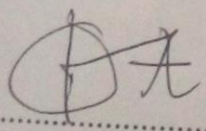
ARWAA ERIC KARIBAYENG
(STUDENT)

12/06/2020
DATE



DR. ANTHONY AFFUL-DADZIE
(SUPERVISOR)

12/06/2020
DATE



DR. KWAKU OHENE ASARE
(CO-SUPERVISOR)

12/06/2020
DATE

II

DEDICATION

Scholarship is said to be a product of the contributions of many people in the society. As a matter of fact, I would not have accomplished this great academic milestone without the support, help and prayers of many people. From the foregoing, I want to dedicate this academic work foremostly to God Almighty for his immense and invaluable spiritual, physical, material and emotional support granted me throughout this daunting two-year Master of Philosophy (MPhil) Operations Management program. Secondly, I would also like to dedicate this work to Mr. Osman Abudu of Enterprise Insurance Ghana, for his initial and subsequent financial support during the pursuit of this program. To my able and affable supervisors, Dr. Anthony Aful-Dadzie and Dr. Kwaku Ohene-Asare, I say, I am most grateful sirs, for your guidance, coaching and direction during the course of this research work. To Nana Ama Atobra, Kelvin, Kelly, Eadda, Nana Esi, Antoinette, Cletus, Mr. and Mrs. Douglas Dergbaan and every family member I say kudos for your immense support, backing and prayers. Finally, I dedicate this work to Hajia Mardi Mohammed, my mate for her enormous support.

May God bless all of you immensely!

ACKNOWLEDGEMENT

My profoundest gratitude goes to all the lecturers in the Operations and Management Information Systems (OMIS) Department of the University of Ghana Business School for their contributions to knowledge and the extent they went to reshape our thoughts. Particularly to Dr. Anthony Afful-Dadzie, Dr. Francis Banuro, Dr. Kwaku Ohene-Asare, Dr. Joseph Amanfo, Dr. Eric Afful-Dadzie, Professor john Effah and Professor Richard Boateng, my encounter with you all has be tremendous to say the least.

To all my colleagues in the 2017/2019 operations management class, particularly Issah Abdul Baki, Mardi Mohammed, Michael Gyampo, Umar Zaid Pro, Ernest Feli, Samuel Foli, Josephine Eshun and Enoch Amoateng, I say I am most grateful for meeting and encountering you guys during this two-year MPhil program. You guys were awesome and I will forever keep the fond memories we shared together.

To the Administrator of GETFUND and all the staffs I encountered with in that institution, I say I am very appreciative for the scholarship granted me for the two-year program.

To my family members and all my love ones especially Jacob Ayiku, I am forever indebted to you all.

ABSTRACT

Purpose - The purpose of this study is to compare the performance of selected West African countries regarding their attainment of the Sustainable Development Goals (SDGs). The study used the Extended Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) as the main framework. This is because TOPSIS creates room for the incorporation of the three dimensions of sustainability-social, economic and environmental to establish threshold below which a country is deemed to have failed the sustainability test. Furthermore, the introduction of time independent threshold permits vivid comparison of countries performance over a given period. The technique also permits the use of plots to present a better visualization of the sustainability performance of countries over time.

Design/Methodology - First of all, realistic thresholds were computed for each of the 37 criteria, using averages method. These thresholds were then incorporated into the model. TOPSIS then generated the composite scores, in which the score of the hypothetical country is set as the threshold below which a country is said to have failed a sustainability test. The square of closeness coefficient is then used to decompose the composite scores into dimensional scores. The scores obtained for the three dimensions illustrate the contributions of each dimension to sustainability. This act as a guide to determining which dimension to concentrate on for improvement going forward. Finally, the relative composite score helps to track the progress of each country over a period of time.

Findings – In the end, the proposed method was able to rank all the 14 West African countries based on the composite scores and classified them from best performing to worst performing countries. The technique further helped in ranking the dimensional scores and showed the actual contributions of each dimension to the composite score. Plots were used to track the progress or otherwise of countries over the three-year period. Results obtained in evaluating the sustainability performance of countries showed the practical application of the technique.

Practical implication- As far as the UN continues to engage countries to never relent in the adoption of strategies to improve the social, economic and environmental dimension of sustainability, this technique can be used to help identify those countries that are meeting the sustainability test or otherwise, as well as track their progress over time.

CONTENT PAGE

LIST OF TABLES AND FIGURES

FIGURES

CHAPTER ONE

INTRODUCTION

In this chapter the researcher presents the background to the study and the statement of the problem which explains the problem the study is seeking to solve. Again, the chapter outlines the study objectives and the possible questions the study is seeking to find answers to. The chapter further presents the contributions of the study to academic research and practice, as well as the limitations encountered by the researcher in the course of the study. The final component of the chapter is the study structure which spells out the organisation of the whole thesis.

1.1 Background of the Study

Sustainability has become a buzz word in many public discourses among nations and businesses at the global, regional, national and local levels. Pitelis (2013) and Walker, et al. (2014) argued that sustainability strives to make sure the utilization of current resources does not deprive future generations of their social, economic and environmental benefits. Sustainable development can be measured using the trio bottom line approach. This means that progress of development is evaluated on three main dimensions- social, economic and environmental. Again, the Brundtland report (1987) views sustainable development to be development that meets the needs of the present generation without compromising the needs of future generations. This means that, sustainable development can only be said to have been achieved when the current generation uses the earth resources like Gold, Bauxite and others to satisfy their present need, while ensuring future generations are not short changed.

Ban Ki-Moon, the eighth Secretary-General of the United Nations articulated the point further, by saying that the end result of sustainable development is improved economic growth, achievement of social justice, proper environmental stewardship and improved governance. In the end, no country can claim it is developing sustainably, if it is unable to ensure improvement in all the three dimensions of sustainability. Measuring sustainability is critical because it helps in assessing whether a country or firm is making progress or otherwise under a given period (Afful-Dadzie, et al., 2016).

In the attempt to measure, track and monitor development across the world, the UN came up with a universal framework that act as a guide or blueprint which all member countries should adopt and incorporate into their national development planning. In the blueprint, the UN spelt out 17 goals called the Sustainable Development Goals (SDGs). In each of the goals, there are several indicators that countries are expected to work towards achieving by 2030. Overall, 230 indicators were outlined by the UN. Additionally, the UN assigned to each indicator a threshold. These thresholds then become the basis on which a country is described as being sustainable or not by 2030.

All the 230 indicators, as formulated and monitored by the Inter Agency Expert Group on SDG (an agency under the UN Statistical Commission) have assigned thresholds which are expected to be met by countries by 2030. These thresholds, to date, remain the primary yardstick for which countries progress are measured or tracked over time. Developing countries continual improvement is key to enabling them meet these thresholds by 2030. Surprisingly, many of the developed countries like Sweden, Denmark, Norway and others as at 2016, 2017 and 2018 had already met some of the goals, like goal 1 (no poverty). The poverty levels in these developed countries is far less than the UN projected poverty headcount threshold of 1.5% per population

(SDG Index and Dashboard, 2016, 2017 and 2018). On the contrary, many developing countries particularly in Africa are still witnessing increasing extreme poverty levels, social exclusion due to wars, conflict and high unemployment rates (SDG Index and Dashboards, 2016, 2017 and 2018; FAO, 2016).

Critics argue that the SDGs are too wide in scope, therefore making it difficult for countries to successfully implement them. Bill and Melinda Gate Foundation, one of the key critics argued that a critical factor that made the Millennium Development Goals (MDGs) not to have much impact on developing countries was that, they were too wide in scope (the Christopher, J.L.M., 2016), therefore making monitoring difficult. The UN (2015a) also argued that the MDGs did not achieve much success because they were narrowly focused and excluded majority of the vulnerable and marginalized groups in society.

Granted their narrowly focused nature, a lot of successes were achieved over the fifteen (15) year period that the eight (8) MDGs were implemented. These successes became a foundation for the SDGs to build on (MDG Report, 2015). For instance, in 2015 reports suggest that global poverty rates had declined by more than half, falling from 1.9 billion in 1990 to 836 million in 2015, with much of the progress occurring within the 2000s. Net primary school enrolment in developing regions had also increased significantly to 91%, representing an 8% increase over the year 2000 figure (MDG Report, 2015). In Sub-Saharan Africa for instance, maternal mortality dropped by 49% between 2000 and 2015 (MDG Report, 2015), as well as reduction in New HIV infections. In fact, between 2000 and 2013 new HIV infections had dropped by 40% from an estimated 3.5 million cases to 2.1 million, and by June 2014, 13.6 million people living with HIV were receiving antiretroviral therapy (ART) globally (MDG Report, 2015).

The SDGs which builds upon the MDGs were adopted by all United Nations Member States in 2015 and have led to awareness in the three pillars of sustainability among countries. Within a spate of three years, the SDGs are already bearing fruits. For example, under 5 deaths dropped from 5.9 million in the year 2015 to 5.4 million in 2017 representing a 0.5 million reduction (SDG Report, 2019).

The successes chalked within this three-year period is largely attributed to close monitoring, strong partnership and collaboration among key stakeholders like donor agencies, civil society organisations and governments (SDG Index and Dashboard, 2016). The UN and its development agencies are stricter on countries to be transparent, accountable and ensure strong reporting systems are instituted for easy monitoring of progress at all levels. As monitoring and reporting become key, it forces countries to record and make available data on indicators for Official Development Assistance institutions. The availability of verifiable and reliable data, makes comparison among countries easier, if the right methodology is applied. Hence countries are now more able to compare their achievements in all indicators with peers at the global, regional, and national levels (SDG Report, 2016, 2017 and 2018). Once countries are compared, it is easy to know which ones are the best performers and which are the worst performers. In the end, comparison will help worst performers to learn from the best performers through collaboration and partnerships. Moreover, monitoring is key because it makes available relevant data that is very crucial for translating the SDGs into practical tools for problem solving as well as reveal the strengths and weaknesses in country specific strategies adopted in implementing the SDGs (SDG Index and Dashboard, 2017; Kroll, C., 2015).

1.2 Problem Statement

Since the adoption of the Sustainable Development Goals (SDGs) in September, 2015, demand to establish independent, robust avenues for monitoring progress has escalated (Chris, J.L.M., 2015). The Global SDG Index, Global Burden of Diseases, Global Competitiveness Index, have become key sources of information for countries since they are able to track progress towards realizing SDGs targets.

Despite the fact that these global comparisons of countries are important, especially so because such indices tell the best performing countries, as well as worst performing countries on a year on year basis, countries in less developed economies like Africa may be unfairly and unrealistically compared with those in developed economies like Norway, Sweden, USA, Germany, etc. Therefore, some form of index is required for less developed countries like Africa and may be further narrowed down to the sub-regional level. With such an index, all the countries considered will be fairly and realistically represented based on their unique characteristics like culture, social setting, economic activities, democracies, etc. Again, with such index, we know we are comparing "apples with apples" and not "apples with oranges" as demonstrated in the case of global indices. Perusing the Global SDG Index 2016, 2017 and 2018 all revealed one trend; countries from Africa are ranked at the bottom, with those from advance economies like Scandinavian countries, Europe and North America topping the rank, thus making it difficult to appreciate the progress made by African countries. Therefore, a comparison of SDG performance on a group of countries that share similar social, economic and environmental status is needed to help inform progress made at a regional level.

Also, most indices in use today fail to incorporate thresholds that could help identify whether a country is on or off track in relation to achieving the SDG target. With thresholds, it means

progress can be tracked, evaluated and monitored from one period to another. A robust mathematical tool that allows incorporation of thresholds and further ensures optimum interactions between the three dimensions of sustainability i.e social, economic and environmental is the Extended TOPSIS technique (Afful-Dadzie, et al., 2016). , The Extended TOPSIS technique is able to determine the contributions made by each dimension to a composite score, a crucial aspect many indices fail to look at. A thorough literature search did not find any index on SDG performance that decomposes the composite score into the three pillars of sustainability. This study therefore applies the Extended TOPSIS technique in order to ascertain the overall SDG performance as well as the performances in relation to the social, economic and environmental aspect of the SDGs among West African countries.

The core of this study is therefore to do a comparative analysis of West African countries attainment of Sustainable Development Goals (SDGs), by first of all determining the best and worst performing countries on the basis of the composite score, secondly determining the best and worst performing countries on the basis of the three dimensions of sustainability, using their relative contributions and finally track the trend in performance of the countries using the square of the relative closeness coefficient.

1.3 Research Objectives

The general objective of the study is to compare the performance of 14 West African Countries, using 37 selected SDG indicators and rank them in ascending order from best performers to worst performers.

The specific objectives are;

1. To identify the top performing countries and worst performing countries based on the composite score.

2. To identify the top performing and worst performing West African countries under the social, economic and environmental dimensions of sustainability.
3. To Track the trend of performance of the 14 West African countries in meeting the SDG targets.

1.4 Research Questions

The study raises the following questions;

1. Which of the 14 West African countries are identified as the top performers and worst performers of the SDG indicators?
2. Which of the 14 West African countries are identified as the top performers and worst performers under the social, economic and environmental dimensions of the SDGs?
3. What is the trend of performance of the 14 West African countries in meeting the SDG targets?

1.5 Contributions of the Study

The contributions of the study are categorised into three folds;

A significant contribution of this study is the ability to perform a sustainability test to examine whether a country is on or off track in the achievement of the SDG targets. This is made possible using the so-called 'Industry Standard' where any country performing better than the 'Standard' is classified as having passed the sustainability test and any country performing worse than the Industry Alternative is classified as having failed the sustainability test.

Secondly, prior to this study, many of the indices like Global SDG Index, Global Burden of Disease, Dow Jones Sustainability Index, etc only look at ranking based solely on their composite scores; however, this study is able to breakdown or decompose the composite scores for each of

the 14 selected West African countries into dimensional contributions. The chosen mathematical model was able to determine the percentage contributions of each of the dimensions, i.e social, economic and environmental to the composite score. This is novel and adds to existing literature.

More importantly, the UN, Member states, Governments, Civil Society Groups and other stakeholders will find the findings from this study very useful as it can inform their policy decisions going forward. Similarly, the Academic community will find this study very useful particularly future researchers who wants to venture into the field of sustainable development.

1.6 Limitations

The few limitations the researcher faced regarding this study include the following;

For obvious reasons, the original number of indicators the researcher planned to work with had to be reduced to 37 due to unavailability of data on many of the 14 selected West African countries. 37 out of 230 indicators is considered a small percentage of SDGs indicators that were used in the study. Moreover, because the TOPSIS technique automatically requires a value before an operation can be performed, indicators with no value labelled 'Not Available' (NA) were eliminated from the list to arrive at the 37 indicators.

Secondly, because the UN have not clearly spelt out the weights or importance attached to the 230 SDG indicators, the researcher assumed that they are all equally important. This necessitated the assignment of the 0.02703 weight to each of the 37 criteria.

Thirdly the researcher had to derive the realistic thresholds for each of the 37 criteria based on the 2030 thresholds given by UN. Again, because the UN thresholds are meant to be achieved by 2030,

they could not have been used as basis to determine the sustainability of a country within this three-year period of the SDGs implementation.

Finally, the researcher had to impute some data to ensure every indicator for each of the 14 countries had a numerical value before applying the TOPSIS to perform the analysis. So, imputation was done based on the assumption of population size, national borders shared, the health and education expenditure of some countries as well as using the previous year data for some countries.

1.7 Thesis Structure

The study is segmented into six chapters. Chapter one presents a background to the study, the problem statement, the study objectives, research questions, study contributions, limitations and thesis structure.

Chapter Two looks at the context of the study. In this section, the researcher presented briefly, historical events, meetings and conferences at the global level that led to the adoption of the SDG framework. The researcher, further looked at the genesis of the SDGs being continuation of the MDGs. The chapter presented the rationale for choosing West Africa as case in point. Lastly, a tabular presentation of the selected SDGs and their respective indicators totaling the 37 is given.

In Chapter three, the researcher reviewed relevant studies in the field of SDGs. Key studies that focused on some of the selected indicators were considered. Apart from these, the researcher also looked at studies that applied the proposed TOPSIS method. Key gaps identified in the papers are also outlined.

The fourth chapter captures the methodology of the study. These include the selection of the 14 West African countries, the selection of the 37 indicators, a description of the extended TOPSIS

method and the steps involve in using the method as well as the approach that was used to derive the thresholds.

Chapter five presents the analysis of data and then proceeds with the findings and discussions.

The summary of key findings, recommendations and conclusions then constitute chapter six which is the final section of the study.

CHAPTER TWO

CONTEXT OF THE STUDY

2.0 Introduction

This chapter focus on the historical backgrounds that led to the implementation of the 17 Sustainable Development Goals (SDGs) in January 2016 with particular emphasis on West Africa as case in point. The chapter therefore begins with an assessment of the Millennium Development Goals (MDGs) in West Africa, followed by a brief history of SDGs, then followed by why the United Nations had to move from MDGs to SDGs. The final two parts depict a presentation of summarised tables showing all the 17 SDGs, the number of targets and indicators for each goal and a table showing the names of all 17 West African countries, their population, GDP, Poverty rates, Electricity consumptions and other indicators.

2.1 Assessment of 15-year period of Millennium Development Goals (MDGs)

The Millennium Development Goals (MDGs) were adopted in September 2000, being a product of the United Nations Millennium Declaration. The UN Millennium Declaration conference was attended by 169 member countries. Eight (8) goals were agreed upon by member countries as goals that could bridge the development gap between developing and developed countries. In total, 21 targets from the eight (8) goals were outlined with specific timelines and measurable (Sachs, 2015a). The aim of the MDGs was to ensure human dignity, equality and equity at the global level (United Nations, 2000), and bridge the development gap between developed and developing nations.

Indeed, MDGs became a priority and informed the developmental agenda of member countries. Sachs (2012) for example asserts that MDGs were seen as a determining factor to "promote global

awareness, political accountability, improved metrics, social feedback and public pressures", and ultimately set the path for future action beyond 2015. Globally, the implementation of MDGs led to many countries to accomplish significant improvement in their socioeconomic development particularly less developed and developing nations. An example is China, which has been cited to have achieved most of the MDGs targets. Sachs (2015a), indicates that poverty was extreme in the world in the 1990s with poverty rate of 37%, but after the introduction of the MDGs, particularly in 2015, global poverty rates had fallen to 10%. This shows the success the MDG program had accomplished over the 15-year period across the world.

According to Sachs (2012), the contributory factors for the success of the MDGs was due to 'public awareness, mobilization, advocacy and continuity. Sach (2012) further indicates that the successes chalked were also as a result of non-legally obligatory and facilitating nature that greatly reduced the negotiation process.

In the view of Bello (2013), the MDGs to an extent were successful in developing countries because there was a moral outrage globally, which creates room for citizens to be involved and subject efforts and activities of their governments to scrutiny.

Nonetheless, the MDGs faced several limitations which negatively affected their overall global success, thereby necessitating the introduction and implementation of the SDGs in 2015. Some of the flaws included; the lack of intermediary indicators, the difficulty to gather relevant and informed data in some countries, the lack of engagement of the private sector, and a general lack of investment from partaking governments (Sachs, 2012). The lack of funding is as a result of the fact that MDGs were funded essentially by aid from foreign donors, particularly developed nations making pledges (0.7%) of their Gross Domestic Products (GDP) for development assistance. So in instances, where developed nations failed to fulfill this pledge, implementation was stalled.

Indeed, literature showed that countries like Denmark, Luxembourg, Norway, Sweden and the United Kingdom had been forthcoming with their 0.7% of GDP pledges (Sachs, 2012). Sachs (2015b) further argued that such a circumstance was warranted by the lack of adapted organisational arrangements and machinery for providing a long-term aid and capably mobilizing funds.

Some researchers have however raised some criticisms. For example, McCloskey (2015) and Moore (2015) strongly argued that, despite the significant role of the MDGs, their limitation can be described by an inadequate thoughtfulness of the fundamental causes of poverty and why there is high disparity among regions "within the global South and between global North and South". Besides, researchers like Pogge and Sengupta (2015) maintained that the MDGs were incapable of focusing on the need to facilitating institutional transformations, because there were structural issues that framers of the goals failed to look at from the onset. Moore (2015) also postulated that, regardless of the ambitious objectives the program sought to pursue, it "did not think to challenge assumptions" on the global economy so as to be able to face the "serious crisis of values and ideas" that the world faces today. This implies that the assertions of Moore (2015) directly corroborates the criticisms toward the reflection of growth as a necessary goal of human development, a statement which has been largely objected to by many in a world of limited resources. Again, some researchers have criticized the "top-down" approach adopted in implementing most programmes, which have proven to be too reductionist and inadequate to define the environment of all the member countries (Tiwari, 2015). Finally, the fact that some key issues, such as inequalities, work conditions, unemployment or, more importantly, climate change, were left out of the scope of the MDGs constituted a major shortcoming which, once identified, paved the way for the constitution of the SDGs in the post-2015 Agenda (Tiwari, 2015).

2.2 Brief History of Sustainable Development (SD)

The concept of sustainable development formed the basis of the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992. The summit represented the first international attempt to draw up action plans and strategies for moving towards a more sustainable pattern of development. It was attended by over 100 Heads of State and representatives from 178 national governments. The Summit was also attended by representatives from a range of other organisations representing civil society. Sustainable development was the solution to the problems of environmental degradation discussed by the Brundtland Commission in the 1987 report; Our Common Future.

The responsibility of the Brundtland Report was to investigate the numerous concerns that had been raised in previous decades, namely, that human activity was having severe and negative impacts on the planet, and that patterns of growth and development would be unsustainable if they continued unchecked. Key works that highlighted this thinking included Rachel Carson's Silent Spring (1962), Garret Hardin's Tragedy of the Commons (1968), the Blueprint for Survival by the Ecologist magazine (1972) and the Club of Rome's Limits to Growth report (1972).

The concept of sustainable development received its first major international recognition in 1972 at the UN Conference on the Human Environment held in Stockholm. The term was not referred to explicitly, but nonetheless the international community agreed to the concept now fundamental to sustainable development that both development and the environment, hitherto addressed as separate issues, could be managed in a mutually beneficial way.

The term became popular 15 years later in Our Common Future, the report of the World Commission on Environment and Development, which included what is deemed the 'classic'

definition of sustainable development: "development which meets the needs of the present without compromising the ability of future generations to meet their own needs".

It was not until the Rio Summit, however, that major world leaders recognised sustainable development as the major challenge it remains today.

In 2002, the World Summit on Sustainable Development was held in Johannesburg, which was attended by 191 national governments, UN agencies, multilateral financial institutions and other major groups to assess progress since Rio. The Johannesburg Summit delivered three key outcomes: a political declaration, the Johannesburg Plan of Implementation, and a range of partnership initiatives. Key commitments included those on sustainable consumption and production, water and sanitation, and energy.

2.3 The Move from MDGs towards SDGs

From the earlier submissions on the Millennium Development Goals (MDGs), it was observed that the MDGs were poorly implemented simply because the goals were not binding on member countries, and therefore did not receive the full commitment from governments of member states. Again, the goals that were captured under the Millennium Development Goals (MDGs) program did not fully encompass all aspects of development including; the social, environmental and economic elements popularly referred to as the “Triple Bottom Line”. It was further observed that the focus of the MDGs was on developing countries, i.e Asia, Africa, and some Latin American countries where development were lacking and poverty ratios were high. The vision primarily was to bring developing countries development at par with the developed economies. From the shortfalls of the MDGs emanated the Sustainable Development Goals (SDGs). Before the SDGs

implementation began, proponents of sustainable development like Sachs had done some studies on the shortfalls of the MDGs and envisioned what the SDGs should comprise of.

Sachs (2012) strongly argued that, the prominent acknowledgement of the "urgency of sustainable development", emanating from empirical evidences, establishes the rationale for the Sustainable Development Goals (SDGs) concept. Though, there is an absence of a common method and objectives to follow, especially on the universal definition of "Sustainable Development", the past three years have witnessed an increase of a shared deliberation of social, economic and environmental goals as a "triple bottom line" on which member states are to base their development agendas (Sach, 2012). Sachs (2012, 2015a), further suggests that the seriousness of sustainability issues confronting member countries, the slothful and slow approach in attempting to solving these matters, and the inability to meeting the triple bottom line on a greater scale, is an indication of the need for "urgent, high-profile, and change producing global goals", in unison with increasing anxieties on a world of vast disparities, which the MDGs failed to tackled. LeBlanc (2015), express that the fundamental aim of the SDGs was to resolve the shortfalls that emanated from the MDGs, as the solutions provided by the MDGs to some of the goals essentially impacted the efforts of goals in other areas. Le Blanc (2015) for that reason advocated that the new SDGs needed to be designed in a form of "network", arising from the "political mapping of the sustainable development universe". There is an interconnectedness between some targets under the Sustainable Development Goals (SDGs) which have fostered the development of more coherent and integrated policies across sectors (Christopher, J.L.M., and Alan, D.L., 2016)

Kim (2016) corroborates the assertions of Le Blanc (2015) by indicating that although the Sustainable Development Goals (SDGs) targets are inspired by an already existing global treaties and programs, there is apparent lack of consistency and long-standing vision, which comprises of

two very imperative features of sustainable development. Indeed, the absence of an "overarching goal" embedded in the post-2015 agenda is yet to be stated, and this has led to varying arguments on the very definition of the ideal future envisioned by the global community. Barkemeyer et al. (2014) and Scott and Lucci (2015), argued that once an ideal future is established, it results in the elusivity of guidance document caused by the manifestation of conflicts, the absence of trade-offs and synergy-enhancing programs. In the view of Kim (2016), doubts about the ideal future can legitimately be solved by a legitimate enough body like the High-Level Forums on Aid Effectiveness, which can provide clear-cut description of expected outcomes in considering Sustainable Development Goals (SDGs) and sustainable development.

Sach (2015a) further suggested that the Sustainable Development Goals (SDGs) seemed to be a possible solution to counteracting the failures of the obligatory agreements approved after the 1992 Rio Summit, i.e the UN Framework Convention on Climate Change (UNFCCC), by using the motivation of the non-obligatory, time-bound model presented by the MDGs (Sachs, 2015a). However, the shortcoming of the MDGs, and the consequential introduction of sustainability by negotiating round this model with the "stated specific and quantified targets" give the impression that it is an interesting substitute to multifaceted international agreements. Koehler (2015) comments on what he terms "conceptual improvements" in the move towards the adoption of SDGs, by focusing on education and health rights, and also looking at the role of industrialization and productivity, for example their value chain.

Scheyvens et al. (2016) argued that a shift that can clearly be observed in the whole transitional from MDGs to SDGs is that of universality. Indeed, sustainability is now imperatively a global issue, and for this fact, the new global goals are now encompassing involving all countries and the attainment of common goals and not primarily focusing on developing nations as was the case

with MDGs (Sachs, 2015b). This represents a very significant change towards the implementation of the SDGs, and therefore depict the will to solve international issues by seeing "it as a whole", instead of following the North-South dichotomy (Koehler, 2015). Tiwari (2015) opined that after 2015 many wealthy countries were witnessing serious economic difficulties, against the rapidly changing nature of economies. Yet on the other hand rich countries are still the most capable of mobilizing financial means, while a lot of low-income countries are lacking financial resources and capacities (Sachs, 2015b).

The funding issues met by the MDGs, jointly with the change of scope observed for the SDGs, lead the international community to consider the possibility to mobilize other resources. Such a reflection introduced the consideration of private funding and investments (Sachs, 2015b). On this issue, Sachs distinguishes goals which are strictly related to public services (such as SDG 3 related to Health or SDG 4 related to Education) and thus will rely more on efficient public financing processes, and other goals, such as SDG 13 related to the will to end human-induced climate change, which would be more adapted for investments from private businesses, and where the public authority would have more of a "steering" role. More broadly, the SDGs discussions have been marked by a will to integrate businesses and civil society at the same level than governments, as necessary actors for the fulfilment of sustainability objectives (Scheyvens et al., 2016). This happens as a result of a longer-term reflection around the development agenda, notably around the High-Level Forums on Aid Effectiveness, which notably focused on the necessity to integrate private sector as a complement to public aid (Mawdsley et al., 2014). Moreover, this new focus on growth, together with the successes of economies such as South Korea, served as an argument to defend a stronger focus on growth, which would happen jointly with a bigger contribution from the private sector (Mawdsley et al, 2014).

As a summary, Scheyvens et al. (2016) identified four major characteristics distinguishing the MDGs and the SDGs: the first characteristic is the importance of environmental sustainability, followed by the importance of economic development, with a focus on inclusive growth. Whereas the third is the universal application to all countries instead of a North or South distinction, and lastly the growing concern for non-material aspects of development, such as inclusion, dignity or justice

2.4 The 17 Sustainable Development Goals and Why the Selection of Some Goals

After a successful evaluation of the implementation of the eight (8) Millennium Development Goals (MDGs) by member states, in 2015, a new program that aimed at resolving the challenges the MDGs battled with was introduced. From the literature, particularly that of Sach (2012, 2015a), Hempell (2016), Koehler (2015), Tiwari (2015), Scheyvens et al (2016), Barkemeyer et al. (2014), Scott and Lucci (2015) and Mawdsley et al, (2014), it was observed that the biggest challenges identified were classified into four;

First of all, the initial MDGs were not binding and as a matter of fact failed to garner the needed commitment and efforts from member states for their implementation. Secondly, implementation was only possible after rich countries had fulfilled their pledges or promises of 0.7% of the GDPs. The third challenge was that the MDGs were primarily focusing on developing countries, however the SDGs are more encompassing and therefore involves all countries developed or developing, rich or poor. The other challenge of the MDGs was that, it did not properly capture development looking at the three major components including; environmental, social and economic classified as the ‘Triple Bottom Line’.

So, in September 2015, the 17 SDGs comprising of 169 targets and 244 indicators were adopted by 189 countries. The 17 SDGs became universal standards for all 189 countries in the world and are expected to be completed by 2030. The 17 goals aim to create a balance between the three aspects of sustainability: economic, social and environmental. These goals include; goal (1) No poverty; goal (2) Zero hunger; goal (3) Good health and well-being; goal (4) Quality education; goal(5) Gender equality; goal (6) Clean water and sanitation; goal (7) Affordable and clean Energy; goal (8) Decent work and economic growth; goal (9) Industry, innovation and infrastructure; goal (10) Reduced inequalities; goal (11) Sustainable cities and communities; goal (12) Responsible consumption and production; goal (13) Climate action; goal (14) Life below water; goal (15) Life on land; goal (16) Peace, justice and strong institutions; and the final goal (17) focuses on Partnership.

Table 2.4: Summarised Table Showing the Number of Goals under Social, Economic and Environmental Sustainability

Table 2.4.1 Social Sustainability Goals, Targets and Indicators

Social Sustainability			
Goal	Description	Number of Targets	Number of Indicators
1	No Poverty	7	14
2	Zero Hunger	8	13
3	Good Health and well-being	13	28
4	Quality education	10	11
5	Gender equality	9	14
10	Reduced inequality	10	11
16	Peace, Justice and Strong Institution	12	23
17	Partnership	19	24
	Total	**88**	**138**

Source: SDG Report, 2018, UN, UNESCO, World Bank Metadata, 2017

Table 2.4.2 Economic Sustainability Goals, Targets and Indicators

Economic Sustainability			
Goal	Description	Number of Targets	Number of Indicators
7	Affordable and Clean Energy	5	6
8	Decent work and economic growth	12	17
9	Industry Innovation and infrastructure	8	12
12	Responsible consumption	11	13
	Total	**36**	**48**

Source: SDG Report, 2018, UN, UNESCO, World Bank Metadata, 2017

Table 2.4.3 Environmental Sustainability Goals, Targets and Indicators

Environmental Sustainability			
Goal	Description	Number of Targets	Number of Indicators
6	Clean water and sanitation	8	11
11	Sustainable cities and communities	10	15
13	Climate action	5	8
14	Life below water	10	10
15	Life on land	12	14
	Total	**45**	**58**

Source: SDG Report, 2018, UN, UNESCO, World Bank Metadata, 2017

Table 2.4.4A Social Indicators with UN Thresholds

Dimension	Goal	Indicator	UN Threshold	Direction	Weights
Social	Goal 1	Poverty headcount ratio at $1.90/day (%)	<=2%	less better	0.02703
	Goal 2	Cereal yield (t/ha)	>2.5	more better	0.02703
		Prevalence of adult obesity (%)	<=10%	less better	0.02703
		Prevalence of stunting, under-5s (%)	<=7.5%	less better	0.02703
		Prevalence of undernourishment (%)	<=7.5%	less better	0.02703
		Prevalence of wasting, under-5s (%)	<=5%	less better	0.02703
	Goal 3	Healthy life expectancy at birth (years)	>=65	more better	0.02703
		Maternal mortality (per 100,000 live births)	<=70	less better	0.02703
		Neonatal mortality (per 1000 live births)	*<=12*	less better	0.02703
		Incidence of tuberculosis (per 100,000)	<=10	less better	0.02703
		Traffic deaths (per 100,000)	<=8.4	less better	0.02703
		Under 5 mortality (per 1000 live births)	<=25	less better	0.02703

Source: SDG Report, 2016, 2017 and 2018, UN, UNESCO, World Bank Metadata, 2017

Table 2.4.4B Social Indicators with UN Thresholds

Dimension	Goal	Indicator	UN Threshold	Direction	Weights
Social	Goal 4	Literacy rate of 15-24-year-old (%)	>=95%	more better	0.02703
		Expected years of schooling (years)	>=12	more better	0.02703
	Goal 5	Unmet demand for contraceptives (%)	<=20%	more better	0.02703
		Women in national parliaments (%)	>=40%	more better	0.02703
	Goal 6	Freshwater withdrawal (%)	<=20%	less better	0.02703
		Access to improved sanitation (%)	>=95%	more better	0.02703
		Access to improved water (%)	>=98%	more better	0.02703
	Goal 16	Corruption Perception Index (0-100)	>=60	More better	0.02703
		Homicides (per 100,000)	<=1.5	less better	0.02703
		Feel safe walking at night (%)	>=80%	More better	0.02703

Table 2.4.5 Economic Indicators with UN Thresholds

Dimension	Goal	Indicator	UN Threshold	Direction	Weights
Economic	Goal 17	Health & Education spending (% GDP)	>=16%	more is better	0.02703
	Goal 7	Access to electricity (%)	>=98%	more is better	0.02703
		Adjusted growth rate (%)	>=0%	more is better	0.02703
		Child labor (%)	<=2%	less better	0.02703
		Unemployment rate (%)	<=5%	less better	0.02703
	Goal 9	Quality of overall infrastructure (1-7)	>=4.5	more better	0.02703
		Internet use (%)	>=80%	more better	0.02703
	Goal 10	Gini index (0-100)	<=30	less better	0.02703

Source: SDG Report, 2016, 2017 and 2018, UN, UNESCO, World Bank Metadata, 2017

Table 2.4.6 Environmental Indicators with UN Thresholds

Dimension	Goal	Indicator	UN Threshold	Direction	Weights
Environmental	Goal 11	Improved water source, piped (%)	>=98%	more better	0.02703
		PM2.5 in urban areas (µg/m3)	<=10	less better	0.02703
	Goal 12	Municipal solid waste (kg/person/year)	<=1	less better	0.02703
		Wastewater treated (%)	<=1	less better	0.02703
	Goal 13	Climate change vulnerability (0-1)	<=0.1	less better	0.02703
		CO2 emissions from energy (tCO2/capita)	<=2	less better	0.02703
		Freshwater withdrawal (%)	<=20%	less better	0.02703
		Access to improved sanitation (%)	>=95%	more is better	0.02703
	Goal 6	Access to improved water (%)	>=98%	more is better	0.02703

Source: SDG Report, 2016, 2017 and 2018, UN, UNESCO, World Bank Metadata, 2017

Table 2.4.7A: Table Showing Some Indicators under the SDG

Country	Population	GDP Per Capita $(PPP)	GDP $ (Million)	No. of people employed in agric	No. of people living in poverty (< $1.90) %	No. of people living below national poverty line	No. of people living in poverty in all its dimensions
Benin	11801595	2219	25407	43%	49.60%	40.10%	
Burkina Faso	20321560	1884	35598	28%	43.70%	40.10%	84%
Cape Verde	560349	6942	3762	68%	8.10%	35.00%	
Cote D'Ivoire	25531083	3857	95887	48%	28.20%	46.30%	58.70%
Gambia	2228075	1686	3607	27%	10.10%	48.40%	
Ghana	30096970	4605	131498	41%	12.00%	24.20%	33.70%
Guinea	13398180	2039	17056	68%	35.50%	55.20%	75.10%
Guinea Bissau	1953723	1806	3089	83%	67.10%	69.30%	77.50%
Liberia	4977720	867	3960	43%	38.60%	54.10%	71.20%
Mali	19689140	2169	40974	58%	49.70%	43.60%	77.70%
Mauritania	4661149	4474	17421	76%	6.00%	31.00%	52.20%
Niger	23176691	1153	21655	76%	44.50%	44.30%	89.30%
Nigeria	200962417	5927	1124627	37%	53.50%	46.00%	53.20%
Sao Tome & Principe	4096	3208	685	17%	38.00%	66.20%	
Senegal	16743859	2678	43326	53%	52.20%	46.70%	56.90%
Sierra Leone	7883123	1791	11551	61%	49.20%	52.90%	
Togo	8186384	1612	12494	32%	32.30%	55.10%	50.10%

Source: IEA Statistics, (2014), World bank Data (2017)

Table 2.4.7B: Table Showing Some Indicators under the SDG

Country	No. of Women in parliament	Literacy rate (Youth 15-24)	literacy rate (Adult 65+)	Maternal Mortality	Under-5 mortality ratio (per 1000)	Access to electricity urban (% of urban pop.)	Electricity Gen. from Renewable (Kwh) (million)	Access to electricity (% of pop.)
Benin	7.20%	52.50%	7%	405	98	70.80%	5	41.40%
Burkina Faso	11.00%	50.10%	8.40%	371	81	60.70%		19.20%
Cape Verde	23.60%	98.10%	36.80%	42	17	93.00%		92.60%
Cote D'Ivoire	10.60%	53.00%	18%	645	89	92.10%	105	64.30%
Gambia	10.30%	60.00%	10.40%	706	64	69%	0	47.80%
Ghana	12.70%	85.70%	34.90%	319	49	89.80%	3	79.30%
Guinea	21.90%	46.30%	13.10%	679	86	82.20%		35.50%
Guinea Bissau	13.70%	60.40%	19.50%	549	84	29.80%		14.70%
Liberia	12.30%	49.10%	32.80%	725	75	34%		19.80%
Mali	8.80%	49.40%	13.60%	587	106	83.60%		35.10%
Mauritania	20.30%	56.10%	26.60%	602	79	81%		41.70%
Niger	17.00%	39.80%	13.70%	553	85	65.40%	4	16.20%
Nigeria	5.60%	66.40%	21.60%	814	100	86%	0	59.30%
Sao Tome & Principe	14.50%	96.70%	49.60%	156	32	73%		65.40%
Senegal	41.80%	69.50%	21.50%	315	45	87.70%	70	64.50%
Sierra Leone	12.30%	57.00%	3.70%	1360	111	46.90%		20.30%
Togo	17.60%	84.30%	20.40%	368	73	87.40%	5	46.90%

Source: IEA Statistics, (2014), World bank Data (2017)

2.5 Why the Focus on West African

The study is properly situated contextually in the West African sub region. It compares the achievement of 14 selected West African countries using 37 indicators of the 230 indicators under the SDGs. The fourteen (14) countries were selected because data covering all the 37 chosen indicators was available for the three-year period; 2016, 2017 and 2018. West Africa is a unique case in point for a comparative analysis because of the challenges facing it. In terms of development, West Africa is considered as one poorly developed region, with high levels of poverty, economic inequality, social exclusion, poor sanitary condition, poor levels of access to electricity, high levels of illiteracy and high levels of unemployment, etc. There is a total of 17 countries in West Africa. The sub-region covers a total area of about 1,974,103 square miles (5,112,903 km2) with an estimated population of 392,666,164 (2019 estimate). There are different cultures in West Africa, some very wide apart, while some cultures like food, clothing and music share some similarities.

The countries in West Africa include Benin, Burkina Faso, Cape Verde, Cote D'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau and Liberia. The rest are Mali, Mauritania, Niger and Nigeria, Senegal, Sierra Leone, Sao Tome and Principe and Togo. West Africa shares boundary with the Atlantic Ocean to the west and south. Meanwhile, it shares borders with the Sahara Desert to the north. Lagos (Nigeria), Abidjan (Cote d'Ivoire), Accra (Ghana), Abuja (Nigeria) and Kumasi (Ghana) are the biggest cities in West Africa. The predominant religion is Islam with more than half of the population being Muslims. Hausa and Niger-Congo languages are the key languages spoken in the region. The most populated country in the sub-region is Nigeria with an estimated population of 200.192 million (www.worldpopulationreview.com). Nigeria is said to be one of the

poorest countries in West Africa per the UN standard of $1.90 a day (SDG Index and Dashboard, 2016).

Figure 2.5.1: Map of West Africa

Source: google.com, 2018

2.6 Brief History on West African

Archaeological literature reveals that people began settling in West Africa somewhere in 12,000 B.C. By somewhere 1,500 B.C. inhabitants of West Africa started using iron to make implements which enhanced their capacity to farm and laid the foundation for civilizations in the region. The foremost civilization in West Africa was the Nok culture. The Nok culture appeared about 1000 BC in modern day Nigeria. It lasted till 300 BC. After the Nok civilization, other civilisations like the Ghana Empire, the Mali Empire, the Kingdom of Nri, the Ashanti Empire, and the Songhai Empire all emerged.

In the mid-1400s, a lot of Europeans began invading the region by establishing settlements along the coast. The Europeans established colonies and started trading in slaves. This lasted for centuries.

Literature revealed that more than half of the estimated ten million slaves captured in Africa and sent to America and Europe between the mid-1600s and the mid-1800s were from West Africa. Subsequent to World War II, there was a wind of nationalist movement that blew across the region which inspired most Africans to rise and fight for their freedom. In 1957, Ghana became the first sub-Saharan colony to gain independence and; by 1974 all countries in West Africa had gained independence.

The borders of West African countries as we have it today, were the colonial boundaries that the European had established. The creation of borders leads to the division of once single ethnic group into two or more states with potential of instigating political instability and wars. The West African sub region have witnessed series of political instability and brutalities including civil wars. Popular among these wars were the Nigerian Civil War, first and second Liberian Civil War, and the Ivorian Civil War.

CHAPTER THREE

LITERATURE REVIEW

3.0 Introduction

This segment of the thesis reviews relevant literature in the area of Sustainable Development Goals (SDGs). The chapter begins by giving the various definitions of Sustainable Development as espoused by authorities in the field. This is proceeded by a chronology of activities leading to the adoption of sustainable development goals. The chapter ends by identifying the various gaps in the literature.

3.1 Definitions of Sustainable Development

Several authors and researchers have in the past decades presented what they believe is sustainable development. The United Nations Commission on Environment and Development (1987) viewed sustainable development to be the kind of development that ensures both current and future generations' needs are met without compromising none. Pearce et al (1989) also indicated that sustainable development is both a social and economic construct which assumes sustainability to be demonstrated in our society where there are real incomes, improvement in educational standards, healthcare and the overall quality of life. Unemployment rates are relatively high in Africa (Africa SDG Index and Dashboard, 2018), particularly among the youth. Those who are fortunate to find jobs, they are usually underpaid, and largely described as unsustainable jobs. In Ghana for instance, even though government has provided 100000 jobs for the youth, under the Nation Builders Corps (NABCO) critics argue whether it is sustainable (myjoyonline.com). Pearce et al (1989), therefore concludes that sustainable development can only be witnessed when the citizens are paid adequate incomes, have access to improve educational and health facilities and enhanced environments that supports dignified life.

Development by nature is evolving, in view of its evolving nature Harwood (1990) argued that sustainable development is an unhindered progressive structure focused on the attainment of maximum human benefits and efficient utilization of resources harmonizing it with the environment needed for all humans and other species. He therefore concludes that sustainable development ought not to be static but revolves around creating greater gains for all humans, other species while enabling the judicious use of environmental resources. The IUCN, UNDP and WWF, (1991) opined that sustainable development is a continuous effort of ensuring the improvement of human life looking at the extent to which the environment supports the population of humans and other species. The environment's carrying capacity is the total population of humans and species that it can support indefinitely given the food, habitat, water, and other necessities available in the environment. Lele (1991), Meadows (1998), PAP/RAC (1999), Vander-Merwe and Van-der-Merwe, (1999), Beck and Wilms, (2004), Vare and Scott, (2007), Marin et al., (2012) and Duran et al., (2015) view sustainable development as development that ought to focus on economic development of a people, ensures social inclusion; involving majority of the vulnerable people in the society as well as guaranteeing environmental sustainability in the end. Lele (1991) argues that sustainable development ought to be targeted towards influencing a certain change process and repetitive as well. Meadow, et al. (1998) views sustainable development to be a progressive process that ensures the integration of human population and economic development in an environment and biochemical methods of the Earth. Meanwhile, PAP/RAC (1999) postulates that any form of development anchored by the carrying capacity of the environment implies sustainable development. From the various views espoused by authorities, few things stand out which include the fact that sustainable development ensures that while the current generation is not prohibited from using the earth resources, however such resources have to be used judiciously so that future

generations are not deprived of it. Again, sustainable development also ensures that development is inclusive meaning, it ought to involve majority of the vulnerable people in society and it ought to improve their ability to earn reliable and sustained incomes that enhance the quality of life.

3.2 Sequence of Events Leading to the Adoption and Implementation of Sustainable Development Concept

Historically, literature suggest that several events took place leading to the adoption and implementation of the 17 Sustainable Development Goals (SDGs). Key amongst these events is the United Nation (UN) report on Man and His Environment in 1969. The UN report on Man and His Environment (1969) focused on activities or actions of man that reduced the likelihood of environmental degradation. More than 2000 scientists were put together to compile this report. Three (3) years after the UN report on Man and his Environment the UNEP global Conference on the Human Environment in Stockholm, was organised. At this conference, action plans were proposed to conserve the environment. The report was titled “Only One Earth” (UN and UNDEP, 1972). Then in 1975, the UNESCO organised a forum on education about the environment in Belgrade, Yugoslavia. At the forum, a global environmental educational agenda was set up, referred to as the Belgrade Charter. In that same year, another conference was organised in Tokyo, Japan dubbed “International Congress of the Human Environment (HESC)”. The congress stressed the same issues on environmental conservation as occurred in Stockholm in 1972.

Table 3.1A: Sequence of Events Leading to the Adoption and Implementation of Sustainable Development

Year	Activities	Brief Description
1969	United Nation (UN) issued the report *Man and His Environment*	Actions focused to prevent global environmental degradation. In excess of 2,000 scientists were included in the establishment of this report.
1972	Initial UN and UNEP global *Conference on the Human Environment*, Stockholm, Sweden.	A pronouncement of action plans published on environmental conservation under the slogan *Only One Earth*.
1975	Forum on education about the environment by UNESCO, Belgrade, Yugoslavia	A global environmental educational agenda was set up, referred to as the *Belgrade Charter*
1975	*International Congress of the Human Environment (HESC)*, Kyoto, Japan	The congress stressed the same issues on environmental conservation as occurred in Stockholm in 1972
1979	*The First World Climate Conference*, Geneva, Switzerland.	Concentrated on the establishment of a research and monitoring programme on environmental change.
1981	*The first UN Conference on Least Developed Countries*, Paris, France	Official report on the guidelines and measures for assisting underdeveloped nations
1984	Creation of *United Nations World Commission on Environment and Development (WCED*).	The Commission is mandated to ensure cooperation among developed and developing nations and the implementation of international development policies on environmental protection.
1987	*Our Common Future* or *Brundtland report* was issued by the WCED.	This report outlined the fundamental philosophies regarding the idea of sustainable development
1987	Publication *of Montreal Protocol*.	Covers outcomes of studies on dangerous effects on the ozone layer.
1990	*The Second World Climate Conference*, Geneva, Switzerland	Advancement of the research and monitoring programme on climate change and the formation of international *Climate Change Monitoring System*.
1992	*United Nations Conference on Environment and Development (Earth Summit* or *Rio Conference)*, Rio de Janeiro, Brazil.	Establishment of the principles of sustainable development and the framework for the future in the *Rio Declaration* and *Agenda 21 Action Plan.*

Source: Reviewed Literature by researcher, 2019

Table 3.1B: Sequence of Events Leading to the Adoption and Implementation of Sustainable Development

Year	Activities	Brief Description
2000	UN issued *Millennium declaration*	The eight Millennium Development Goals (MDGs) were set at the UN Declaration.
2002	*The World Summit on Sustainable Development*, Johannesburg, South Africa.	An account on the achievements of the Rio Conference, which reiterated the former commitments and agreed on the guidelines for future implementation of the concept.
2009	*The Third World Climate Conference*, Geneva, Switzerland	Advancement of the world Climate Change Monitoring System to adequately anticipate for potential disasters.
2009	Global Congress *Summit G20*, Pittsburgh, USA.	G20 member states agreed on a moderate and sustainable economy.
2012	United Nations (UN) Conference *Rio +20*, Rio de Janeiro, Brasil.	Renewal of the commitment towards the goals of sustainable development and encouraged matters of international green economy.
2015	United Nations (UN) *Sustainable Development Summit 2015*, New York, SAD	Publication of the *United Nations (UN) 2030 Agenda for Sustainable Development* outlining the 17 Sustainable Development Goals to be accomplished by 2030.
2015	United Nations (UN) forum on environment change *COP21Paris Climate change Conference*, Paris, France.	Treaty on the decrease of greenhouse gas emissions to minimise and stop worldwide warming

Source: Reviewed Literature by researcher, 2019

3.3 Review of Relevant Papers on Sustainable Development Goals (SDGs)

SDGs have become an interesting area of research, and it is gaining a lot of traction from researchers. In the last three years key indices have emerged and these indices have attempted to measure the performance of countries relative to the 230 indicators outlined by the Inter-Agency Expert Group on SDG (IAEG-SDG, 2015). The aim is to provide reliable means of data at the global level to monitor and track progress made by individual countries (SDG Index and Dashboard, 2016, 2017, 2018). The SDG Index and Dashboard report has become an annual activity or ritual undertaken by the Bertelsmann Stiftung Institute and the Sustainable Development Solution Network (SDSN). Other key indices which rank countries performance

include the Ocean Health Index (Halpem, et al, 2012), the Index of Economic Freedom (Miller, 2015), the Global Competitiveness Index (Schwab and Shai-Martin, 2016) and the Human Development Index (UN, 2016a). Other independent researchers like Chris (2016), Kedir (2016), Avorgbedor, et al (2017), Biadgilign, Mgutshini, Haile, et al (2017) and others who have contributed significantly to knowledge in Sustainable Development Goal.

In total 37 indicators were selected for this study. This comprised of 8 environmental indicators, 9 economic indicators and 20 social indicators. The Global SDG Index and Dashboard captures 230 indicators which include the 37 selected for this study. The proceeding paragraphs in this chapter looked at a detailed review of the relevant literature gathered.

The Global SDG Index and Dashboard has become an annual report generated by the Bertelsmann and Stiftung Institute in collaboration with the Sustainable Development Solutions Network (SDSN) to inform over 150 countries in the world on their composite or combined performance on SDG attainment. The index ranks countries using the weighted aggregation method based on the data gathered on the 230 indicators provided by the IAEG-SDG (2015). The first ranking was done in 2016 and subsequently in 2017 and 2018. Consecutively, over the three-year period Africa has performed abysmally. Many of the worst performers on the index were from West Africa, while the best performers were Scandinavian countries. The SDG Index and Dashboard (2016) report suggest that OECD countries especially those in the Scandinavian countries like Sweden, Denmark and Norway made significant progress in meeting the SDGs, nonetheless, they are confronted with serious challenges in meeting the targets for climate change (SDG 13), ecosystem conservation (SDG 14, 15). It further revealed that Eastern Europe and Central Asia showed impressive performance as some of those countries were able to overcome the challenges in providing social services and access to basic infrastructure. Even though, the region largely ended

extreme income poverty (SDG 3), it was confronted with challenges regarding gender equality (SDG3), addressing renewable energy and climate change (SDG 7, 13), sustainable consumption and production (SDG 12), protecting ecosystems (SDG 14, 15). Regarding Sub-Saharan Africa, the report showed that many of the countries in the region are facing serious challenges particularly regarding the fight against extreme poverty (SDG1), hunger (SDG2, health (SDG3), education (SDG4) and access to basic infrastructure (SDG9). The report therefore concludes that urgent actions needs to be taken to tackle urban development (SDG11), reduction of high inequality (SDG10) and peace, security and institutions (SDG16). The findings discovered in the 2017 and 2018 reports of the Global SDG Index and Dashboard suggest great similarities with that of the 2016 report.

The Africa SDG Index and Dashboard (2018) is a fragment of the Global SDG Index and Dashboard. This report specifically focuses on Africa in totality. It ranked the performance of countries in the Northern, Central, Western, Eastern and Southern Africa. Morocco was ranked highest with 66.1, meaning it is 66.1% near to attaining the SDGs. Carbo Verde and Ghana were identified as best performers in West Africa ranked 5th and 6th with a total score of 63.0 and 62.0 respectively. Guinea-Bissau was ranked as the worst performer with a total score of 43.0.

The Ocean Health Index by Halpem, et al. (2012) is another index that ranks countries by using data collected on marine waters under national jurisdiction, coastlines, and oceans within 200 nautical miles. The index uses a weighted aggregation method to rank 200 countries across the world. The index suggests that, regions with stable and effective governance scored much higher than regions where corruption, dictatorship, civil strife, war and poverty have been chronic. This stresses the interconnected nature of SDGs, meaning that improving ocean health will require efforts from all stakeholders to promote peace, justice, gender equality, socially-responsible

business and other aspects of civil health, because progress in those areas makes it much easier for communities and nations to improve the environmental and economic conditions needed to boost ocean health. Seven African countries were found to have scored 50. This means, these African countries are 50% near attaining sustainable oceans. This figure shows that almost all African countries are performing poorly regarding the achievement of sustained ocean health. The Index of Economic Freedom by Miller (2015) suggest that overall global average economic freedom score stood at 60.4. This implies that the global performance of countries towards the attainment of economic freedom is 60.4%. Out of 101 countries, a greater portion of them were from developing countries which showed progress in economic freedom over the years. The paper concludes that globally the increase in economic freedom was driven by improvements in trade freedom, monetary freedom, and freedom from corruption, for which global ratings have advanced by close to one point or more on average.

On the issue of global competitiveness of countries, Switzerland, Singapore and USA were ranked 1st, 2nd and 3rd whiles Chad, Mauritania and Yemen ranked 136th, 137th and 138th (Schwab and Shai-Martin, 2016). The paper also found that Sub-Saharan Africa's competitiveness has slightly weakened year on year, mainly as a consequence of deteriorating macroeconomic environments across the region. Mauritius and South Africa were ranked 45th and 47th indicating the highest performing countries in SSA. Air quality has consistently become a leading environmental threat to public health across the globe due to industrialization.

Airborne pollutants are estimated to contribute to two-thirds of all life-years lost to environmentally related deaths and disabilities. Air pollution issues are especially acute in rapidly urbanizing and industrializing nations such as India and China. The report further suggests that globally a lot of strides have been made in protecting marine and terrestrial habitats, exceeding the

international goal for marine protection in 2014. The Global Burden of Disease Index (2016) found out that globally the median health related SDG index score was 56.7, implying that averagely the world's performance towards eradicating diseases is 56.7%. However, countries like Singapore, Iceland and Sweden scored 86.8%, 86% and 85.6% respectively. Meanwhile, Afghanistan, Central African Republic and Somalia scored 10.9%, 11%, and 11.3% respectively representing the lowest score. Brauer, et al. (2016) also discovered that in 2013, 87% of the world lived in areas with air quality of 10 μg/m3 PM2.5 annually. ECA, AUC, AfDB, UNDESA (2015) revealed that economic growth has increased by 4.5% on average in West Africa since the era of the MDGs and the three years of SDGs. On the issue of economic growth Burkina Faso, Cape Verde, Liberia and Mali, were found to be the best performers, whiles Cote D'Ivoire, Guinea, Guinea-Bissau and Togo were found to be the worst performers. The report suggest that poverty is still high in West Africa. Unemployment was reported to be high in Benin, Burkina Faso and Niger.

Christopher, J.L.M. (2016) conducted a study focusing on the mapping of under 5 and neonatal mortality in Africa using data between 2000 and 2015. The study used Bayesian Geostatistical Analytical framework to analyse the data covering neonatal mortality. It found that though child survival rates are improving in Africa, there is heterogeneity in absolute levels of under 5 and neonatal mortality. It further observed that Botswana, Rwanda and Ethiopia recorded the largest reduction in child mortality rates since 2000 positioning them well to achieving the SDGs by 2030 or earlier. It concluded that for countries in Central and Western Africa to achieve child mortality targets by 2030, they should reduce mortality rate by 8.8%.

Bjegovic-Mikanovic, et al (2018) carried out a Gap Analysis of Mother, New-born, and Child Health in West Africa with Reference to the Sustainable Development Goals. They discovered that Carbo Verde was the only country in West Africa that had attained its target for maternal mortality,

whereas Ghana was identified to be among the countries making significant strides in attaining the neonatal mortality target. Benin was discovered not to be making enough progress. Guillaume, L. et al (2018), makes a case of the relevance of including thresholds in the measurement of SDGs. They observed that thresholds enabled the separation of performance of countries across groups and vividly shows whether a given country is meeting or not meeting the threshold. They also drew a link between the SDGs, for instance their findings revealed a strong correlation between SDG1 and SDG11. Additionally, SDG12 was found to have a strong correlation with SDG16 signifying that where there are strong institutions, inequalities and corruptions tend to be minimal. Christopher, J.L.M. (2018) did a comparative assessment of the status and drivers of maternal, newborn, child and adolescent health in the Islamic World using Standardised Method, Hierarchical Multivariable Analysis Technique. In the end the study found out that despite notable progress in reducing mortality rates in Muslim Majority Countries (MMCs) between 1990 and 2015 compared with global estimates of all countries, MMCs had higher mortality rates compared to non-MMCs. Secondly, they also discovered that coverage of essential interventions across continuum of care was on averaged lower among MMCs for the reproductive health, prenatal care, delivery, labour and childhood vaccines. Finally, they concluded that Muslim Majority Countries (MMC) are largely influenced structurally and contextually due to weak women empowerment policies and conflicts. These indicators were worst in MMC compared with non-MMCs within the high-burden countdown countries and shown to be strongly correlated with child and newborn, mortality within low income and middle income MMCs. Falebita and Koul (2018), did a comparative assessment of India and Nigeria focusing on the shift from development to sustainable economies. Ten SDG indicators were used as the basis of comparison between the two countries. They observed that for a country to move towards Sustainable Development, then its key focus

should be on planning. For instance, because India had a five-year development plan that is consistent and focused, it has progressively moved towards SD in the selected 10 indicators than Nigeria, which often varies its development plans. They further indicated that, the ability of a country to translate SDGs into simple and easy to understand forms makes implementation easier and effective for policy makers. The UN in 2018 published a report on Sustainable Development Goal. In the publication they indicated that maternal mortality ratios in sub Saharan African has reduced by 35%, similarly under-five mortality was found to have drastically reduced by 50%, while child marriage was found to have reduced by 40% and access to electricity doubling over the three-year period of the SDGs implementation. Chris (2016) in looking at a projection of national poverty (SDG1) by 2030 using trend analysis technique predicted that predicted that two thirds of developing countries will meet their national poverty targets and halve national poverty by 2030 if growth rates, distribution of growth rates and national poverty lines remain unchanged. He further observed that for poverty reduction targets to be achieved, programs need to be pro-poor in nature, this will enable many countries to attain their targets. Lastly, he indicated that if growth rate is increased to an average of 4% per year every developing country will be able to attain the SDG Targets by 2030. Kedir (2018) used time series approach to analyse data that spanned from 1991 to 2015, and the augmented Dickey-Fuller unit root test, Johansen cointegration test and linear regression to assess the prevalence of undernourishment in sub-Saharan Africa. He found that the trends confirmed that prevalence of undernourishment has fallen from 33.73% in 1991 to 20.15% in 2015 in sub Saharan Africa. The augmented Dickey-Fuller unit root test and Johansen cointegration test showed 14.55 and 12.15 which were less than the critical values of 15.41 and 14.07 respectively. The adjusted R^2 of the linear regression was 0.39, which was greater than the p-value of 0.05 this means the results obtained was statistically insignificant.

Similarly, Avorgbedor, et al. (2017) assessed the nutritional status of under-five in Lower Manya Krobo District in Ghana. They employed questionaires as the means of data collection instrument, to predict the outcome of variables using regression analysis technique. They found that 40%, 5% and 7% of sampled children were malnourished, stunted and underweight respectively. Secondly, they realised that mother's knowledge in nutrition was high, being driven by information from media. Biadgilign, Mgutshini, Haile, *et al*. (2017) also carried out a study on the Epidemiology of obesity and overweight in sub-Saharan Africa: a protocol for a systematic review and meta-analysis. They used a technique called the Der Simonian–Laird random effects meta-analysis (random effects model) and the obesity proportion (with 95% CI). The key finding obtained showed that there was a growing trend in obesity in the urban centres in Sub Saharan African countries due to nutrition alteration (fast food). Khama, Oucho, and Mwalali, (2003) in a study to assess disease and mortality in Sub Saharan Africa, revealed that SSA countries find it difficult to compare the study of trends and causes of maternal mortality due to coverage, reference dates and that because of lack of reliable data, SSA will continue to rely on estimate models which can be misleading. UNICEF (2006) using a trend analysis to predict data gathered between 1991 and 2015 discussed that on average 61% of SSA countries witnessed a growth in enrollment between 1991 and 2005 in pre-primary school, while Ghana was found to have moderate level of participation. It further found that children in rural communities have less access to primary education in SSA countries. One key technique that has not seen enough application in the reviewed literature is the TOPSIS technique. While the technique is applied in multicriteria decision making circumstances, little is seen in the case of the papers reviewed particularly regarding the ranking of SDGs and classifying them under three dimensions of sustainability. Though, TOPSIS has seen much application in supply chain, management information system, project management and logistics

(Tzeng, G. H. and Huang, J. J., 2011; Xu, J. and Tao, Z., 1987; Yoon, K.P. and Hwang, C., 1995), little application is seen in the area of SDGs.

According to Afful-Dadzie, et al (2016), the extended TOPSIS technique can be appropriate in comparing West African countries performance regarding SDGs achievement because it allows for incorporation of a threshold in the model and secondly to decompose the composite index into the three dimensions of sustainability - economic, environmental and social and subsequently shows which sustainability test a country is able to meet or fail to meet.

Furthermore, whereas many of the major indices fail to adhere to scientific rules of normalization, weighting, measurement units and aggregation of indicators toward a composite index, the TOPSIS model follows through these scientific rules (Singh, et al., 2009).

Besides, Singh and Benyoucef (2011) argued that TOPSIS is most appropriate in circumstances where alternatives have to be simultaneously evaluated on the basis of cost (or less is better) criteria and benefit (or more is better) criteria. The TOPSIS technique was initially propounded by Hwang and Yoon (1981) and is based on a distance to a frontier (ideal) point using two theoretically established ideal solutions called the positive ideal and the negative ideal solutions.

Triantaphyllou (2000) expressed that in evaluating an alternative using the TOPSIS model, the alternative under assessment must be first of all closer to the positive ideal solution and secondly farther away from the negative ideal solution in order to attain a higher rank. Afful-Dadzie, et al. (2016) also argued that TOPSIS is preferred over many Multi-Criteria Decision Making (MCDM) techniques because, apart from its several relevance it has fewer rank setbacks comparable to other MCDM approaches. Additionally, TOPSIS exhibits several desired features comparable to other MCDM approaches, thereby making it one of the widely accepted and applied MCDM methods in academia and industry (Shih et al., 2007). In terms of application, papers have adopted the

technique to measure sustainability concepts in various areas of industry, chief amongst them include; Kannan et al. (2014) Büyüközkan and Çifçi (2012) used Fuzzy TOPSIS to choose ecofriendly suppliers under commonly recognized green supply chain management practices. Awasthi et al. (2011) applied fuzzy TOPSIS method to appraise sustainable transport systems under uncertain information. Govindan et al. (2013) and Wittstruck and Teuteberg (2012) applied a fuzzy TOPSIS and fuzzy-AHP-TOPSIS approach, individually, in evaluating the choice of a supplier in supply chain management based on the three dimensions of sustainability- economic, social and environmental. Similarly, Wibowo and Deng (2013) evaluated the sustainability of semiconductor companies using inter-valued-based intuitionistic fuzzy TOPSIS on the basis of social, environmental and economic and product dimensions. Kucukvar et al. (2014) also applied TOPSIS to rank the life cycle sustainability performance of pavement types under social, economic and environmental dimensions of sustainability. Demirtas (2013), used a number of MCDM methods including Fuzzy TOPSIS to determine the best renewable energy technology that can be used to plan sustainable energy.

Afful-Dadzie, et al. (2016), Lancker and Nijkamp (2000) and Arrow et al. (2012) have all argued that the Extended TOPSIS approach enables the incorporation of thresholds which support in the determination and measurement of sustainability. They further opined that the Extended TOPSIS technique creates room for tracking of the overall contributions by each of the three dimensions of sustainability to the final composite index score for each country.

3.4. Literature Gaps Identified

The researcher identified the following gaps in the papers that were reviewed:

- ✓ A lot of the papers reviewed focused more on measurable indicators like poverty (SDG1), hunger (SDG2), health (SDG3) and education (SDG4) (Falebita, O. and Koul, S, 2018;

Bjegovic-Mikanovic, V. et al, 2018; ECA, AUC, AfDB, UNDESA, 2015). In West Africa, not much work has been done particularly regarding the assessment of countries on selected indicators using thresholds.

- ✓ While many of the researchers who used a mathematical method to review the performance of countries regarding SDGs attainment, many of them failed to incorporate thresholds in their models, even though threshold is critical to determine whether a given country is meeting the sustainability requirements or not.

CHAPTER FOUR

METHODOLOGY

4.0 Introduction

This chapter of the thesis focused on the analysis of secondary data gathered. A three-year panel data was obtained. This data covers 2016, 2017 and 2018. About 98.8% of the data was obtained mainly from the Global Sustainable Development Goal (SDG) Index and Dashboard 2016, 2017 and 2018; an annual report produced by the Bertelsmann Stiftung Institute and the Sustainable Development Solution Network (SDSN). The additional, 1.2% was imputed from other authentic sources. The TOPSIS method was then applied in performing the analysis.

4.1 Selection of West African Countries

The study focused on West Africa since the author hails from this part of the world, and familiar with the culture, economic and environmental conditions of this area. Further, few studies have been conducted on SDGs, particularly with regards to the three dimensions of sustainability among West African countries. However, while the study focuses on West Africa, the methods and analysis employed can be easily adopted by other regions in Africa. Per the United Nations description, there are currently 17 West African countries. These include; Benin, Burkina Faso, Cape Verde, Cote' d'Ivoire, Ghana, The Gambia, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo, and Sao Tome Principe. However, regarding this study 14 of the 17 West African countries were selected because of data unavailability for three of the countries namely; Cape Verde, Sao Tome and Principe and Guinea Bissau.

The reason been that in searching for the relevant data covering the period 2016, 2017 and 2018 under review for the 17 West African countries, it was revealed that, there was lack of data on Sao

Tome and Principe, Cape Verde and Guinea Bissau on the 37 selected SDG indicators (criteria), on this ground it became obvious the three countries be expunged from the list.

Similarly, in the researcher's quest to understand why there was no data on particularly Sao Tome and Principe and Cape Verde, it came to light that the Global SDG Index and Dashboard 2016 had a population threshold for countries in general, before they can capture data on them. Per their threshold any Island with population less than one million is excluded from the index (Global SDG Index, 2016). This was the reasoning behind the non-availability of data on the two countries; Sao Tome and Principe, and Cape Verde. Then again, Guinea Bissau the third country was not selected as a result of inconsistent data for some of the indicators (criteria) in the selected 37. Further, the 37 indicators were selected because first of all, there was available data on all 14 selected West African countries, secondly, the indicators chosen in the context of West Africa are very crucial to attaining sustainable development in the long run. For instance, poverty is still a big issue in West Africa, with majority of people in the continent being classified as poor based on the UN threshold of $1.90 per day. Again, there are also issues of high unemployment levels, comparably high levels of illiteracy rate, high levels of environmental degradation as majority depend on the physical environment for survival, weak institutions, low funding for tertiary institutions, etc. from the myriad of factors affecting Africa's development and most importantly the Western part of the continent, putting the spot light on the region is critical. This is why West Africa was selected for this particular study. Overall, the 14 selected West African countries represented 85.35%, while the percentage of non-selected countries was 17.65%.

4.2 Selection of Indicators (criteria)

The chosen model; thus Extended TOPSIS can only perform its function when all chosen indicators have values, however in the data that was gathered for the period 2016, 2017 and 2018

for all 14 countries, it was observed that not all 230 indicators had values and therefore the need to reduce it to final 37 indicators. The 230 indicators were classified under social, economic and environmental dimensions, however because of lack of data for all 14 countries for the period 2016, 2017 and 2018, 37 of the indicators was selected comprising the three dimensions. Narrowing it down further 20 of the indicators representing 54% were chosen from the social dimension of sustainability, while 9 and 8 indicators depicting 24% and 22% were chosen from the economic and environmental dimensions of Sustainability. The table 4.2.1 below shows the breakdown of indicators according to social, economic and environmental dimensions.

Table 4.2.1: Shows the Classification of Indicators and their Percentages

Dimension	Number of Indicators selected	Percentage
Social	20	54
Economic	9	24
Environmental	8	22
Total	37	100

Source: Reviewed Data, 2019

The Inter-Agency Expert Group on Sustainable Development Goal (IAEG-SDG) in 2015, provided the framework for data gathering on 230 indicators. Indeed, the Global SDG Index and Dashboard uses publicly verifiable data from the IAEG-SDG on annual basis (SDG Index and Dashboard, 2016, 2017 and 2018). The Cooperation of Development Assistance also tracks the progress made in some results-oriented indicators. In fact, overall, they indicate that the results-oriented indicators are 161. The Cooperation of Development Assistance usually anticipate to see their intervention bearing fruits within a 1 to 3-year period. All 37 selected indicators are result driven, and part of the 161 result-oriented indicators captured by the Cooperation of Development Assistance.

The data was structured into three time periods; thus 2016, 2017 and 2018 with each period having 37 criteria representing the 37 indicators selected from the 230 indicators under the SDGs. The 37 indicators are numbered from C1, C2, C3, ..., C37. For each of the dimensions; social, economic and environmental, the criteria were classified under positive and negative. A positive criterion represents a more is better situation, while a negative criterion represents a less is better situation. For instance, the 20 criteria selected grouped under the social dimension comprised of 8 positive criteria and 12 negative criteria. While that of the 9 economic criteria constituted 6 positive and 3 negative criteria. Additionally, the 8 criteria selected under the environmental dimension comprised of 3 positive and 5 negative criteria. So overall, 17 criteria representing 45.95% were positive criteria, while 20 criteria representing 54.05% were negative criteria.

4.3 The Extended TOPSIS Technique

The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is a widely applied or used technique in operations management. It has seen wide application in supply chain management (Jyoti, et al., 2012; Zaeri, et al. 2011; Elanchezian, 2010) and in selecting vendors for Enterprise Resource Planning Systems (Brzozowski and Birfer, 2017;). Though the technique can be useful in assessing the performance of UN member countries and by extension rank their performance based on the 2030 thresholds, only few papers seem to be keen on this. Example of such papers include (Piwowarski, et al. 2018; Shen, and Tzeng, 2018; Balcerzak, and Pietrzak, 2016; Opricovic, and Tzeng, 2004).

The researcher adopted the Extended Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) as the right mathematical tool that helped in achieving the study objective. According to Afful-Dadzie, et al (2016) the extended TOPSIS technique is appropriate for such a comparative study since it allows the researcher to first of all incorporate thresholds for the selected

criteria in the model and secondly to decompose the composite index into the three dimensions of sustainability; economic, environmental and social and subsequently shows which sustainability test a country has been able to meet or fail to meet.

Besides, Singh and Benyoucef (2011) argued that TOPSIS is most appropriate in circumstances where alternatives have to be simultaneously evaluated on the basis of cost (less is better) criteria and benefit (more is better) criteria. The TOPSIS technique was propounded by Hwang and Yoon (1981) and is based on a distance to a frontier (ideal) point using two theoretically established ideal solutions called the positive ideal and the negative ideal solutions.

Triantaphyllou (2000), expressed that in evaluating an alternative (countries) using the TOPSIS model, the alternative under assessment must first of all be closer to the positive ideal solution and secondly farther away from the negative ideal solution in order to attain a higher rank. Afful-Dadzie, et al. (2016) also argued that TOPSIS is preferred over many Multi-Criteria Decision Making (MCDM) techniques because, apart from its several relevance it has fewer ranking setbacks comparable to other MCDM approaches. Additionally, TOPSIS exhibits several desired features comparable to other MCDM approaches, thereby making it one of the widely accepted and applied MCDM methods in academia and industry (Shih et al., 2007).

To be able to measure the contributions of each dimension of sustainability as well as allow for interactions between criteria in the three dimensions, the TOPSIS technique is then extended. The extension part is a decomposition of the TOPSIS. Afful-Dadzie, et al. (2016), Lancker and Nijkamp (2000) and Arrow et al. (2012) have all argued that the Extended TOPSIS approach enables the incorporation of thresholds which support the determination and measurement of sustainability. They further opined that the Extended TOPSIS technique creates room for tracking

of the overall contributions by each of the three dimensions of sustainability to the final composite index score for each country.

4.3.1 Steps Involved in Using the Extended TOPSIS Technique

There are twelve (12) steps that one has to go through when using the Extended TOPSIS technique (Afful-Dadzie, et al. 2016). The first eight (8) steps comprised of steps that has to be followed in order to compute the values for the purpose of ranking the alternatives, while the last four steps focus on the decomposition of the composite score to actually determine the contributions of each dimensions.

Usually, for a set $A = \{A^k | k = 1,2, \dots, n\}$ of n alternatives evaluated under a set $C = \{C_j | j = 1,2, \dots, m\}$ m criteria with associated relative weights $W = \{W_j | j = 1,2, \dots, m, \sum_{j=1}^{m} W_j = 1\}$, a decision matrix with elements x_j^k for k=1, 2,…, n and j=1, 2,…, m in the form as displayed in Table I. An element x_j^k is the rating for alternative k under criterion j, and W_j is the importance weight assigned to criterion j, using information from the decision matrix, the ranking of the alternatives is generated through the following steps.

Table 4.3.1 Decision Matrix

	Criterion			
Alternative	c_1	c_2	…	c_m
A_1	x_1^1	x_2^1	…	x_m^1
A_2	x_1^2	x_2^2	…	x_m^2
⋮	⋮	⋮	⋮	⋮
A_n	x_1^n	x_2^n	…	x_m^n
Weight(W)	w_1	w_2	…	w_m

Step 1: Converting criteria dimensions into non-dimensional criteria.

The preliminary stages of the TOPSIS technique is the development of a normalized decision matrix called R of elements x_j^k which is a converted form of x_j^k using Equation (1).

$$r_J^K = \frac{x_J^K}{\sqrt{\sum_{k=1}^{n}(x_J^K)}}, for\ k = 1,2,\dots,n\ and\ j = 1,2,\dots,m \qquad (1)$$

This is done in order for the criteria dimensions to be transformed into a non-dimensional criterion as suggested by Afful-Dadzie, et al (2016). The formula for computing the x_j^k is shown below:

Step 2: Form Weighted Normalised Decision Matrix ($\boldsymbol{V_j^k}$)

In this second step, the normalized decision matrix is weighted to take into account the importance weights of each criterion. To attain the weighted normalised decision matrix, we multiply the weight w_j with the already normalised elements r_j^k in step 1 to get the weighted normalised matrix element v_j^k using Equation (2).

$$v_j^k = W_j r_j^k, \qquad for\ k = 1,2,\dots,n\ and\ j = 1,2,\dots,m \qquad (2)$$

Step 3: Determination of the Positive Ideal (A^+) and Negative Ideal (A^-) Solution

In this step the researcher generated an imaginary positive and negative ideal solutions which aimed to be a benchmark for assessment. In this manner any alternative that is closer to the positive ideal (A^+) solution is classified as a high ranked alternative, conversely, such alternative must be farther away from the negative ideal (A^-). So, J^+ and J^-, representing more is better for positive criteria and less is better for the negative criteria. The ideal solution is computed using information

from the weighted normalized decision matrix as shown in equation (2). The ideal solution formulae are shown below;

$$A^+ = \{v_1^+, \dots, v_m^+\}, \quad where\ v_j^+ = \{(maxk\ \ v_j^k | j \in J^+),\ \ (mink\ v_j^k | j \in J^-)\} \qquad (3)$$

$$A^- = \{v_1^-, \dots, v_m^+),\quad where\ v_j^- = \{(mink\ v_j^K | j\ \in J^+), (maxk\ v_j^k | j \in J^-)\} \qquad (4)$$

Step 4: Computation of Separation Measures using Euclidean Distance Formula.

In this step, the researcher computed the separation measures or distances from the positive ideal (A^+) solution, represented by S^{K^+} and from the negative ideal (A^-) solution, represented by S^{K^-} for each of the alternatives. These distance measures are computed using the m-dimensional Euclidean distance formula:

$$S^{K^+} = \sqrt{\sum_{j=1}^{m}(v_j^+ - v_j^k)^2}, \qquad \text{for } for\ k = 1,2,3, \dots, n \qquad (5)$$

$$S^{K^-} = \sqrt{\sum_{j=1}^{m}(v_j^- - v_j^k)^2} \qquad for\ k = 1,2,3, \dots, n \qquad (6)$$

Step 5: Calculation of the Closeness Coefficient (C^k) to the Ideal Solution

Whereas the S^{K^+} depicts the closeness of an alternative to the positive ideal solution, the S^{K^-} is the reverse which depicts how far away the same alternative is from the negative ideal (A^-) solution. Among the k alternatives, there is usually a contemplation as to which of the two separation distances to use. The closeness of coefficient is used as a mechanism to curb the dilemma. This is shown below:

$$C^k = \frac{S^K}{S^{k^+} + S^{k^-}} \qquad 0 \leq C^k \leq 1 \qquad (7a)$$

Afful-Dadzie, et al (2016) suggested that the relative closeness coefficient C^k permits the ranking of alternatives on the grounds of the S^{K^-} by taking into account the presence of S^{K^+}. Subsequently, the alternative with the highest C^k surfaces as the best. This means that alternatives can then be ranked in descending order of C^k from best to worst. On the other hand, when the S^{K^+} (i.e. the distance to the positive ideal solution) is the focus, the best alternative is attained by selecting the alternative with the smallest. The formula below aided the computation of the closeness of coefficient to ideal solution (C^k).

$$\frac{S^{k^+}}{S^{k^+} + S^{k^-}} = 1 - C^k \qquad (7b)$$

Similarly, alternatives can equally be ranked in an ascending order from best to worst using values from Equation (7b).

4.3.2 Decomposition of the TOPSIS Closeness Coefficient

This step of the technique actually represents the extension of the TOPSIS. Steps 1 to 7b all represent the series of steps that the researcher employed in determining the composite index. In trying to ascertain the contributions of each of the dimensions to a country's sustainability composite score, the composite score is decomposed. In the view of Pitelis (2013), sustainability is observed as the quest in attaining the "triple bottom line" – social, economic and environmental goals so that as present generation uses resources, it is done in such a way that future generations are not deprived of such benefits in later years. Similarly, Wittstruck and Teuteberg (2012) as well as Govindan et al. (2013) suggested approaches for choosing rival organizations under all three dimensions of sustainability. Since the final composite score cannot clearly show the contributions

made by each of the dimensions, it is proper to decompose the composite score which is possible using the Extended TOPSIS technique (Afful-Dadzie, et. Al, 2016). Decomposing the composite score is key, because it helps pinpoint which sustainability dimension a country is performing better or poorly so it can propose appropriate strategies to improve such dimension and consequently improve its sustainability score. The square of the closeness coefficient therefore helps in decomposing the final composite score into the three dimensions of sustainability.

Now, as observed in the initial normalization procedure above, the importance weight becomes W_{ij} for criterion j under factor i and r_{ij}^{k} becomes the normalized element in matrix K for criterion j under dimension i for alternative K. Then, Equation (2) becomes $v_{ij}^{k} = W_{ij} r_{ij}^{k}$ where $i = 1,2,3,\dots,m_i \; and \; k = 1,2,3,\dots,n$. The weighted normalised value is then computed using the formula v_{ij}^{k} to obtain the value of criterion j under factor i for alternative k. For any alternative k, the criteria could be decomposed into i dimensions by squaring Equation (5) which leads to the following equation:

$$(S^{k^-})^2 = \sum_{i=1}^{p} \sum_{i_j=1}^{m_i} \left(v_{i_j}^{-} - v_{i_j}^{k}\right)^2 \qquad (8)$$

$$v_{i_j}^{-} = \left\{\left\{mink\ v_{i_j}^{k} \middle| j \in J_i^{+}\right), \left(maxk\ v_{i_j}^{k} \middle| j \in J_i^{-}\right)\right\}$$

$$(S^{k^-})^2 = \sum_{1_j=1}^{m_i} \left(v_{1_j}^{-} - v_{1_j}^{k}\right)^2 + \sum_{2_j=1}^{m_2} \left(v_{2_j}^{-} - v_{2_j}^{k}\right)^2 + \cdots + \sum_{p_j=1}^{m_p} \left(v_{p_j}^{-} - v_{p_j}^{k}\right)^2, \quad k = 1,2,\dots,n \; and \; i = 1,2,\dots,p$$

The relative closeness coefficient can then be expressed as shown in the following equation:

$$(C^k) = \frac{\sum_{1_j=1}^{m_1} \left(v_{1_j}^{-} - v_{1_j}^{k}\right)^2 + \sum_{2_j}^{m_2} \left(v_{2_j}^{-} - v_{2_j}^{k}\right)^2 + \cdots + \sum_{p_j=1}^{m_p} \left(v_{p_j}^{-} - v_{p_j}^{k}\right)^2}{\left(S^{k^+} + S^{k^-}\right)^2} \qquad (9)$$

Now $S_i^{k^-}$ and $S_i^{k^+}$ represent the overall distance from the negative ideal alternative and the positive ideal alternative respectively for the set of criteria under factor *i* for alternative *k*. Then:

$$\left(S_i^{k^-}\right)^2 = \sum_{i_j=1}^{m_i} \left(v_{i_j}^- - v_{i_j}^k\right)^2$$

For $k = 1,2,3, \ldots, n$, Equation (9) can be expressed succinctly as:

$$C^k = \frac{\left(S_1^{k^-}\right)^2}{\left(S^{k^+} + S^{k^-}\right)^2} + \frac{\left(S_2^{k^-}\right)^2}{\left(S^{k^+} + S^{k^-}\right)^2} + \cdots + \frac{\left(S_p^{k^-}\right)^2}{\left(S^{k^+} + S^{k^-}\right)^2} \qquad (10)$$

Now $\left(C_i^k\right)^2$ becomes the contributions to the overall composite value $(C^k)^2$ by the sub-criteria under dimension *i*. following this process, the Equation (7a) and Equation (10) can then be expressed in the form below:

$$(C^k)^2 = \left(C_1^k\right)^2 + \left(C_2^k\right)^2 + \cdots + \left(C_p^k\right)^2 \quad k = 1,2, \ldots, n \qquad (11)$$

For $k = 1,2,3$, Equation (11) reduces to $(C^k)^2 = \left(C_1^k\right)^2 + \left(C_2^k\right)^2 + \left(C_3^k\right)^2$

Consequently, after obtaining the final composite value for an alternative k, this composite value can then be decomposed into *p* components, one for each dimension *i*. In equation (7a) which shows the formula used in computing the composite score C^k, 0 and 1 becomes the possible values between which the square of C^k lies. In the view of Afful-Dadzie et al (2016), applying the square of C^k aids in the measurement of sustainability, where the composite final value is decomposed into the three dimensions - social, economic and environmental and help in accentuating the specific contributions of each dimension. Similarly, Afful-Dadzie, et al (2016) further concludes that it serves as a blueprint for organizations or countries to ascertain which of the three dimensions to attract greater attention in the quest to adopting strategies to improve its total composite score.

4.3.3 Establishment of Threshold for Sustainability Measurement

In the view of Lancker and Nijkamp (2000) threshold is a key requirement in ascertaining the sustainability of a country and when a country fails to meet the threshold then that country is described as having failed the sustainability test. This is comparable to establishing a standard value for all criteria supposed to be attained by an alternative (Afful-Dadzie, et al., 2016). When sustainability thresholds are identified, progress of countries under assessment can be suitably supervised for the right policies to be affected. According to Afful-Dadzie, et al (2016) sustainability threshold are established by "setting minimum industry standard values for the list of criteria under study and assigning these values to a hypothetical alternative". In proceeding, "industry standard" are established as an alternative to the initial list of alternatives under assessment so that, there are now *k+1* alternative where the industry standard alternative is the $(k+1)^{th}$ alternative. With $(C^S)^2$ being the square of the closeness coefficient for the industry standard alternative, any alternative *k* meeting equation (12) can be described as passing the sustainability test:

$$(C^k)^2 \geq (C^s)^2 \qquad (12)$$

The $(C^s)^2$is therefore viewed as a focal reference point (or a threshold) under which an alternative (country) is classified as having failed a sustainability test. Afful-Dadzie, et al. (2016) emphasised that by allocating the standard values to a new alternative, all aspects of the TOPSIS method are maintained. Particularly, it is possible to determine the positive and negative ideal alternatives. This implies that equation (12) can further be expressed as in the formula below;

$$\left(C_1^k\right)^2 + \left(C_2^k\right)^2 + \cdots + \left(C_p^k\right)^2 \geq (C_1^s)^2 + (C_2^s)^2 + \cdots + \left(C_p^s\right)^2$$

For a specific dimension *i*, $\left(C_i^k\right)^2$is comparable to $(C_i^s)^2$observe the performance of alternative *k* under dimension *i* with regards to the industry standard (in relation to all *i* dimensions).

4.3.4 Tracking the Progress of Alternatives (Countries) Over a Period Using the Relative Composite Score (R_t^k)

In the view of Arrow, et al (2012) true sustainability can be established when a measured performance is maintained over time. Therefore, for a country to be described as sustainable, its performance over the period ought to be improving or maintained in the sustainability ranking. A time series plot is then generated for easy visualization of the sustainability performance over time. For this to be achieved, a constant threshold is established.

To determine the Relative Composite Score (R_t^k) the square of the relative closeness coefficient for alternative *k* and the industry standard alternative in time *t* are used in calculating the (R_t^k) using the formula;

$$R_t^k = \frac{\left(C_t^k\right)^2}{(C_t^s)^2}$$

4.5. Approach used in Deriving Thresholds

The UN thresholds for the 15-year period for the 17 SDGs (2015-2030) are unrealistic for many developing economies including West African (Marseille, et al. 2015). Especially where a blanket threshold is set to be achieved by 2030 by all UN member countries. Development varies significantly between the developed and developing economies, therefore as a matter of need, the UN ought to categorise the thresholds by regions. Realistically, how would Ghana for instance with all of its development challenges perform on the global ranking index if compared with Sweden, Norway, or Denmark. It is obvious that it will perform poorly. However, if Ghana is compared with Nigeria, Niger or any other West African country, in the same region, some progress can be established.

Therefore, the researcher these views are taken into account in SDG comparisons. In view of this, the researcher proposes a new and innovative way to derive realistic thresholds for SDG comparisons. The new proposed thresholds are derived using averages as explained in the steps that follow.

Step 1: Computation of the mean values for Criterion

Here the researcher summed up all the individual scores of the 14 countries under each criterion. The sum value is divided by the number of countries; which is 14. The mean value becomes the newly proposed realistic threshold for 2016. The mean formula is shown below;

$$\bar{X} = \frac{\sum_{i=1}^{n} x_i}{n}$$

Step 2: Find the Difference between the Threshold Used by the UN under Each Criterion and the Mean Value

After obtaining the mean values for all the 37 criteria, the difference between the thresholds proposed by the UN for the 37 selected criteria and the mean values for all 37 criteria is determined. The formula is given as; Difference = (UN proposed Threshold for each criterion) - (mean value for each criterion). The researcher represented the UN proposed threshold for each criterion by X, while that of the mean value for each criterion by $\bar{X}$. So, the difference becomes; $D = X - \bar{X}$ for each criterion.

Step 3: Divide the Difference (D) by the Remaining Number of Years till 2030

In this step the researcher divided the value obtained from subtracting the mean value of criterion from the UN proposed threshold by the remaining number of years till 2030. In this case, for 2017 the difference (D) is divided by 14 years, while 2018 is divided by 13 years. In the long run the value obtained becomes the annual expected growth rate of each country under each criterion.

Step 4: Add Back the Average Expected Annual Growth Rate obtained in Step 3 to the Mean Value Obtained in Step 1 for 2016

In order to get the newly proposed threshold for each criterion in 2017 and 2018 respectively, the researcher added back the average of the difference obtained by dividing *D* by the remaining number of years to the 2016 and 2017 mean values to obtain the realistic thresholds for 2017 and 2018 respectively. In the end, the researcher had derived newly realistic thresholds for each of the criterion selected for each of the period under assessment or evaluation; thus 2016, 2017 and 2018 respectively.

4.6 Determination of Weights

The weights assigned to a particular criterion indicates the importance attached to that criterion. The Extended TOPSIS technique is able to accommodate weights. In the application of different Multicriteria Decision Making models weights have always been a critical component of such models. In studies by Payne, Bettman, and Johnson (1993), Saaty (1980), Vaidya and Kummar (2006), Al-Subhi Al-Harbi (2001), Zhang and Yang (2001), Mikhailov (2003) and Afful-Dadzie, et al. (2016) they all espoused the importance of assigning weights in a MCDM situation.

In this study, the researcher assumed equal weights for the 37 selected criteria (indicators) since all the 230 SDG indicators are equally important.

CHAPTER FIVE

ANALYSIS AND DISCUSSION

5.0 Introduction

Data gathered on the 37 selected indicators (criteria) and the derived thresholds were put into the Extended TOPSIS model. The criteria were assigned numbers (C1… C37). For each dimension of sustainability, the criteria were grouped or arranged into more is better (benefits) and less is better (cost). Because all the 17 SDGs are assumed to be equally important, a weight of 0.02703 was assigned to each of the 37 criteria in the model. The analysis is shown in the tables below;

5.1 Results Obtained from Analysis

First of all, a table showing the weights assigned to the 37 criteria is presented in table 5.1.1. Of the 37 criteria, 20 were selected and grouped under the social dimension of sustainability, while 9 and 8 were selected and grouped under the economic and environmental dimensions respectively. Each criterion was assigned a weight 0.027027027, as shown in Table 5.1.1 column 3. The weights show the importance attached to the said criterion.

Table 5.1.1A: Criteria and Criteria Weights under the Three Dimensions of Sustainability

Criteria	Criteria Symbol	Criteria Weight	Dimension
Cereal yield (t/ha)	C1	0.027027027	
Healthy life expectancy at birth (years)	C2	0.027027027	
Literacy rate of 15-24-year-old (%)	C3	0.027027027	
Expected years of schooling (years)	C4	0.027027027	
Women in national parliaments (%)	C5	0.027027027	
Access to improved water (%)	C6	0.027027027	
Corruption Perception Index (0-100)	C7	0.027027027	
Feel safe walking at night (%)	C8	0.027027027	
Poverty headcount ratio at $1.90/day (%)	C9	0.027027027	
Prevalence of adult obesity (%)	C10	0.027027027	
Prevalence of stunting, under-5s (%)	C11	0.027027027	
Prevalence of undernourishment (%)	C12	0.027027027	
Prevalence of wasting, under-5s (%)	C13	0.027027027	
Maternal mortality (per 100,000 live births)	C14	0.027027027	
Neonatal mortality (per 1000 live births)	C15	0.027027027	
Incidence of tuberculosis (per 100,000)	C16	0.027027027	
Traffic deaths (per 100,000)	C17	0.027027027	
Under 5 mortality (per 1000 live births)	C18	0.027027027	
Unmet demand for contraceptives (%)	C19	0.027027027	
Homicides (per 100,000)	C20	0.027027027	`Social

Source: Global SDG Index and Dashboard, 2016, 2017 and 2018, IAEG-SDG, 2015

Table 5.1.1B: Criteria and Criteria Weights under the Three Dimensions of Sustainability

Criteria	Criteria Symbol	Criteria Weight	Dimension
Access to electricity (%)	C21	0.027027027	Economic
Adjusted growth rate (%)	C22	0.027027027	
Quality of overall infrastructure (1-7)	C23	0.027027027	
Internet use (%)	C24	0.027027027	
Government efficiency (1-7)	C25	0.027027027	
Health & Education spending (% GDP)	C26	0.027027027	
Child labor (%)	C27	0.027027027	
Unemployment rate (%)	C28	0.027027027	
Gini index (0-100)	C29	0.027027027	
Improved water source, piped (%)	C30	0.027027027	Environmental
Access to improved sanitation (%)	C31	0.027027027	
PM2.5 in urban areas (µg/m3)	C32	0.027027027	
Municipal solid waste (kg/person/year)	C33	0.027027027	
Wastewater treated (%)	C34	0.027027027	
Climate change vulnerability (0-1)	C35	0.027027027	
CO2 emissions from energy (tCO2/capita)	C36	0.027027027	
Freshwater withdrawal (%)	C37	0.027027027	

Source: Global SDG Index and Dashboard, 2016, 2017 and 2018, IAEG-SDG, 2015

5.1.2 Imputation of Missing Data

Imputation means the process of assigning a value to something by inference from the value of the products or processes to which it contributes. Because some data was missing for some of the indicators for some of the 14 selected West African countries, data was imputed. Imputation was done based on the following assumptions:

National Population: For instance, the municipal waste generated kilogram per person per year was assumed to be the same for countries with similar national population size.

Past Data: For countries which had values for a particular indicator in a particular year, such indicator values were imputed into the previous or current year which had no indicator value.

The tables 5.1.2, 5.1.3 and 5.1.4 depict detail information of imputed data.

Table 5.1.2 Imputed Data for 2016

Country	Indicator	Value	Imputation	Year
Burkina Faso	GCI: Quality of overall infrastructure (1-7)	2.5	imputed using the 2017 figure	2016
	GCI: Government efficiency (1-7)	3.2	imputed using the 2017 figure	2016
Guinea	[Global-only] Municipal solid waste (kg/person/year)	0.54	Imputed using the figure of Benin due to similarity of size	2016
Liberia	[Global-only] Municipal solid waste (kg/person/year)	0.5	Imputed using Mauritania due to similar size	2016
Mauritania	Health & Education spending (% GDP)	7.0	Imputed using the 2017 figure	2016
Nigeria	Health & Education spending (% GDP)	12.35	Imputed from the 2016 budget for education and health	2016
Niger	GCI: Government efficiency (1-7)	2.2	Imputed using the 2017 figure	2016
Togo	GCI: Government efficiency (1-7)	3.562	Imputed using that of Mali due similarity of size	2016

Source: Global SDG Index and Dashboard, 2016, 2017 and 2018, IAEG-SDG, 2015

Table 5.1.3 Imputed Data for 2017

Country	Indicator	Value	Reference/imputation	Year
Gambia, The	Feel safe walking at night (%)	46	Imputed data from Senegal since they share border	2017
Guinea	Municipal solid waste (kg/person/year)	0.5	Imputed using the figure of Benin because of similar size	2017
Liberia	Municipal solid waste (kg/person/year)	0.5	Imputed using the figure of Mauritania because of similar size	2017
Nigeria	Health & Education spending (% GDP)	12.35	Imputed from the 2016 budget for education and health	2017
Niger	Government efficiency (1-7)	3.5	Imputed using figure of Mali	2017
Togo	Government efficiency (1-7)	3.4	Imputed using Benin	2017
Sierra Leone	Adjusted GDP Growth rate	-4.712	imputed from 2016 figure	2017

Source: Global SDG Index and Dashboard, 2016, 2017 and 2018, IAEG-SDG, 2015

Table 5.1.4 Imputed Data for 2018

Country	Indicator	Value	Reference/imputation	Year
Gambia, The	Feel safe walking at night (%)	46	Imputed data from Senegal since they share border	2018
Gambia, The	Wastewater treated (%)	0.4	Imputed from 2017 figure	2018
Nigeria	Health & Education spending (% GDP)	12.35	Imputed from the 2016 budget for education and health	2018
Guinea	Municipal solid waste (kg/person/year)	0.5	Imputed using the figure of Benin because of similar size	2018
Liberia	Municipal solid waste (kg/person/year)	0.5	Imputed using the figure of Mauritania because of similar size	2018
Niger	Government efficiency (1-7)	3.4	Imputed using figure of Mali	2018
Togo	Government efficiency (1-7)	3.3	Imputed using Benin	2018
Niger	Quality of overall infrastructure (1-7)	2.2	Imputed using 2017 figure	2018
Togo	Quality of overall infrastructure (1-7)	2.2	Imputed using 2017 figure	2018

Source: Global SDG Index and Dashboard, 2016, 2017 and 2018, IAEG-SDG, 2015

5.2 Results Showing the Dimensional Score, Composite Score, Composite Ranking, Dimensional Ranking and Percentage Contribution for 2016

According to Arrow et al (2012), true sustainability can be attained when a country is able to maintain or improve its performance over time. It can be deduced from this assumption that true sustainability of a country ought to show an improving trend of performance in all its three dimensions over time. The composite score alone does not show the contributions of each of the dimension. According to Afful-Dadzie et al. (2016), the extended TOPSIS technique is able to decompose the composite score, so that the specific contributions of each dimension is determined. The composite score is the total value of all the values of the three dimensions put together.

As is seen in table 5.2.1, the composite score is found in column 5 with label "Total". It can be observed that the composite score for Ghana in 2016 was 0.4389 indicating the highest score among the 14 selected countries, in the same manner, its dimensional contributions was 0.1403, 0.0867 and 0.2119 for social, economic and environmental dimensions respectively. It can also be seen that Senegal had a composite score of 0.3166, with dimensional contributions of 0.1676, 0.0642 and 0.0849 for social, economic and environmental dimensions respectively. While Ghana is the 1st ranked country on the list of the 14 selected countries, Senegal is ranked 2nd on the composite score. Cote d'Ivoire had a composite score of 0.2656 and ranked 3rd among the 14 selected West African countries. Meanwhile, its dimensional scores for social, economic and environmental was 0.0893, 0.0627 and 0.1136 respectively. Benin had a composite score of 0.2287 with dimensional scores of 0.0935, 0.0592 and 0.0759 respectively for 2016.

Table 5.2.1 Shows the Composite Score and Ranking, the Contributions of Each Dimension and Their Rankings and Percentage For 2016

	$(C^k_i)^2$			$(C^k)^2$			Dimensional Ranking			Percentage Dimensional Contribution		
Country	Soc.	Econ	Envt	Total	Ranking	R_t 2016	Soc.	Econ	Envt	%	%	%
Benin	0.0935	0.0592	0.0759	0.2287	4	1.0416	5	6	9	40.90	25.90	33.20
Burkina Faso	0.0771	0.0489	0.0618	0.1877	11	0.8551	9	7	12	41.05	26.04	32.91
Cote d'Ivoire	0.0893	0.0627	0.1136	0.2656	3	1.2097	7	4	2	33.61	23.62	42.76
Gambia, The	0.0734	0.0198	0.1086	0.2018	9	0.9191	11	14	3	36.37	9.81	53.82
Ghana	0.1403	0.0867	0.2119	0.4389	1	1.9992	2	2	1	31.97	19.75	48.28
Guinea	0.0651	0.0470	0.1077	0.2198	6	1.0014	12	8	4	29.62	21.36	49.01
Liberia	0.0607	0.0430	0.0793	0.1829	13	0.8333	13	10	8	33.16	23.50	43.34
Mali	0.0909	0.0391	0.0707	0.2008	10	0.9145	6	12	11	45.30	19.46	35.24
Mauritania	0.1108	0.0190	0.0204	0.1503	15	0.6844	3	15	15	73.77	12.64	13.59
Niger	0.0763	0.0436	0.0599	0.1798	14	0.8190	10	9	13	42.42	24.25	33.34
Nigeria	0.0532	0.1086	0.0584	0.2202	5	1.0030	15	1	14	24.15	49.34	26.51
Senegal	0.1676	0.0642	0.0849	0.3166	2	1.4423	1	3	6	52.93	20.26	26.81
Sierra Leone	0.0548	0.0423	0.0877	0.1847	12	0.8415	14	11	5	29.64	22.88	47.48
Togo	0.0999	0.0382	0.0799	0.2180	8	0.9929	4	13	7	45.81	17.51	36.68
Industry Standard	0.0856	0.0605	0.0735	0.2195	7	1	8	5	10	38.99	27.54	33.47

Source: Analysed Data, 2019

According to table 5.2.1 as shown above, Sierra Leone, Liberia, Niger and Mauritania had composite scores of 0.1847, 0.1829, 0.1798, and 0.1503 respectively. They ranked 12th, 13th, 14th and 15th respectively on the composite ranking.

This means, these four countries were the worst four performers on the composite ranking in 2016, whereas Ghana, Senegal, Cote d'Ivoire and Benin were the top four best performers on the composite ranking in 2016. Overall, six countries passed the sustainability test for 2016, whereas eight countries failed the sustainability test as evident by score of 7 by the 'Industry Standard'.

The same table 5.2.1 shows some interesting revelations regarding the dimensional scores and ranking of the 14 West African countries. First of all, on the social sustainability dimension, Senegal was ranked 1st on the list, followed by Ghana ranking 2nd and Mauritania placing 3rd.with dimensional scores of 0.1676, 0.1403 and 0.1108 respectively. Indeed, these three countries were the best performers on the social dimension of sustainability. On the other hand, Nigeria, Sierra Leone and Liberia had ranked 15th, 14th and 13th respectively on the list with dimensional scores of 0.0532, 0.0548 and 0.0607. These three countries were classified as the worst performers on the social dimension of sustainability in 2016.

Surprisingly, Nigeria which ranked 15th on the social dimension, ranked 1st on the economic dimension with dimensional score of 0.1086. However, Ghana maintained it position at the 2nd place on the economic dimension as well. This shows consistency in Ghana's performance in the social and economic dimensions in the 2016 year of assessment. It suggest then that based on the nine criteria selected under the economic dimension, which are adjusted growth rate (%), quality of overall infrastructure (1-7), internet use (%), government efficiency (1-7), health and education spending (% GDP), child labour (%), unemployment rate (%) and Gini index (0-100) Nigeria and Ghana seems to be doing something right. For instance, Nigeria education and health spending as

a percentage of Gross Domestic Product (GDP) of 12.35% is considered one of the highest in the sub region as at 2016. Senegal was placed ranked 3rd with dimensional score of 0.0642. Meanwhile, Togo, the Gambia and Mauritania occupied the bottom part of the list with dimensional scores of 0.0382, 0.0198 and 0.0190 placing 13th, 14th and 15th respectively. These three were concluded as the worst performing countries amongst the 14 selected West African countries in the 2016 year of assessment.

On the environmental dimension of sustainability, the results showed that Ghana came 1st, followed by Cote d'Ivoire (2nd) and the Gambia (3rd) in that order with dimensional scores of 0.2119, 0.1136 and 0.1086. The results further depict that based on the eight (8) selected environmental indicators including improved water source, piped (%), access to improved sanitation (%), wastewater treated (%), Particulate Matter (PM) 2.5 in urban areas (µg/m3), municipal solid (kg/person/year), climate change vulnerability (0-100), CO_2 emissions from energy (tCO_2/capita) and freshwater withdrawal (%) the three countries performed extremely well. Comparatively, Ghana performed extremely well on the environmental dimension of sustainability being ranked as 1st on the list. Ghana's performance in all three dimensions can be concluded to be consistent as it is part of the top two in the list.

On the other hand, Niger, Nigeria and Mauritania were ranked 13th, 14th and 15th respectively with dimensional scores of 0.0599, 0.0584 and 0.0204. This can be inferred that the performance of the three countries regarding the chosen 8 environmental indicators was abysmal, perhaps due to lack of effective strategies instituted over the years to improve the sector. The results showed that Mauritania performed abysmally in two of the dimensions (economics and environmental) placing 15th in both dimensions. However, it ranked well under the social dimension placing 3rd. It can be

inferred that, probably regarding social interventions, Mauritania is getting the right strategies instituted, which is influencing its tremendous performance.

In terms of percentage dimensional contribution to the composite score, it can be observed from table 5.2.1 that under the social dimension, Mauritania contributed the highest with 73.77% to its composite score in 2016, followed by Senegal with 52.93%, Togo with 45.81%, and Mali with 45.30%. The worst contributors were Nigeria with 24.15%, Guinea with 29.62%, Sierra Leone with 29.64%. Surprisingly, Ghana which ranked 2nd regarding the dimensional scores and ranking, in terms of its percentage social contribution had 31.97% as its contributions to composite score in 2016.

Meanwhile, regarding the contributions of countries economic dimension to the composite score, the table 5.2.1 again shows that Nigeria had contributed 49.34% to its composite score via its economic dimension. All the other 13 countries fell below the industry standard which is the hypothetical country. This implies that in terms of percentage economic contributions to the composite score, the industry standard outperformed all the 13 West African countries apart from Nigeria. Burkina Faso's (26.04%) contribution was a little below the industry standard percentage of 27.54%. Benin also came close to Burkina Faso with 25.90%, followed by Niger with 24.25%. The worst contributors however were the Gambia with 9.81%, Mauritania with 12.64%, Togo with 17.51% and Ghana with 19.75%.

Environmentally, Gambia made the highest percentage contributions to its composite score with 53.82% followed by Guinea with 49.01% to its composite score, Ghana with 48.28%, Sierra Leone with 47.48% and Liberia with 43.34% to their respective composite scores. On the contrary, Mauritania, Nigeria, Senegal and Burkina Faso contributed 13.59%, 26.51%, 26.81% and 32.91% to their respective composite scores in the 2016 year of assessment.

It can be concluded, that apart from the industry standard (hypothetical country), none of the country had its contributions across the three dimensions to be fairly distributed.

Table 5.2.2 Shows the Composite Score and Ranking, the Contributions of Each Dimension and Their Rankings and Percentage For 2017

	$(C^k_i)^2$			$(C^k)^2$			Dimensional Ranking			Percentage Dimensional Contribution		
Country	**Soc**	**Econ**	**Envt**	**Total**	**Ranking**	**R_t 2017**	**Soc.**	**Econ**	**Envt**	**%**	**%**	**%**
Benin	0.0847	0.1198	0.0720	0.2765	6	0.9551	8	3	10	30.62	43.33	26.04
Burkina Faso	0.0821	0.0762	0.0554	0.2136	10	0.7379	9	8	13	38.42	35.67	25.91
Cote d'Ivoire	0.1037	0.0634	0.1288	0.2959	3	1.0222	4	13	3	35.05	21.42	43.53
Gambia, The	0.0682	0.0190	0.1137	0.2008	14	0.6937	12	15	4	33.95	9.45	56.60
Ghana	0.1491	0.1179	0.1630	0.4299	1	1.4851	2	4	1	34.67	27.42	37.91
Guinea	0.0698	0.0698	0.1458	0.2853	5	0.9856	11	11	2	24.46	24.45	51.09
Liberia	0.0452	0.0690	0.0880	0.2022	13	0.6984	14	12	7	22.36	34.10	43.53
Mali	0.0853	0.0750	0.0711	0.2315	9	0.7997	7	9	11	36.86	32.42	30.72
Mauritania	0.1057	0.0483	0.0213	0.1753	15	0.6057	3	14	15	60.29	27.54	12.17
Niger	0.0648	0.0872	0.0533	0.2052	11	0.7089	13	6	14	31.56	42.47	25.97
Nigeria	0.0709	0.1243	0.0568	0.2520	8	0.8704	10	2	12	28.16	49.31	22.53
Senegal	0.1494	0.1262	0.0986	0.3742	2	1.2925	1	1	5	39.92	33.73	26.35
Sierra Leone	0.0372	0.0744	0.0920	0.2036	12	0.7032	15	10	6	18.25	36.54	45.21
Togo	0.1008	0.0771	0.0819	0.2598	7	0.8974	5	7	8	38.81	29.68	31.51
Industry Standard	0.0970	0.1110	0.0815	0.2895	4	1	6	5	9	33.52	38.35	28.14

Source: Analysed Data, 2019

Table 5.2.2 shows the results obtained from the analysis of the 2017 SDG data on the 37 selected indicators. In accomplishing the study objective, once again the analysis focused on the determination of the composite scores, the composite ranking, the dimensional scores and rankings as well as the percentage contributions of each of the dimensions to the composite score in 2017.

Overall, the table 5.2.2 shows that regarding the composite scores and ranking, Ghana once again topped the league in 2017 in the overall or composite score with 0.4299. It was followed by Senegal with 0.3742 placing 2nd on the composite score. Meanwhile, Cote d'Ivoire and the industry standard (hypothetical country) ranked 3rd and 4th with composite scores of 0.2959 and 0.2895 respectively. This implies that apart from Ghana, Senegal and Cote d'Ivoire, the industry standard composite score was higher than the 11 other countries, clearly showing they failed to meet the sustainability test requirement in 2017. Sierra Leone, Liberia, The Gambia, and Mauritania occupied the bottom 4 positions with composite scores of 0.2036, 0.2022, 0.2008 and 0.1758 respectively therefore making them to rank 12th, 13th, 14th and 15th respectively in the league.

As postulated by Arrow et al (2012) and corroborated by Afful-Dadzie, et al (2016), true sustainability can only be attained when a given alternative; in this case a country is able to maintain or improve its performance over time. Similarly, one cannot say a country is attaining its sustainability test requirement by simply using its composite score to make that argument. At least, it is fair to establish the contributions of each of the dimensions to the composite score so that appropriate strategies can be implemented to improve performance of such a dimension in the long run. On this ground, with the help of the Extended TOPSIS model, the composite scores for each of the 14 countries were decomposed into the three dimensions of social, economic and environmental. This helped to determine the specific contributions of each dimension to composite the score.

So, from the table 5.2.2, it can be observed that Senegal ranked highest on the social dimension with a score of 0.1494. It was followed by Ghana and Mauritania occupying the 2nd and 3rd positions with dimensional scores of 0.1491 and 0.1057 respectively. On the flip side, Niger, Liberia and Sierra Leone occupied the bottom of the league at 13th, 14th and 15th positions with dimensional scores of 0.0648, 0.0452 and 0.1008 respectively. This means that whereas, Senegal, Ghana and Mauritania were the top three best performing countries in the attainment of the 20 social indicators, Niger, Liberia and Sierra Leone were identified as the bottom three worst performing countries among the 14 selected West African countries.

Economically, the countries that performed best pertaining to the 9 economic indicators were Senegal at 1st position, followed by Nigeria at 2nd and Benin and Ghana occupying 3rd and 4th positions. The dimensional scores were 0.1262, 0.1243, 0.1198 and 0.1179 for Senegal, Nigeria, Benin and Ghana respectively. This means that these four countries performed well in ensuring efficient management of their governments, increasing the percentage of GDP allocated for health and education, increasing the number of people using internet services, improvement in quality of infrastructure, reducing child labour and decreasing unemployment rates below the UN threshold of 5% per population. The countries that trailed at the bottom economically were Cote d'Ivoire with a score of 0.0634, Mauritania with score of 0.0483 and the Gambia with a score of 0.1137 and occupying the 13th, 14th and 15th positions respectively. The inference that can be made is that Cote d'Ivoire, Mauritania and the Gambia performed poorly on the grounds of the 9 economic indicators selected. Ghana, Guinea, Cote d'Ivoire and Gambia topped the league regarding the environmental dimension of sustainability. In fact, Ghana scored 0.1630 placing 1st position, followed by Guinea with a score of 0.1458 occupying the 2nd, then by Cote d'Ivoire with a score of 0.1288 occupying the 3rd and finally, Gambia with a score of 0.1137 placing 4th. This is inferred

that regarding the 8 selected environmental indicators including; improved water source, piped (%), access to improved sanitation (%), wastewater treated (%), Particulate Matter (PM) 2.5 in urban areas (µg/m3), municipal solid (kg/person/year), climate change vulnerability (0-100), CO_2 emissions from energy (tCO_2/capita) and freshwater withdrawal (%), these four countries performed well in achieving the set targets.

Nigeria, Burkina Faso, Niger and Mauritania were found to have performed poorly under the environmental dimension of sustainability. Their specific contributions to the composite score were 0.0554, 0.0533, 0.0213 and 0.0568 thereby influencing them to occupy the 12th, 13th, 14th and 15th positions in the league. Clearly, the logical conclusions that can be drawn from their poor ranking status is that perhaps they have not been able to develop the right state policies, and strategies to manage their environmental issues well hence influencing their poor ranking status.

In terms of percentage contributions, it can be observed that Mauritania had a 60.29% contribution to its overall composite score of 0.1753. Again, Senegal had the 2nd highest contributions under the social dimensions to its overall composite score, followed by Togo with 38.8%, Burkina Faso with 38.42% and Mali with 36.86% to composite score. Sierra Leone had the worst social contributions in terms of percentage to its composite score of 18.25%, followed by Liberia, Guinea and Nigeria with 22.36%, 24.46% and 28.15% respectively. On the economic side, the highest contributor to the composite scores according to the table 5.2.2 is Nigeria with 49.31%, Benin with 43.33% and Niger 42.47%. Meanwhile, the worst contributors were Gambia with 9.45%, Guinea with 24.45% and Cote d'Ivoire with 21.42%.

Gambia contributed the highest in terms of environmental dimension to its composite score. It was followed by Guinea with 51.09% and Sierra Leone with 45.21%. On the other hand, Mauritania,

Nigeria and Burkina Faso were the worst contributors in the environmental dimension or category to composite scores.

Clearly, it can be seen however that Ghana's performance in terms of percentage contributions by each dimension to the composite score is fairly distributed, unlike others. In fact, across board, the percentage contributions from all three dimensions; social, economic and environmental was 34.67%, 27.42% and 37.91%, unlike others who could contribute as much as 60.29% from social dimension to the composite score.

It can be concluded that, in the 2017 year of assessment regarding the realistic threshold that was derived using the averages method and incorporated into the TOPSIS model, in the end only three countries attained the sustainability test requirements; that is if $(C^k)^2$ is greater or equal to $(C^s)^2$. These countries are Ghana with 0.4299, Senegal with composite score of 0.3742 and finally Cote d'Ivoire with composite score of 0.2959. These composite scores exceeded the industry standard composite score of 0.2895, hence their attainment of the sustainability test requirement. These three are therefore classified as outperforming countries based on the incorporated thresholds.

The rest of the 11 countries in the league, however had composite scores less that the industry standard, therefore violating the rule that says if $(C^k)^2 \geq (C^s)^2$ and therefore classified as not being able to attain their sustainability test and can be consequently termed as underperforming countries. Table 5.2.3 depicts the results obtained from the analysis of data for 2018. It can be seen that using the composite scores for the period, Ghana topped the league once again with a composite score of 0.5041.

Table 5.2.3 Shows the Composite Score and Ranking, the Contributions of Each Dimension and Their Rankings and Percentage For 2018

	$(C^k_i)^2$			$(C^k)^2$			Dimensional Ranking			Percentage Dimensional Contribution		
Country	**Soc.**	**Econ**	**Envt**	**Total**	**Ranking**	**Rt 2018**	**Soc.**	**Econ**	**Envt**	**%**	**%**	**%**
Benin	0.1185	0.0305	0.0950	0.2440	8	0.7934	6	11	10	48.57	12.48	38.95
Burkina Faso	0.1152	0.0209	0.0751	0.2112	10	0.6866	7	13	13	54.55	9.89	35.56
Cote d'Ivoire	0.1077	0.1094	0.1493	0.3664	2	1.1913	8	2	3	29.40	29.86	40.74
Gambia, The	0.0825	0.0419	0.1246	0.2489	7	0.8094	13	8	4	33.14	16.82	50.04
Ghana	0.1982	0.1103	0.1956	0.5041	1	1.6390	1	1	2	39.32	21.88	38.81
Guinea	0.0911	0.0345	0.2108	0.3363	4	1.0935	11	10	1	27.08	10.26	62.66
Liberia	0.0562	0.0369	0.1085	0.2015	13	0.6551	14	9	6	27.87	18.30	53.83
Mali	0.1060	0.0134	0.0908	0.2102	11	0.6834	9	15	11	50.43	6.37	43.20
Mauritania	0.1237	0.0206	0.0283	0.1727	15	0.5615	5	14	15	71.65	11.95	16.40
Niger	0.0848	0.0449	0.0725	0.2022	12	0.6574	12	7	14	41.96	22.19	35.85
Nigeria	0.0997	0.0486	0.0819	0.2301	9	0.7482	10	5	12	43.30	21.12	35.58
Senegal	0.1896	0.0682	0.1044	0.3622	3	1.1775	2	3	7	52.35	18.83	28.82
Sierra Leone	0.0505	0.0264	0.1221	0.1990	14	0.6471	15	12	5	25.37	13.26	61.37
Togo	0.1336	0.0458	0.1015	0.2809	6	0.9133	4	6	8	47.57	16.29	36.14
Industry Standard	0.1429	0.0649	0.0997	0.3076	5	1	3	4	9	46.46	21.11	32.43

Source: Analysed Data, 2019

Cote d'Ivoire also came 2nd with a composite score of 0.3664 while, Senegal occupied the 3rd position with composite scores of 0.3622. These three countries were the top ranked countries among the 14 countries and are said to be the top three best performing countries in West Africa in 2018.

On the contrary, Niger, Liberia, Sierra Leone and Mauritania occupied the bottom four spots as usual on the list with composite scores of 0.2022, 0.2015, 0.1990 and 0.1727. They ranked 12th, 13th, 14th and 15th respectively. It can be inferred from the results obtained that apart from Ghana, Cote d'Ivoire, Senegal and Guinea that can be described as passing the sustainability test requirements because their composite scores greater than the industry standard score of 0.3076, the remaining 10 countries had composite scores below the industry standard. This means that these 10 were unable to meet the sustainability test, which says that for sustainability to be achieve, the $\left(C_i^k\right)^2 \geq (C_i^s)^2$. Therefore, with the proposed realistic thresholds, only Ghana, Cote d'Ivoire, Senegal and Guinea outperformed the industry standard, while the 10 countries fell below the industry standard in the 2018 year of assessment.

Mauritania's performance over the three-year period has been consistently poor, because, in all the three-year period, it has been found among the worst performing countries using both the composite scores and dimensional scores as yardsticks. Again, comparing the 2016 and 2018 composite scores, Mauritania decreased its performance on the composite by -1.50% in 2018 against a 14.94% increase in its composite score in 2017. Liberia also performed poorly in 2016, 2017 and 2018 ranking 13th throughout. This could be as a result of Liberia being described as a fragile state. Even though, 19 years is considered a long period, in its practice of democracy, Liberia is still battling with a lot of social, economic and environmental issues. This could have influenced the abysmal performance it recorded regarding the 37 selected SDGs indicators. Since,

sustainable development is underpinned by good governance, and strong institutions, any country that lacks these fundamental principles will certainly not perform well regarding the SDGs attainment. The Gambia has also shown an improvement in its performance particularly in 2018 over the 2017 performance. Whereas in 2016 and 2017 it ranked 7th and 14th respectively, in 2018 it ranked 9th with composite scores of 0.2018, 0.2008 and 0.2489. Examining critically, it can be observed that, in 2017 rather Gambia's composite score dropped by --0.5%, but increased in 2018 by about 15%. This reflect an improvement in 2018 over the 2017 performance.

Reiterating the point that Arrow et al (2012) and Afful-Dadzie, et al (2016) espoused, one cannot based on the composite score alone to conclude that a country is meeting its sustainability test, decomposition of the composite score becomes imperative as the contributions of each dimension to the composite score will become clear. Therefore, in tracking the progress of the three dimensions in 2018, is made manifest by the TOPSIS model.

On the social dimension aspect, it can be seen that in 2018, Ghana ranked 1st with a dimensional score of 0.1982, this was followed by Senegal (2nd), while the industry standard occupying the (3rd) position with dimensional scores of 0.1896 and 0.1429. Therefore, in 2018 apart from Ghana and Senegal whose dimensional scores were above the industry standard of 0.1429, the remaining 12 countries had scores below the industry standard. Conclusively, Ghana and Senegal were the only two best performing countries in 2018, while the remaining 12 were classified as underperforming countries. The worst performers found at the bottom of the league were Liberia and Sierra Leone with dimensional scores of 0.0562 and 0.0505 placing 14th and 15th respectively.

On the economic dimension, Ghana once again topped the list with a score of 0.1103, followed by Cote d'Ivoire (0.1094) on the 2nd spot, whereas Senegal occupied 3rd the position with 0.0682. The

industry standard came 4th with a score of 0.0649. This means that the remaining 11 countries had scores below the industry standard and can conclusively be referred to as underperforming countries. However, among the underperforming countries, Sierra Leone, Burkina Faso and Mauritania with dimensional scores of 0.0264, 0.0209 and 0.0206 were classified as the bottom three worst performing countries among the 14 selected West African countries in 2018.

Regarding the environmental dimension sustainability, Guinea topped category placing 1st with a dimensional score of 0.2108, followed by Ghana with 0.1956, Cote d'Ivoire with a score of 0.1493 placing 3rd. On the other hand, Burkina Faso, Niger and Mauritania occupied the 13th, 14th and 15th position on rank. Conclusively, it can be said that, of the 14 selected West African countries, the Guinea, Ghana and Cote d'Ivoire were categorised as the top three best performing countries under the environmental dimension of sustainability, while Burkina Faso, Niger and Mauritania were categorised as the bottom three worst performing countries under the environmental dimension of sustainability.

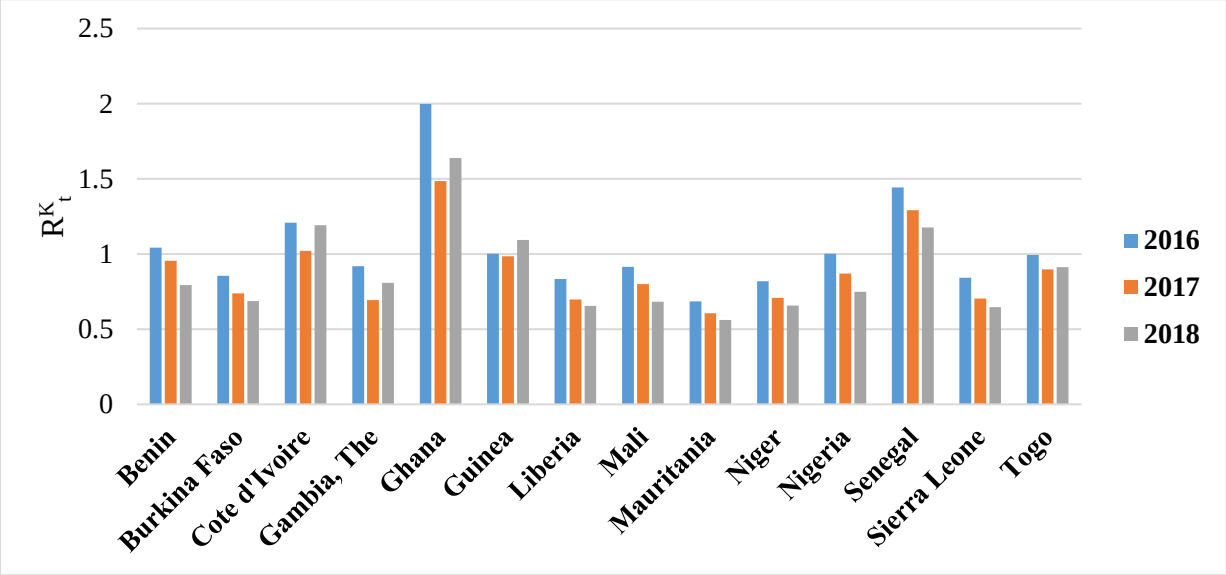
In summary, except Ghana, Cote d'Ivoire, Senegal and Guinea which had composite scores greater than the industry standard, the remaining 10 countries had comparatively lower composite scores relative to the industry standard. Therefore, Ghana, Cote d'Ivoire, Senegal and Guinea passed the sustainability test requirement in 2018, while the remaining 10 countries failed the test.

5.3 Trend Analysis of Performance of West African Countries over the Three-Year Period (2016, 2017 and 2018)

Arrow, et al. (2012) and Afful-Dadzie, et al. (2016) argued that to determined true sustainability, performance of an organisation ought to be maintained or consistently improve over a long period. Therefore, in assessing that, the only measure in this case is to use the Relative Composite Score

R_t for each period to plot the trend analysis. Figure 5.3.1 shows the relative composite scores for 2016, 2017 and 2018 for all 14 selected West African countries.

Figure 5.3.1: Sustainability Test from 2016 to 2018



Source: Analysed Data, 2019

Consistently over the three-year period Benin, Ghana, Senegal, Cote d'Ivoire, Guinea, Nigeria and Senegal outperformed the thresholds.

Arrow, et al (2012) emphasised the fact that true sustainability is determined when a firm is able to maintain or improve its performance over a long period. The Figure 5.3.5 shows the true sustainability test of the 14 countries over the three-year period. The table explains the progress of performance of the 14 countries and indicates whether a given country outperformed or underperformed in a particular year. As observed earlier in Figure 5.3.1; which illustrates the relative composite scores for the 14 countries, it was concluded that 6 of the countries outperformed the realistic incorporated thresholds in 2016, whereas only three outperformed the industry standard in 2017 and while 4 outperformed the industry standard in 2018. Figure 5.3.5 shows the pattern of performance between 2016 and 2018.

Table 5.3.1 shows the relative composite score for the 14 countries in 2016, 2017 and 2018. It is interpreted as the size of the square of closeness coefficient $(C^k_t)^2$ relative to the thresholds values $(C^s_t)^2$ in time t. For instance, the R^k_t =1.999203 for Ghana in 2016 means Ghana's $(C^k_t)^2$ value is 1.999203 times than the industry standard alternative. Additionally, $R^k_t - 1$, measures how much alternative k outperforms or underperforms the industry alternative. In the case of Ghana, it means that Ghana outperforms the industry standard by 0.999203 times representing 99.99%.

From the table 5.3.1, it can be observed that because of the incorporated realistic thresholds, six of the 14 selected West African countries including Benin, Cote d'Ivoire, Ghana, Guinea, Nigeria and Senegal had relative composite scores greater than the industry standard score of 1. Benin had a score of 1.041636, Cote d'Ivoire had a score of 1.209693, while Ghana, Guinea, Nigeria and Senegal had relative composite scores of 1.9999203, 1.001378, 1.003039 and 1.442277 respectively.

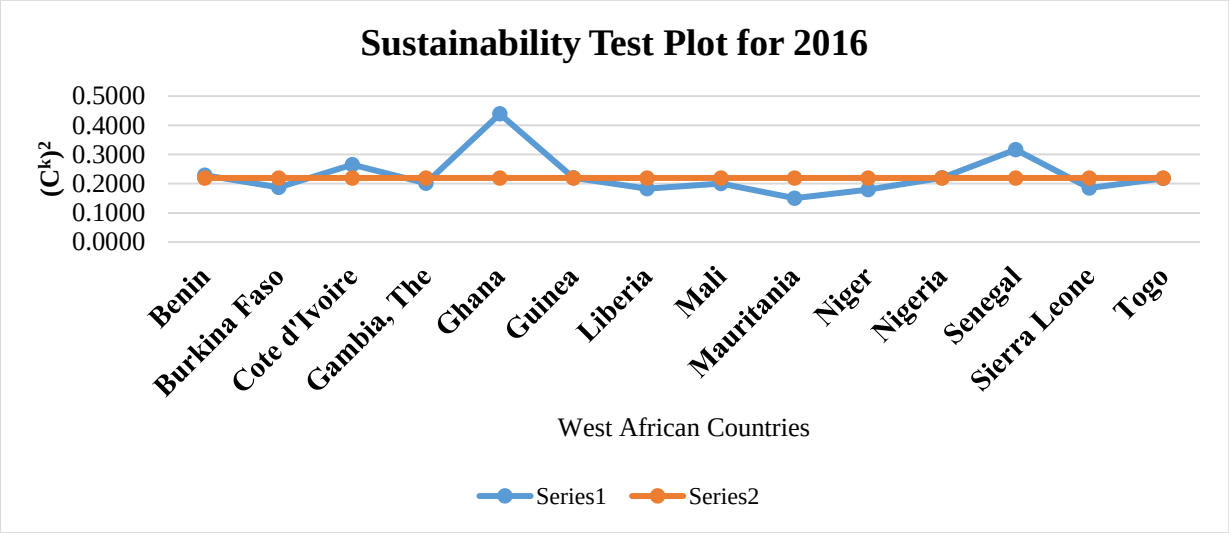
In similar fashion, Cote d'Ivoire, Ghana and Senegal were the only three West African countries among the selected 14, who had relative composite scores greater than 1. In fact, Cote d'Ivoire's score was 1.022234 in 2017, whiles Ghana relative composite score was 1.455073 and 1.292503 for that of Senegal. Therefore in 2017, only three countries passed the sustainability test. In 2018, four countries including Cote d'Ivoire, Ghana, Guinea, Nigeria and Senegal with relative composite scores of 1.19131, 1.63898, 1.093542 and 1.177495 respectively passed the sustainability test, while the rest of the 10 failed. Consistently, Ghana's performance regarding the 37 selected indicators exceeded the industry standard by 99.99%, 45.51% and 63.90% in 2016, 2017 and 2018 respectively. Cote d'Ivoire's performance also exceeded the industry standard by 20.96%, 2.22% and 19.13% in 2016, 2017 and 2018 respectively. Meanwhile, Guinea's performance exceeded the industry standard by 0.13% and 9.4% in the 2016 and 2018 industry

standard. Nigeria only managed to exceed the industry standard by 0.3% in 2016, but could not match up with it in the 2017 and 2018-year period. Senegal, also showed tremendous improvement over the three-year period, because its relative composite scores exceeded the industry standard all three-year period by 44.23%, 29.25% and 17.75% respectively.

Therefore, strictly speaking Ghana, Cote d'Ivoire and Senegal can be said to have been consistent over the three-year period and therefore stand out as the most sustainable countries among the 14 selected countries.

Figure 5.3.6, 5.3.7 and 5.3.8 show the sustainability test plots for the 14 countries over the three-year period.

Figure 5.3.6: Sustainability Test for 14 West African Countries

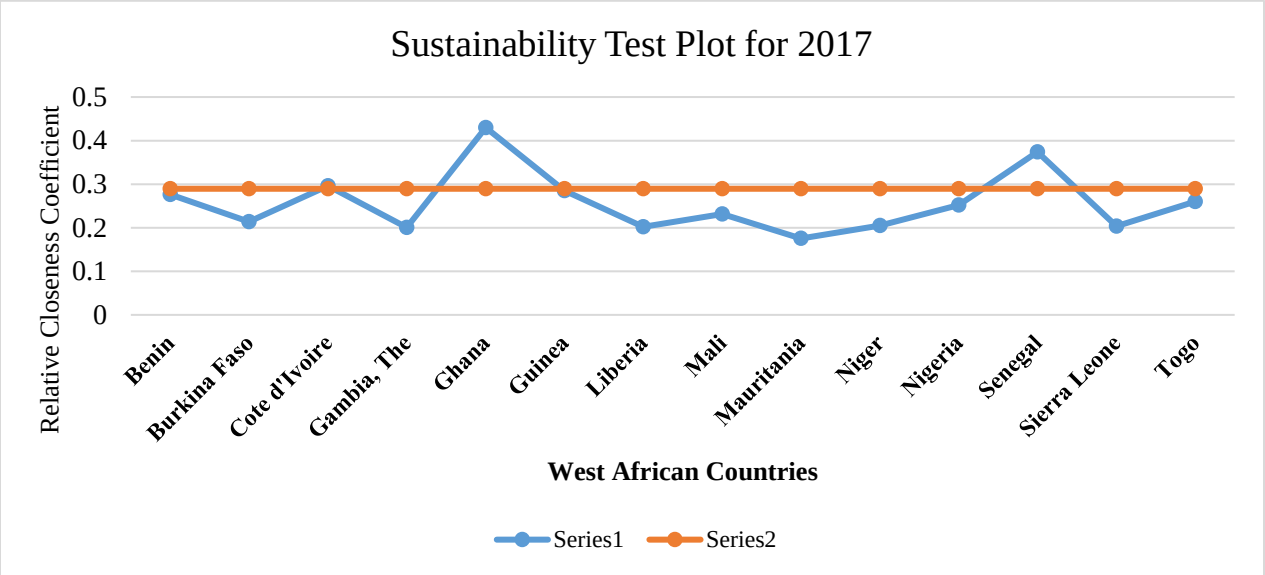


Source: Analysed Data, 2019

The blue line depicts the square of the relative closeness coefficient of TOPSIS and is shown on the vertical axis, whereas the orange line depicts the industry standard. The industry standard line is the threshold below which a country is said to have failed its sustainability test.

It can be realised in table 5.3.6 that 6 of the countries including Benin, Cote d'Ivoire, Ghana, Guinea, Nigeria and Senegal were above the industry standard. Ghana was way above the orange line depicting the industry standard, Benin is exactly on the orange line, with Cote d'Ivoire slightly above the orange line. Guinea is found to be lying exactly on the orange line, as well as Nigeria. Senegal is also quite above the orange line. This implies that these six countries have met the sustainability test as shown in the sustainability plot test. Burkina Faso, Mauritania, Liberia, Mali, Togo, the Gambia, Sierra Leone and Niger all fell below the orange line showing their non-attainment of the sustainability test.

Figure 5.3.7 Sustainability Test for 14 West African Countries



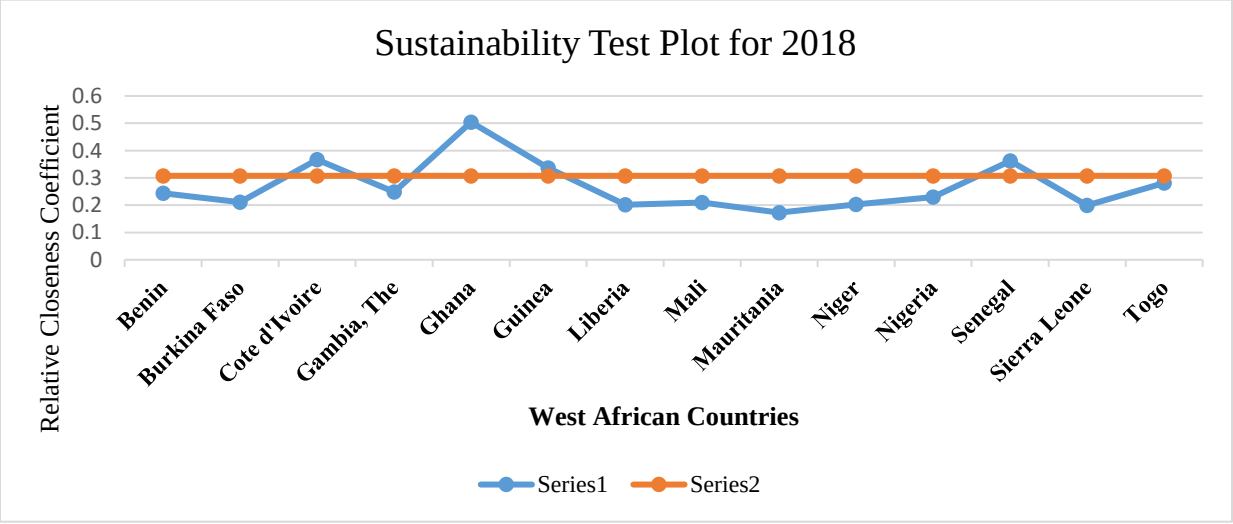
Source: Analysed Data, 2019

Observing Figure 5.3.7, it can be seen that only three countries including Cote d'Ivoire, Ghana and Senegal had their square of the relative closeness coefficient being higher that of the industry standard. Whereas Ghana was way above the threshold, meaning it has exceeded the threshold with a wide margin, Senegal is also quite above the threshold. Meanwhile, Cote d'Ivoire was exactly on the threshold line. Apart from these three, the remaining 11 countries fell below the industry standard. While some were quite farther away from the threshold, others were quite close

to the threshold. Mauritania for instance, was far below the threshold line comparable to other underperforming countries. This is quite understandable because, Mauritania's square of the relative closeness coefficient, was relatively lower compared to others, hence influencing its overall composite ranking, dimensional ranking and its attainment of sustainability test. Benin was relatively closer to the industry standard compared to other underperforming countries. Togo was also close distance away from the industry standard. In conclusion, only three West African countries including Ghana, Cote d'Ivoire and Senegal had their square of the relative closeness coefficient above the industry standard, thereby enabling them to meet the sustainability test requirement. However, the remaining 11 countries were unable to meet the sustainability test requirement, therefore indicating their underperforming status.

Similarly, in 2018, 4 of the 14 West African countries were able to meet the sustainability test requirement. These countries included; Cote d'Ivoire, Ghana, Guinea and Senegal. Their square of relative closeness coefficients was above or greater than the industry standard. On the contrary, the remaining 10 countries failed to meet the sustainability test.

Figure 5.3.8: Sustainability Test for 14 West African Countries



Source: Analysed Data, 2019

It can be observed in Figure 5.3.8 that Ghana is way above the industry standard line, implying its performance exceeded the industry standard. Cote d'Ivoire, Guinea and Senegal are slightly above the industry standard line.

CHAPTER SIX

KEY FINDINGS, CONCLUSION AND RECOMMENDATIONS

6.0 Introduction

This segment of the study focused on the summary of key findings obtained from the analysis of data. It also looked at the conclusions that are drawn from the findings as well as the key recommendations made for consideration by policymakers, civil society organisations, the UN and governments of West African countries.

6.1 Key Findings

The study was underpinned by three main objectives. The first objective was to identify the West African country that ranks highest based on the composite scores over the three-year period. Secondly, the study sought to identify the best and worst performing West African countries under the social, economic and environmental dimensions of sustainability. Lastly, it sought to track the progress made by West African countries in the attainment of the 37 selected SDG indicators using an incorporated threshold.

Regarding research objective one, the results obtained showed that in 2016 Ghana was ranked highest with a composite score of 0.4389, followed by Senegal and Cote d'Ivoire with composites scores of 0.3166 and 0.2656 respectively. On the other hand, the worst performers were Liberia, Niger and Mauritania with composite scores of 0.1829, 0.1798 and 0.1503 placing 13th, 14th and 15th respectively considering the inclusion of the industry standard. Excluding the industry standard, they could have ranked 12th, 13th and 14th. Likewise, in 2017, Ghana once again topped the rank with the highest composite score of 0.4299, followed by Senegal and Cote d'Ivoire with composite scores of 0.3742 (2nd) and 0.2959 (3rd) respectively. The worst performers in 2017 were

the Mauritania, the Gambia and Liberia with composite scores of 0.1753, 0.2008 and 0.2022 occupying the 14th, 13th and 12th respectively excluding the industry standard. Again, in 2018 the results showed that Ghana was once again the highest ranked country in the league with composite score of 0.5041 (1st), whereas Cote d'Ivoire placed 2nd on the league with a score of 0.3664, while Senegal occupied the 3rd position with composite score of 0.3622. The worst performers however were once again Mauritania with a composite of 0.1727 placing 14th, Sierra Leone with 0.1990 composite score and 0.2015 composite score for that of Liberia. The results confirmed the findings of the Global SDG Index and Dashboard (2016, 2017and 2018).

In relation to research objective two, the results revealed that in 2016, under the social dimension of sustainability Senegal ranked highest with dimensional score of 0.1676, followed by Ghana and Mauritania placing 2nd and 3rd with dimensional scores of 0.1403 and 0.1108. In contrast, Liberia, Sierra Leone and Nigeria were the worst performers placing 12th, 13th and 14th excluding the industry standard under the social dimension of sustainability with dimensional scores of 0.0607, 0.0548 and 0.0532 respectively. Similarly, under the economic dimension Nigeria ranked highest with a score of 0.1086, followed by Ghana and Senegal with dimensional scores of 0.0867 and 0.0642. The worst performers under the economic dimension were Togo, Gambia and Mauritania with scores of 0.0382, 0.0198 and 0.0190 placing 12th, 13th and 14th excluding the industry standard. Finally, regarding the environmental dimension in 2016, the best performers were Ghana with a score of 0.2119 placing 1st, followed by Cote d'Ivoire with a score of 0.1136, whereas the Gambia occupied the 3rd place with dimensional score of 0.1086. The worst performing however were Niger, Nigeria and Mauritania with dimensional scores of 0.0599, 0.0584 and 0.0204 occupying the 12th, 13th and 14th positions respectively excluding the industry standard.

Similarly, in 2017 Ghana was the highest ranked country in West African regarding the attainment of the 37 selected SDG indicators. In fact, it had a composite score of 0.4299. Senegal and Cote d'Ivoire occupied the 2nd and 2rd places with composite scores of 0.3742 and 0.2959 respectively. On the flip side, Liberia, The Gambia and Mauritania performed poorly in the league in 2017.

In looking at the contributions made by each dimension to the composite score, it can be observed that under the social dimension of sustainability, Senegal was the best performing country in 2017 with a score of 0.1494. It was followed by Ghana and Mauritania occupying the 2nd and 3rd positions with dimensional scores of 0.1491 and 0.1057 respectively. On the flip side, Niger, Liberia and Sierra Leone performed poorly on the social dimension. They scored 0.0648, 0.0452 and 0.1008 respectively being the worst dimensional scores in that category.

Economically, the countries that performed best pertaining to the 9 economic indicators were Senegal at 1st, followed by Nigeria at 2nd and Benin and Ghana occupying 3rd and 4th positions. The dimensional scores were 0.1262, 0.1243, 0.1198 and 0.1179 for Senegal, Nigeria, Benin and Ghana respectively. However, Cote d'Ivoire, Mauritania and Gambia with dimensional scores of 0.0634, 0.0483 and 0.1137 trailed at the bottom of the league.

Again, Ghana, Guinea and Cote d'Ivoire were the top three best performing countries in 2017 with 0.1630, 0.1458 and 0.1288 scores. Whereas Burkina Faso, Niger and Mauritania were found to have performed poorly under the environmental dimension of sustainability.

In terms of percentage contributions, Mauritania had contributed 60.29% to its overall composite through the social dimension. Senegal also contributed 39.92% to its overall composite score, with the worst contributor being Sierra Leone with a contribution of 18.25% to its overall composite score.

Nigeria made the highest percentage contribution of 49.31% to its composite score through the economic dimension, followed by Benin with 43.33% to its overall composite score. Meanwhile, Gambia had the least contributions of 9.45% from the economic dimension to its overall composite score. The Gambia contributed 56.6% from its environmental dimension to its overall composite score in 2017.

In 2018, Ghana ranked 1st with a composite score of 0.5041, followed by Cote d'Ivoire with a score of 0.3664 and lastly by Senegal with score of 0.3662. These three countries were classified as the best performing countries using the composite scores in 2018. On the contrary, Liberia, Sierra Leone, Mauritania found themselves at the bottom of the league placing 12th, 13th and 14th respectively.

On the social dimension aspect, Ghana had the highest score of 0.1982 placing 1st, followed by Senegal and the industry standard with 0.1896 and 0.1429 placing 2nd and 3rd. So, strictly speaking, only Ghana and Senegal met the sustainability test requirement in the social category. Meanwhile, the bottom three worst performing countries were the Gambia, Burkina Faso ad Sierra Leone with dimensional scores of 0.0825, 0.0562 and 0.0505 respectively.

On the economic dimension, Ghana once again was found among the best performing in that particular category with dimensional score of 0.1103, followed by Cote d'Ivoire and Senegal with 0.1094 and 0.06682. Burkina Faso, Mauritania and Mali were found to have performed poorly in the economic aspect. Interestingly, on the environmental aspect, Guinea topped the category with 0.2108 score, whereas Ghana and Cote d'Ivoire came 2nd and 3rd with scores of 0.1956 and 0.1493. The bottom three worst performing countries regarding the environmental dimension were Burkina Faso, Niger and Mauritania with 0.0751, 0.0725 and 0.0283 respectively.

Regarding percentage contributions by dimensions to the composite score, it was revealed that in 2018 Mauritania had the highest percentage of 71.65% contributions in the social dimension to its composite score. Meanwhile, Burkina Faso came 2nd with 54.55% contribution of the social dimension to its composite score. The least percentage contribution in the social dimension was Sierra Leone with 25.37% to its composite score. Under the economic dimension, Cote d'Ivoire was found to have contributed the highest percentage of 29.86% to its composite score by the economic dimension, followed by Niger with 22.19% and Mali with 6.37% being the least contributions in the category.

Environmentally, Guinea had the highest percentage of 62.66% contribution to its composite score. Similarly, Sierra Leone via its environmental dimension contributed 61.37% to its composite score. The least contributor was Mauritania with 16.40% of environmental dimension contributing to its composite score.

Pertaining to research objective three, the results revealed that, overall, the performance of 6 countries in 2016, 2 in 2017 and 4 in 2018 of the 14 selected West African countries was impressive over the three-year period using the incorporated thresholds as yardsticks of sustainability test. In all three consecutive periods, the 6, 2 and 4 outstanding countries outperformed the industry standard.

Therefore, the realistic thresholds derived, using the averages method were able to determine the annual progress that West African countries should be making to be able to reach the UN targets or thresholds by 2030.

5.2 Conclusions

In order to determine sustainability measurement among countries, measuring techniques that are able to establish minimum thresholds and be able to rank countries based on their present SDGs results will be key in identifying the best performing and worst performing countries for recognition purposes will be most appropriate. The TOPSIS technique was used in this study, because it is able to establish minimum thresholds, which become the basis on which comparison is made among the 14 selected West African countries. The TOPSIS method helped to establish industry standard which became a hypothetical alternative, whose relative closeness coefficient became the threshold for comparison. Therefore alternatives (countries) with relative closeness coefficient below the industry standard are classified as underperforming countries and concluded to be failing their sustainability test, whereas those with relative closeness coefficient above the industry standard are said to be meeting their sustainability test.

Additionally, by using the square of relative closeness coefficient, the researcher was able to decompose the composite scores into dimensional scores, so as to be able to establish the contributions made by each dimension to the composite score in totality. Decomposing the composite scores enabled the researcher to track the trend of progress among countries using the composite scores, as well as the dimensional scores. Once countries know which aspects they are not doing well, the right strategies and policies can be applied to see improvement in the long run. Time series plots was plotted for the purposes of easy visualization using the performance of countries over the period against the industry standard to establish whether the sustainability test definition by Arrow, et al (2012) was met.

5.3 Recommendations

First of all, based on the findings it is imperative individual countries within the West African sub-region develop short- and medium-term targets that feed into the long-term UN targets expected to be achieved by 2030. Progress should be monitored regularly, say annually or every 5 years so as to ensure individual countries are on track in attaining the 37 indicators chosen for the study and by extension the 197 indicators. Generally, Ghana, Senegal and Cote D'Ivoire performances have been good comparatively in all the three-year panel data across the three dimensions compared to the rest of the countries in the sub-region. However, a lot more efforts is required from them to improve their rankings.

On the basis of composite scores Ghana was ranked highest in the list, followed by Senegal and Cote d'Ivoire, however these countries should not be complacent with this current development because there are other global benchmarks that rank these countries lowest using a global index. It is important they adopt robust strategies that can aid development across all levels of society, so they can improve their global ranking as well.

Again, West African countries should consider strategies that can help improve their performance across dimensions especially the environmental bit as many of the 14 selected performed far below the industry threshold. Though majority of the citizens tend to depend on the physical environment for their survival, alternative livelihood programs should be adopted by governments in these countries. Adopting such pro-poor programs will go a long way to reduce the impact on the physical environment and for that matter result in overall improvement in their performance above the industry threshold.

Since poverty is still considered highest in the sub-region, much more efforts of West African countries should focus on eliminating poverty, therefore pro-poor programs will be critical to achieving such goal in the long run.

Many countries in West African can still not boast of an accessible, reliable and verifiable data systems or sources, as a result there is limited available data for planning and policy making. Therefore, the UN should prioritise supporting state agencies in capacity build and acquisition of the needed infrastructure for effective data gathering on all measurable indicators.

REFERENCES AND APPENDIX

7.0 References

U. N. (2016). *A Snapshot of the world's water quality: Towards a Global Assessment*. Retrieved from https://uneplive.unep.org/media/docs/assessments/unep_wwqa_report_web.pdf.

Afful-Dadzie, A, Afful-Dadzie, E. and Turkson, C. (2016). "A TOPSIS extension framework for re-conceptualising sustainability measurement". *Kybernetes, Vol. 45*(Iss. 1), Pp. 70-86. Retrieved June 28, 2019, from http://dx.doi.org/10.1108/K-04-2015-0106

Allen, C. and Clouth, S. (2012). *Green Economy, Green Growth, and Low-Carbon Development-history, definitions and a guide to recent publication.* USA: UNDESA: A guidebook to the Green Economy.

Anthony Afful-Dadzie Eric Afful-Dadzie Charles Turkson. (2016). "A TOPSIS Extension Framework for Re-Conceptualizing Sustainability Measurement". *ResearcgGate, Vol. 45*(Iss 1), pp. 1-23.

Antoine, B. (2015). The integration of the Sustainable Development Goals in private sector activities. *The International Institute for Industrial Environmental Economics*, Pp. 1-87.

Arrow, K.J., Dasgupta, P., Goulder, L.H., Mumford, K.J. and Oleson, K. (2012). "Sustainability and the measurement of wealth". *Environment and Development Economics, Vol. 17*, Pp. 317-353. Retrieved June 28, 2019

Awasthi, A., Chauhan, S.S. and Omrani, H. (2011). "Application of fuzzy TOPSIS in evaluating sustainable transportation systems". *Expert Systems with Application, Vol. 38*, Pp. 12270-12280. Retrieved June 28, 2019

Bank, W. (2010). *Global Monitoring Report 2010. The MDGs after the Crisis.* Washington DC: World Bank. Retrieved from https://www.imf.org/external/pubs/ft/gmr/2010/eng/gmr.pdf

Bank, W. (2015). *Global Monitoring Report 2014/2015. Ending Poverty and Sharing Prosperity.* Washington D.C.: World Bank. Retrieved from http://www.worldbank.org/content/dam/Worldbank/gmr/gmr2014/GMR_2014_Full_Report.pdf

Belinda R., Stafford-Smith, M., and Karl-Heinz E.,. (2017). Essential Variables help to focus Sustainable. *ScienceDirect*, Pp. 1-9.

Bohringer, C. and Jochem, P.E. (2007). "Measuring the immeasurable-a survey of sustainability indices. *Ecological Economics, Vol. 63*(No.1), Pp. 1-8. Retrieved June 28, 2019

Brundtland, G. (1987). *Report of the World Commission on Environment and Development: Our Common Future.* Washington DC: United Nations General Assembly document A/42/427.

Buyukozkan, G. and Cifci, G. (2012). "A novel hybrid MCDM approach based on fuzzy DEMATEL, fuzzy ANP and Fuzzy TOPSIS to evaluate green suppliers". *Expert Systems with Applications, Vol. 39*(No.3), Pp. 3000-3011. Retrieved June 28, 2019

Cerin, P. and Dobers, P. (2001). "What does the performance of the Dow Jones sustainability group index tells us?". *Eco-Management and Auditing*(Vol. 8), Pp. 123-133. Retrieved June 28, 2019

Demirtas, O. (2013). "Evaluating the best renewable energy technology for sustainable energy planning". *International Journal of Energy Economics and Policy, Vol. 3*(Special Issue), Pp. 23-33. Retrieved June 28, 2019

Development, H. L. (2018). *2018 HLPF Review of SDG implementation: SDG 6 – Ensure availability and sustainable management of water and sanitation for all.* UN.

Fosu, K. (2016). Growth, inequality, and poverty reduction in developing countries: Recent global evidence. *Research in Economics*, Pp. 1-31.

Fowler, S.J. and Hope, C. (2007). "A critical review of sustainable business indices and their impact". *Journal of Business Ethics, Vol. 76*(No.3), Pp. 243-252. Retrieved June 28, 2019

Giovannucci, D., et al. . (2012). *Food and Agriculture: the future of sustainability. A strategic input to the Sustainable Development in the 21st Century (SD21) project.* USA: UNDESA.

Godfrey, L. and Todd, C. (2001). "Defining thresholds for freshwater sustainability indicators within the context of South African water resource management", 2nd WARFA/Waternet Symposium: Integrated Water Resource Management: Theory, Practice, Cases. Pp. 30-31. Retrieved June 28, 2019

Govindan, K., Khodaverdi, R. and Jafarian, A. (2013). "A fuzzy multi-criteria approach for measuring sustainability performance of a supplier based on tripple bottom line approach". *Journal of Cleaner Production, Vol. 47*, Pp. 345-354. Retrieved June 28, 2019

Group, U. N. (2016). *Tailoring SDG to national, sub-national and local context*. Retrieved from https://www.undg.org/2030-agenda/mainstreaming-2030-agenda/tailoring-sdg-to-national-context/.

GSS. (2014). *Poverty Reports in Ghana* . GSS.

Hwang, C.L. and Yoon, K. (1981). *Multiple Attribute Decision Making: Methods and Application.* Berlin: Springer.

Jiuying, D. and Shuping, W. (2016). "A new method for multi-attribute group decision making with triangular intuitionistic fuzzy numbers". *Kybernets, Vol. 45*(No. 1), Pp. 158-180. Retrieved June 28, 2019, from http://dx.doi.org/10.1108/K-02-2015-0058

Julian, K., Katrina, J.C. and Matthew, J.W. (2016). Multi-causal pathways of public opposition to dam projects in Asia: Afuzzy set qualitative comparative analysis (fsQCA). *Global Environmental Change*. Retrieved July 10, 2019

Kannan, D., Jabbour, A.B.L.D.S. and Jabbour, C.J.C. (2014). "Selecting green suppliers based on GSCM practices: using fuzzy TOPSIS applied to a Brazilian electronics company". *European Journal of Operational Research, Vol. 233*(No. 2), Pp. 423-447. Retrieved June 28, 2019

Kassebaum, N.J., Barber, R.M., Bhutta, Z.A., et al. (2015). *Global, Regional and National levels of maternal mortality, 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015.* Lancet 2016. Retrieved July 10, 2019

Katrin M., Agnieszka K., and Thomas D. (2017). The Gap Frame - Translating the SDGs into relevant national grand challenges for strategic business opportunities. *The International Journal of Management Education*, Pp. 1-21.

Kucukvar, M., Gumus, S., Eglimez, G. and Tatari, O. (2014). "Ranking the sustainability performance of pavements: an intuitionistics fuzzy decision making method". *Automation in Construction, Vol. 40*, Pp. 33-43. Retrieved June 28, 2019

Labuschagne, C., Brent, A.C. and Van Erck, R.P. (2005). "Assessing the sustainability performances of industries". *Journal of Cleaner Production, Vol. 13*(No. 4), Pp. 373-385. Retrieved June 28, 2019

Lanker, E. and Nijkamp, P. (2000). "A policy scenario analysis of sustainable agricultural development options: a case study of Nepal. *Impact Assessment, Project Appraisal, Vol. 18*(No.2), Pp. 111-124. Retrieved June 28, 2019

Le Blanc, D. (2015). "Towards integration at last? The Sustainable development goals as a network of targets". *Sustainable Development*, Pp. 176-187. Retrieved July 10, 2019

Lee, D.D. and Faff, R.W. (2009). "Corporate sustainability performance and idiosyncratic risk: a global perspective". *Financial Review, Vol. 44*(No. 2), Pp. 213-237. Retrieved June 28, 2019

Loucks, D. (1997). "Qualifying trends in system sustainability". *Hydrological Sciences Journal, Vol. 42*(No.4), Pp. 513-530. Retrieved June 28, 2019

Nadia A., Mahdis K., Nour B., Maaz, M., Seema M., Al-Gashm, S. and Zulfiqar, A. B. (2018). Status and drivers of maternal, newborn, child and adolescent health in the Islamic world: a comparative analysis. *The Lancet*, Pp. 1-20.

United Nation. (2016). *Sustainable Development Goals Report.* Washington DC: UN.

United Nation (1992, June 3 to 14). Agenda 21, United Nations Conference on Environment and Deveopment.

United Nation (2007). *Indicators of Sustainable Development: Guidelines and Methodolies.* UN.

United Nation (2012). United Nations Conference on Sustainable Development Outcome Document: The future we want . *A/CONF.216/L.1 of 19.* UN.

United Nation (2015). *Millenium Development Goals Reports.* Washington DC: UN. Retrieved from http://www.un.org/millenniumgoals/reports.shtml

Oluwabunmi F. and Saroj K. (2018). From developing to sustainable economy: A comparative assessment of India and Nigeria. *Environmental Development*, pp. 1-8.

ILO (2015). *Poverty Reduction; the Role of Job Creation.* ILO.

WHO (2015). *Children: reducing mortality.* Washington DC.: WHO.

WHO (2015). *Global Health Observatory Data Repository. MDG5: Maternal and Reproductive Health.* Washington DC: WHO. Retrieved from http://apps.who.int/gho/data/node.main.530?lang=en

Pitelis, C. (2013). "Towards a more 'ethically correct' governance for economic sustainability". *Journal of Business Ethics, Vol. 118*(No. 3), Pp. 655-665. Retrieved June 28, 2019

Piwowarski, M., et al. (2018). Application of the Vector Measure Construction Method and Technique for Order Preference by Similarity Ideal Solution for the Analysis of the Dynamic of Changes in the Poverty Levels in the European. *Sustainability, MDPI, Vol. 8*(No. 10), Pp. 1-24. Retrieved August 1, 2019

Piwowarski, M., et al. (2018). TOPSIS and VIKOR methods in study of sustainable development in the EU countries. *ResearchGate*, Pp. 1-11. Retrieved from https://www.researchgate.net/publication/327292676

Piwowarski, M., Milaszewicz, D., Latuszynska, M., Borawski, M. and Nermend, K. (2018). TOPSIS and VIKOR methods in study of sustainable development in the EU countries. *Elsevier Ltd*, Pp-1683-1692. Retrieved June 29, 2019

Rachel P., Joyce K., Mateyo B., Patrick R., and Caroline D. (2018). Why do water quality monitoring programs succeed or fail? A qualitative comparative analysis of regulated testing systems in sub-Saharan Africa. *International Journal of Hygiene and*, Pp. 1-14.

Review, N. V. (2016). *Year One of Implementing the SDGs in the Republic of Korea: From a Model of Development Success to a Vision for Sustainable Development.* The Government of the Republic of Korea.

Sachs, J., Schmidt-Traub, G., Kroll, C., Durand-Delacero, D. and Teksoz, K. (2016). *An SDG Index and Dashboards-Global Report* . New York: Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN).

Sachs, J., Schmidt-Traub, G., Kroll, C., Durand-Delacre, D. and Teksoz, K. . (2018). *An SDG Index and Dashboards-Global Report.* New York: Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN).

Sachs, J., Schmidt-Traub, G., Kroll, C., Durand-Delacre, D. and Teksoz, K. (2017). *An SDG Index and Dashboards-Global Report.* New York: Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN).

Sara J. M., Emily K., Jean, G., Jamie, B., Jennifer D. (2018). Pathways to sustainability: A fuzzy-set qualitative comparative analysis of rural water supply programs. *Journal of Cleaner Production*, Pp. 1-10.

Schmidt-Traub, G. (2018). *On metrics and financing for the Sustainable Development Goals.* PhD Thesis.

Schwarz, J., Beloff, B. and Beaver, E. (2002). "Use sustainability metrics to guide decision making". *Chemical Engineering Progress, Vol. 98*(No. 7), Pp. 58-63. Retrieved June 28, 2019

Shih, H.S., Shyur, H.J. and Lee, E.S. (2007). "An extension TOPSIS for group decision making". *Mathematical and Computer Modelling, Vol. 45*(No. 7), Pp. 801-813. Retrieved June 28, 2019

Singh, R.K. and Benyoucef, L. (2011). " A fuzzy TOPSIS based approach for e-sourcing". *Engineering Applications of Artificial Intelligence, Vol. 24*(No. 3), Pp. 437-448. Retrieved June 28, 2019

Singh, R.K., Murty, H.R., Gupta, S.K. and Dikshit, A.K. (2009). "An overview of sustainability assessment methologies". *Ecological Indicators, Vol. 9*(No. 2), Pp. 189-212. Retrieved June 28, 2019

The Global Burden of Disease. (2016). a comprehensive assessment of mortality and disability from diseases, injuries, and risk factors in 1990 and projected to 2020.

Triantaphyllou, E. (2000). *Multi-Criteria Decision Methods.* Dordrecht: Kluwer Academic Publishers. Retrieved June 28, 2019

UN. (2001). *Deciding a Future for the World.* Rio: UN Millenium Declaration .

UN Secretary-General High-Level Panel on Global Sustainability . (2012). *Resilient People, Resilient Planet: A future worth choosing.* USA: UN.

UNDESA. (2012). *Back to our common future.* USA: UNDESA.

UNDESA. (2013). *Sustainable Development Scenarios for Rio +20.* Brazil: UN.

UNESCO. (2015). *Comparative Analysis of Universal Primary Education in Africa.* UNESCO.

UNICEF. (2015). *UN Inter-agency Group for Child Mortality Estimation (UN-IGME). Levels and Trends in Child Mortality Report 2015.* New York: UNICEF. Retrieved July 10, 2019, from http://www.unicef.org/publications/files/Child_Mortality_Report_2015_Web_9_Sept_15.pdf

UNICEF, WHO, and the World Bank. (2015). *UNICEF/WHO/World Bank joint malnutrition estimates.* New York: WHO. Retrieved July 10, 2019, from http://www.who.int/nutgrowthdb/estimates/en/; 2015

IPU, (2015). *Global Inter-Parliamentary Union's Ranking.* Inter-Parliamentary.

UNRISD. (2010). Combating poverty and inequality: Structural Change, Social Policy and Politics.

UN-Water. (2018). *Sustainable Development Goal 6 Synthesis Report 2018 on Water and Sanitation.* New York : United Nations.

Walker, H., Klassen, R., Sarkis, J. and Seuring, S. (2014). Sustainable operations management: recent trends and future directions". *International Journal of Operations and Production Management, Vol. 34*(No. 5). Retrieved June 28, 2019

WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. (2015). *Trends in maternal mortality: 1990 to 2015: estimates by WHO, UNFPA, World Bank Group and the United Nations Population Division.* Geneva: WHO. Retrieved July 10, 2019, from . http://www.who.int/reproductivehealth/publications/monitoring/maternal-mortality-2015/en/

Wibowo, S. and Deng, H. (2013). "A fuzzy multicriteria approach for evaluating the sustainability perfomance of seniconductor companies". *8th IEEE Conference on Industrial Electronics and Applications (ICIEA), IEEE, June*, Pp. 278-283. Retrieved June 28, 2019

Wittstruck, D. and Teuteberg, F. (2012). "Integrating the concept of sustainability into the partner selection process: a fuzzy-AHP-TOPSIS approach". *International Journal of Logistics Systems and Management, Vol. 12*(No. 2), Pp. 195-226. Retrieved June 28, 2019

World Health Organisation (WHO) and United Nations Children's Fund (UNICEF). (2017). *Progress on Drinking Water, Sanitation and Hygiene: 2017 Update and SDG Baselines.* Geneva. Retrieved from https://washdata.org/report/jmp-2017-report-final