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## **The Role of Science, Technology and Innovation in Implementation of Sustainable Development Goals**

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### **Abstract**

*Sustainable development goals (SDGs) is global plan of action for planet, people, peace and prosperity. The SDGs were built on the Millennium Development Goals (MDGs) a development plan aimed to eradicating poverty and fostering development. The SDGs were meant to conclude the unfinished business of the MDGs and respond to new challenges. The 2030 Agenda for sustainable development recognizes science, technology and innovation (STI) as key drivers enabling and acceleration towards prosperous inclusive and environmentally sustainable economies in all countries. Some of the SDGs and targets have major focus on environmental and natural resources. Many challenges in these two areas need science, technology and innovation as solutions to the problems. Due to this, the objectives of this paper is to address the role of science, technology and innovation in implementing the sustainable development goals. This has been done with particular reference to the SDGs that have main focus to environmental and natural resources which are SDGs 2, 6, 7, 11, 12, 13 and 14. This have been done by pinpointing the strategies, barriers and remedies that are encountered when applying STI in implementation of these goals nationally and globally. The paper is divided into five sections which include, introduction, methodology used in looking for the references, literature review, implementation of SDGs using STI, conclusion and references. The role of STI in the implementation of the SDGs have been shown by the reviewed studies in terms of strategies, barriers and remedies.*

*Keywords: Sustainable development goals; science, technology and innovation; research.*

### **1.0. Introduction**

The sustainable development goals (SDGs) otherwise known as global goals are a set of objectives within the universal agreement to end poverty, protect all that makes the planet habitable and ensure that all people enjoy peace and prosperity now and, in the future, (Morton, Pencheon & Squares 2017). The SDGs also known as the 2030 Agenda is a 15-year global plan of action which is built on the Millennium Development Goals, (MDGs). It is comprised of 17 sustainable development goals containing 169 targets and 230 indicators (Colglazier, Diab, Fledming, Gadelha & Mukherjee, 2019). In comparison with the MDGs, the SDGs contain additional elements to the main aspect of sustainable development agenda that apply to all countries such as encourage peaceful and inclusive societies, realizing human rights for all, achieve gender equality, create better jobs and deal with environmental challenges of our time particularly the climate change (Akinloye, 2018). The SDGs will shape the global course of action to end poverty, promote prosperity and well-being for all while taking into account environmental and resources limited and tackling climate change (Giovannini, Niestroy, Nilsson, Roure & Spanos, 2015). A lot of organizations are seeing the benefits of environmental health, human well-being, economic sustainability and long-term profitability (Austrian Government, 2018). Organizations which manage to successfully implement and perform a coherent action plan across all the three spheres of sustainable development (economy, social and environment) can assure long term benefits, business continuity and public support and recognition (Zdanyte, Neverauskas, & Sabaliuskaite, 2014). Coherent relationship needs to be observed across multi-levels of government. For example, for policy makers and planners put



in place different legal framework, investment framework, capacity development mechanisms and policy instruments that may or may not pull in the same direction (Nilsson, Griggs, Visbeck, Claudia & McCollum, 2017).

Despite the current trend of linking issues of environment and economic development the developed countries have clung to their historical tendency of placing economics above concerns over equity and poverty and the environment. They pay lip service to norms of sustainable development but compliance remains poor as international system has not been given the law enforcement machinery to compel the developed countries to alter environmentally unfriendly economic practices (Iqbal & Pierson, 2016). The UN's categorization of means of implementation for the SDGs include, finance, technology, capacity building, trade, policy coherence, partnership, data monitoring and accountability (Jaiyesimi, 2016). The 2030 Agenda for sustainable development emphasizes on science, technology and innovation (STI) as a key driver enabling and accelerating towards prosperous, inclusive and environmentally sustainable economies in developing and developed countries (UNCTAD, 2019). Science for sustainable development must provide the evidence to support breaking through the current social economic and especially political impasses to enable creative and transformative solutions that bring both far reaching if not permanent changes (UN, 2019). A key means of implementation of sustainable development goals, which are part of the 2030 Agenda is the effective use of science, technology and innovation (UNESCO, 2016). Due to this, the study of this paper has been decided to be on the role of science, technology and innovation in the implementation of the sustainable development goals. The paper will look into the strategies of implementation the barriers that hinder implementation and the remedies to their barriers.

### **1.1 Theoretical framework for MDGs and SDGs**

The SDGs were developed following the United Nations Conference on Sustainable Development in 2012 ('Rio+20') build on the Millennium Development Goals (MDGs) adopted in September 2000 as a part of the UN Millennium Declaration (Nilsson et al., 2017). The principles related with any framework related to sustainable development that were established by the High-level Panel on Sustainability of the UN in 2012 were: It should be universal in character covering challenges to all countries rather than just developing countries; it should express a broadly agreed global strategy for sustainable development; it should incorporate a range of key areas that were not fully covered in the MDGs; it should be comprehensive reflecting three dimensions of SD; it should incorporate near-term benchmarks while being long-term in scope looking ahead of perhaps 2030; it should engage all stakeholders in the implementation and mobilization of resources; it should provide scope for the review of the goals in view of evolving scientific evidence (Montaldo, 2013). The MDGs commitments were to eradicate poverty, promote human dignity, equality peace democracy and environmental sustainability. These commitments were converted into eight goals and corresponding targets the world could achieve by 2015 (UNDP, 2016). In many contexts, MDGs have played a role by providing a common development agenda globally and focusing attention on critical aspects of poverty reduction (Nilsson, Lucas & Yoshida, 2013). With the adoption of 2030 Agenda for sustainable development, 17 sustainable development goals were established defining the world's development objectives for the next 15 years starting from 2016 and replacing the MDGs as the global agenda (UNDP, 2016). The SDGs provide a more holistic and integrated approach to development than the MDGs. They are designed to be universal and therefore apply to all countries including poor, rich, middle income and all segments of the society (Nilsson et al., 2017).

## **2.0. Methodology**

### **2.1 Search Criteria**

To carry out this study required to look into documents and literature materials available from online publications, academic domains, official publications and policy papers that were obtained from Google and Google Scholar. The following criteria were used in searching for the studies in this paper. Studies that have addressed development goals including the MDGs as well as SDGs were selected. Studies that have compared the two development goals i.e. MDGs, versus SDGs were selected. The studies that have shown the strategies and challenges to SDGs including ways of solving them were selected. Studies that have addressed science, technology and innovation (STI) as ways of solving problems associated with SDGs were selected. Publications that have presented information associated with research and development (R&D) as solutions to SDGs were chosen. Publications with data on environmental challenges towards SDGs and ways to mitigate through research, science, technology and innovation were chosen. Also, publications that have addressed industrialization goal of SDGs through promotion of modern technology application to industries for sustainable development were chosen. Publication with data concerning technology transfer between developed and developing countries for SDGs were selected. In order to identify the above categories, the following databases were searched Google and Google Scholar



## 2.2 Term used in the search

The terms used in the search were ‘Millennium development goals (MDGs)’, ‘Sustainable development goals (SDGs)’, ‘Development goals’, ‘environmentally friendly sustainable development’, ‘socially sustainable development’, ‘economically sustainable development’, ‘energy sustainability’ and ‘economic development’, ‘challenges on implementation of SDGs’, ‘Health for all and SDGs’, ‘STI and sustainable cities and communities’, ‘STI and affordable and clean energy’, ‘STI and clean water and sanitation goals’, ‘STI and the industry, Innovation and infrastructure’, ‘STI and the implementation of climate action’, ‘STI and conservation of life below water’, ‘STI and sustainable use of terrestrial ecosystems’.

## 2.3 Screened Publications

The total number of screened publications were 76. Among the studies identified 16 publications reported on implementation of SDGs, 18 publications reported on science, technology and innovation as solutions to problems encountered in sustainable development goals, 1 publication reported on poverty alleviation in relation to SDGs, 1 publication on capacity building for SDGs, 5 publications reported on health issues in relation to SDGs, 3 publications reported on family planning in relation to SDGs, 3 publications reported on strategic planning and SDGs, 1 publication reported on research in relation to SDGs, 5 publications reported on implementation of SDGs in Africa, 3 publications reported on implementation of SDGs in Europe, 2 publications reported on North-South political and economic obstacles to SDGs, 4 publications reported on application of integrated approach to SDGs, 6 publications reported on education training and knowledge in relation to SDGs, 2 publications on water and SDGs, 1 publication reported on sustainable cities and communities in relation on accountability regimes and policy integration for SDGs, 1 publication reported on inequality reduction as a strategy of implementation of SDGs and 1 publication reported on the linkage between economy, society and environment in relation to SDGs.

## 3.0. Literature Review

### 3.1. MDGs and SDGs

The SDGs were developed as a recommendation of having a more holistic approach to the MDGs in the UN Millennium Declaration along four dimensions of inclusive, economic development, environmental sustainability and peace and security (UNSTT, 2012). In order to show a comparison of what was meant for the SDGs to conclude the unfinished business of the MDGs and respond to new challenges, see Table 1 below (Pisano, Lange, Berger & Hametner, 2015).

**Table 1: Comparing MDGs and proposed SDGs (Pisano et al, 2015)**

MDGs	Proposed SDGs
1. Eradicate extreme poverty and hunger.	1. End poverty in all its forms everywhere.
2. Achieve Universal Primary Education.	2. End hunger, achieve food security and improve nutrition and promote sustainable agriculture.
3. Promote gender equality and empower women.	3. Ensure healthy lives and promote well-being for all at all ages.
4. Reduce child mortality.	4. Ensure inclusive and equitable quality education and promote life-long learning opportunities for all.
5. Improve maternal health.	5. Achieve gender equality and empower all women and girls.
6. Combat HIV/AIDS, malaria and other diseases.	6. Ensure availability and sustainable management of water and sanitation for all.
7. Ensure environmental sustainability.	7. Ensure access to affordable, reliable, sustainable and modern energy for all.
8. Develop a global partnership for development.	8. Promote sustainable economic growth full and productive employment and decent work for all.
	9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
	10. Reduce inequality within and among countries.
	11. Make Cities and human settlements inclusive, safe, resilient and sustainable.
	12. Ensure sustainable consumption and production patterns.
	13. Take urgent action to combat climate change and its impacts.
	14. Conserve and sustainably use oceans, sea and marine resources for sustainable development.



	<ol style="list-style-type: none"><li>15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.</li><li>16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.</li><li>17. Strengthen the means of implementation and revitalize the global partnership for sustainable development.</li></ol>
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### **3.2. The Sustainable Development Goals (SDGs) and STI**

The SDGs agenda involves a deliberate commitment to STI and focus on inclusive and sustainable development, presenting an opportunity to improve coherence across STI, economic development, and sustainable environmental management strategies (Mkhize, 2018). The Northern sustainability agenda is predominantly focusing on environmental protection e.g. climate change, biodiversity protection of species and habitat while the south struggles to secure improvements to human health, develop its enterprise based and achieve the necessary economic growth for its development (Scottish Executive Social Research, 2006). In order to enhance the role of science in global policy making towards SDGs aspirational targets require the best knowledge, innovation and application from all sectors and to use scientific inputs to take the economic, social and environmental stress striking the planet (Song, 2017). When applying STI based solutions to development challenges, countries may wish to consider the ethical, social and legal impacts of STI application (G20DWG, n.d.). STI policy for development should be consistent with global development framework provided by the 2030 Agenda for sustainable development where economic growth, social inclusion and environmental sustainability reinforce each other (UNCTAD, 2018).

In order to achieve this, it is important to close the gaps in technology and innovation capabilities that separates developed and developing countries. Integrating knowledge from different sources can foster reflectivity and learning as well as evidence-based policy making. Strengthening science policy interface for sustainable development is important given the complexity of sustainable development challenges (EU, 2019). The issue of technology transfer should primarily focus on devising a system of learning, adapting, utilizing and disposing of imported technologies in order to meet national demand. Science, technology and innovation plays pivotal roles in poverty eradication and sustainable development (Quaye, Akon-Yamga, Daniels, Ting & Asante, 2019). The SDGs provide a tool for organizations to identify and mitigate risks and opportunities. Governments are applying whole analysis to identify problems and solutions in policy (Zdanyte, Neverauskas, & Sabaliuskaite, 2014). A more recent understanding of innovation recognizes that capabilities are important not only in formal research and development but also in design, engineering, management and entrepreneurship and that innovation in all forms of organization and social practice is relevant. (UNCTAD, 2017). Science, technology and innovation are crucial for implementation of SDGs. They increase efficiency and effectiveness of achieving the SDGs (RIS, 2018). Important impact channel of economic growth and competition is support of resource and energy efficiency innovation activities and used for sustainable policies (Arak, Olko, & Sabat, 2018). Sustainable science probes interactions between global, social and human system by identifying and addressing complex challenges that are not typically considered in traditional academic disciplines. This trans-disciplinary proved way forward to a sustainable global society (Saito, Manigi, Kanie, Kauffman & Takeuchi, 2017).

In order to have gender equality and empowering all women and girls you need to promote non-traditional careers e.g. women in technical jobs study on the impacts of male and female use of ICT in empowerment, participation creativity, collaboration and social engagement (Lee & Pollitzer, 2016). Inequality reduces efficiency and productivity of the poor thereby causing low economic growth and undermining social cohesion (Adetunji, n.d.). Social exclusion promotes violence, drugs, family break down and dependence on state benefits. When women have control over their own income or family earnings, they are able to reinvest in their families, children and communities which has a positive impact on all the SDG targets (Agarwal, Gneiting & Mhlanga, 2017). Increasing gender equality have the following benefits, having more talented and satisfied pool of workers and more stable supply chains. STI are key drivers of social economic progress in any country. The experience of successful developing countries shows that STI policies that are properly integrated into national development plan strategies and combined with institutional and organizational changes can help raise, improve global competitiveness, support enhanced economic growth and facilitate employment creation (EASTECO, 2018).



Available domestic resources have been insufficiently utilized to promote sustainable development and productivity largely attributed to low levels of scientific and technological innovation (Swartz, Hooker, Chehidi & Kumar, 2017). Science, technology and innovation (STI) policies are closely related to industrial policy but they are also relevant for environmentally sound productivity, growth in agriculture, the development of modern services and meeting the challenge of climate change adaptation and mitigation (UNCTAD, 2018). Research play a very important role in the social economic development. It aims at creating, dissemination and sharing of existing and new knowledge and utilizing products, processes and services (UDSM, 2018). Technological progress can come from domestic research and development and domestic learning effort or from transfer of technology from more advanced economies (UNCTAD, 2018). Advanced foreign technology is acquired through the import of machinery and equipment by domestic or foreign investors. Least developed countries governments must support an increase in the capacity of domestic firms to take up and utilize new technology. Also, they must strengthen domestic knowledge system (UNCTAD, 2018). Most countries that have succeeded in expanding their economies have done so through STI by giving science and technology significant prominence in their government structure (COSTECH, 2018).

#### **4.0. Implementation of Sustainable Development Goals Using Science Technology and Innovation**

##### **4.1. Strategies towards implementation**

In analysis of the environmental related goals and targets show, that eight SDGs have major focus on environmental and natural resources. These are: (2) Food and Agriculture (6) Water and sanitation (7) Energy (11) Human settlement (12) Sustainable consumption and production (13) Climate change (14) Oceans (15) Terrestrial eco system (Karlson-Vinkhuyzen, Dahl, & Persson, 2018). Seven of these SDGs have been used in this study to obtain the strategies and barriers to STI on their implementation as follows.

##### **4.1.1. Strategies and barriers to STI on implementation of SDG 2**

The strategy for implementation of SDG 2 should include the international cooperation on STI capacity, technology access and transfer by increasing investments, including international cooperation in rural infrastructure, agricultural research and extension (UN, 2016, p. 44). To achieve this, there should be plans, roadmaps and integrated assessment for national and international action plans and for achieving the SDGs individually and together. Technology investment need to be increased significantly. Remove barriers to technology deployment and increase R&D investment and support incentives for deployment of cheaper technologies with systemic benefits (UN, 2016. P.45). Increase food crops by investing in sustainable agriculture technologies, innovations of bio-based products and processing, storage technologies, horticulture techniques and irrigation technologies. Overall improvement of technology performance in order to maintain the genetic diversity of seeds, cultivated plants, and framed and domesticate animals and their related wild species. Potential threats that might be associated to these technologies can include irreversible changes to health and environment, job losses and inequalities between developed and developing countries (UN, 2016 p. 53).

##### **4.1.2. Strategies and barriers to STI on implementation of SDGs 6**

Improvement of the overall technology performance such that by 2030 the proportion of treated water should be increased by halve. Qualitative technology should be used to improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials. Increase water reuse and recycling globally through use of technology to increase substantially water-use efficiency (UN, 2016 p. 43). To have universal access to sustainable technology and use it to achieve universal and equitable access to safe and affordable drinking water for all and end open defecation. By 2030 expand international cooperation and capacity building support to developing countries in water and sanitation related activities and programmes, including water harvesting, desalination, water efficiency, waste water treatment, recycling and reuse technologies (UN, 2016 p. 44). Access to affordable water and sanitation related modern technology in developing countries. To use nano-technology in decentralized water and waste water treatment and also for desalination. Use of Green-technology in water such as mobile water treatment technology, waste water technology and advanced metering infrastructure. The potential risks to these technologies include human health (toxicity) and environmental impact (nano-waste), inequalities and job losses UN, 2016 p. 53).

##### **4.1.3. Strategies and Barriers to STI on implementation of SDG 7**

The SDG 7 is concerned with overall technology performance improvement which will enable quantitative technology targets by 2030 by doubling the global rate of improvement in energy efficiency. Qualitative technology performance targets for 2030 by increasing substantially the share of renewable energy in the global energy mix. Also, by expanding infrastructure and upgrading technology for supplying modern and sustainable energy for all in developing countries.





To have access to sustainable technology which will enable to ensure universal access to affordable, reliable and modern energy services (UN, 2016 p. 43). By 2030 enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency, advanced and cleaner fossil fuel technology and promote investment in energy infrastructure and clean energy technology (UN, 2016 p. 44). Communication, education and public awareness raising are essential, especially among consumers of energy in order to have environmentally sustainable energy use. To use nano technology in solar energy (nano material solar cells). The potential risk for using nanotech include human health (Toxicity) and environmental impact on disposing (Nano waste). Green technology in energy should include modern cook stoves with emissions comparable to those of LPG stove, deployment of off-grid electricity systems, mini grids based on intermittent renewables with storage, advance in battery technology, heat pumps for space heating, natural gas technologies small and medium size nuclear reactors, biofuel supply claims solar photo-voltaics, wind and micro-hydro-technologies and LED lamps UN, 2016 p. 53). Potential threats to these technologies include inequalities, and job losses.

#### **4.1.4. Strategies and barriers to STI on implementation of SDG 11**

The SDG 11 is: Make cities and human settlements inclusive, safe, resilient and sustainable. The implementation strategy should be to use universal access to technology in order to ensure access for all adequate, safe and affordable housing and basic services and upgrade slums. Another target of implementation will be to use sustainable technology to provide access to safe, affordable, accessible and sustainable transport systems for all and improve road safety. Use technology to expand public transport (UN, 2016 p. 43). The green technology that can be used in integrated public infrastructure electric vehicles (such as e-car, e-bike) hydrogen fueled vehicles and supply infrastructure. Also, it can be used in sustainable building technology and passive building (UN, 2016 p. 53). Threats are inequality and job loss.

#### **4.1.5. Strategies to STI on implementation of SDG 12**

For the strategies on the implementation of SDG 12, there should be an improvement in technology in order to minimize food losses along the production and supply chains, including post-harvest losses. Also, qualitative technology performance should be applied in order to reduce waste generation through prevention, reducing, recycling and reuse (UN, 2016 p. 43). To include international cooperation on STI capacity, technology access and transfer by supporting developing countries to strengthen their scientific and technological capacity to move towards more sustainable pattern of consumption and production. Apply green technology by encouraging circular economic through technologies for product life-cycle extension such as re-use, refurbishment and technologies for recycling (UN, 2016 p. 53).

#### **4.1.6. Strategies to STI on implementation of SDG 13**

SDG 13 deals with taking urgent action to combat climate change and its impacts. To apply higher education and STI capacity building to improve education awareness-raising and human and institutional capacity on climate change mitigation, adaption, and impact reduction (UN, 2016 p. 44). Green technologies can be applied in CO<sub>2</sub> mitigation technology. Other technologies include new mining and extraction technologies, shale gas in ocean and deep-sea mining technologies (UN, 2016 p. 53). Potential threats include inequalities, job losses and pollution.

#### **4.1.7. Strategies and barriers to STI on implementation of SDG 14**

Goal 14 is to conserve and sustainably use oceans, seas and marine resources for sustainable development. The qualitative technology performance targets for 2030 is to prevent and significantly reduce marine pollution of all kinds in particular from land-based activities including marine debris and nutrient pollution by 2025 (UN, 2016 p. 43). To use qualitative performance for 2030 that will minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels. Increase scientific knowledge, develop research capacity and transfer marine technology (UN, 2016 p. 44).

### **5.0. Conclusion**

The reviewed studies have shown that the SDGs were developed to have a more holistic approach to the previous MDGs. The role of STI in the implementation of SDGs in terms of strategies, barriers and remedies have also been shown in the review. The challenges that have being pinpointed in the review were lack of public budget allocation, lack of private budget allocation, lack of understanding of the benefits of the STI investment in the private sector, lack of incentives for the private sector funding, high cost of imported technologies, restrictive and ill-developed patent protection, weak leadership, multitasked holder partnership, collaboration within STI sectors, inadequate mechanism for including new area of research into national agenda, defining national research priorities, low number of qualified researchers and poor hiring and training processes (Swartz, Hooker, Chehidi & Kumar, 2017). In order to strengthen



national systems of innovation to accelerate technology progress, support for R&D and incentives for deployment of cheaper technologies with systemic benefits such as off-grid electricity system, e-mobility and novel antimicrobial medicine should be encouraged (UN, 2016). Research agenda need to be aligned with global, regional and national SDGs of the UN 2030 Agenda (UDSM, 2018). Encourage cooperation between south-south and north-south in science and technology e.g. cooperation under India Brazil and South Africa (IBSA) and Brazil, Russia, India, China and South Africa (BRICS) has resulted in collaboration in areas such as health, water, sanitation, information and communication technology (ICT) for development and in technologies like nano-technology, advanced materials, biotechnology for health and ICTs that have benefited the countries) (Chaturvedi, Rahman & Srinivas, 2019). Also it is suggested that when SDGs contain goals/targets that cut across the individual SDGs and aim for the mutual attainment of the goals, the national governments should alter the procedural and institutional changes to policy making and implementation in order to attain policy coherence/inter sectorial approach e.g. rural electrification as one type of policy can also help to improve infrastructure for health services (Tosum and Leininger, 2017). Finally, in order to promote resource efficiency, there should be drive to deliver a more circular economy i.e. preventing, reducing and recycling materials and facilitating more environmentally responsible waste management (Kettunen, Bowyer, Vaculova & Charreriat, 2018).

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