Government Policies and Engineers’ Roles in Facilitating Nigeria’s Transition to Circular Economy

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Abstract
There are ongoing global efforts at changing from the traditional linear economy to a circular economy. Nigeria as the largest economy in Africa cannot afford to lag behind. This study evaluated potential impacts of the current Nigerian resource use and exploitation policies as well as engineering practitioners’ training and practices on Nigeria’s transition to circular economy. The study further attempted to identify changes in government policies and engineering training and practices that would be necessary to facilitate Nigeria’s successful transition to a circular economy. This paper is based on a desk and literature review, a web-based research on government policies, engineering training and engineering practices in Nigeria. Contributions of this study include provision of insights to the government officials on regulations that need to be improved to facilitate Nigeria’s transition to circular economy. It also provided agencies regulating engineering education and engineering practices in Nigeria opportunities to see areas of deficient that may need to be improved for successful transition to a circular economy

Keywords: Circular economy, Engineering education, Government policies, Material cycling, Resource optimization, Sustainable development

1 Introduction
The concept of circular economy is currently making waves both in the political circles and in the business world. It is being promoted by the EU, several national governments and many businesses around the world [Korhonen et al]. Circular economy can be defined as a proactive approach to waste prevention and resource conservation. Although the concept is currently tilted towards the attainment of environmental- and economic sustainability, it also has great potential for the attainment of social equity and justice.

Importance of circular economy stems from the need for careful management of our resources in a way that appropriate development would be promoted while our environment and the social fabric of our community are preserved. It is a common knowledge that our economic activities require the use of material, energy, and, in many cases, water. Availability of these three resources in ready-to-use form vary from one location to another both in quantity and quality. Many times they have to either be grown or mined and processed to usable forms for industrial applications. Undertaking such activities often necessitate ecosystem disturbance that results in environmental stresses such as resource depletion, loss of biodiversity, soil and water erosion, surface water contamination, groundwater pollution, and several other human health and ecosystem related impacts. Reactive approach to solving these and other related problems are often costly and usually take years to achieve restoration. Many times, these negative consequences of our economic activities do generate socio-political upheavals, disrupt social order and communal peace, lead to loss of cultural heritage, and result in loss of lives. Application of circular economy concept attempts to avoid the “bandage” approach to solving these problems. It also prevents emanation of new unexpected problems. Circular economy (CE) facilitate the achievement of the
aforementioned benefits by demanding the development of policies, processes and technologies that require wise and sustainable use of resources. It promotes multi-level, economically sensible and environmentally friendly cycling of resources (Fig. 1). By fostering transition from the conventional linear flow of material in our economic environment to circular one, CE minimizes resource leakages that upset environmental balance. It is the spiraling effects of the upset that often result in all the aforementioned environmental woes such as soil degradation, pollution, and others. The next section explained the approach used in developing this paper. The following section detailed out the conditions found to be necessary for effective implementation/operation of a circular economy-based system. This is followed by an overview of Nigerian resource exploitation and utilization policies as well as Nigerian engineering training and practices and their possible impacts on the implementation of circular economy system in Nigeria. The paper is concluded by itemizing some of the necessary changes required to assure successful transition of Nigerian economic system from linear to circular economy. It also identified some possible implementation challenges and how to eliminate/minimize them.

Fig. 1 A type of circular economy system: An Eco-industrial Park
Source: https://greenbuildingelements.com/wp-content/uploads/2012/12/ECO-INDUSTRIAL-PARK-CONCEPT2.jpg

2. Methodology
This paper is based on a desk and literature review on circular economy and factors affecting its implementation in a number of countries and by businesses. It also involved a web-based research on government policies, engineering training and engineering practices in Nigeria. Understandings derived from these reviews were used to articulate necessary conditions for successful operation of a circular economy-based system in any locality. The review of Nigerian resource policies
facilitated proper evaluation of where and how these policies would affect implementation of CE in Nigeria. Furthermore, it facilitated identification of required changes in policies and engineering education for a successful take off of circular economy implementation in Nigeria.

3 Necessary conditions for effective/successful implementation of circular economy

There are a number of necessary conditions for successful implementation of circular economy projects whether at corporate, local, regional, national or multinational levels. These enabling conditions can be divided into four groups, namely regulatory, infrastructural, social and technical.

3.1 Regulatory/institutional conditions

Supportive legislative/regulatory policies need to be put in place that will provide muscle for a successful operation of circular economy projects. The regulations need to identify specific institutions that would have an oversight of various aspects of the framework. It would need to specify their roles and how they will function to ensure smooth operation of CE projects. Such regulations also need to be crafted in a way that would prevent overlap of responsibilities that could result in clashes and cripple the system. In addition, such regulations should have both short-, medium- and long-term view of goals and desired achievements of the CE system with the aim of making adequate provision for anticipated changes as time goes on.

3.2 Infrastructural requirements

Implementation of circular economy principles require that a number of infrastructures be put in place in order to achieve a smooth operation of the system. Among these infrastructures are energy supply system that is stable, sustainable, adequate and adaptable to circular economy needs at various levels, localities and cultures. Renewable energy sources such as wind, solar, hydro and geothermal implemented at communal level. Other infrastructure that are necessary for successful implementation of circular economy are water supply system, transport infrastructure and communication systems that are adapted/suitable for the locality and the kind of circular economy that is planned to be operated in the region. Infrastructure development that involves the citizens/users and adapted to communal scale as well as local conditions rather than the usually imported mega scale technologies are generally advocated because of its many benefits. Among the benefits include its potential to boost the local economy, rural employment opportunities, lower ecological footprints, rural development, local acceptance and ownership, longevity of service and capacity building at the grassroots.

3.3 Socio-cultural attitude

People have various ways of harnessing resources at their disposal, maintaining their assets, and attending to issues. While some people group and individuals are caring and meticulous, some take things easy and do not pay attention to details. While some take steps to address issues promptly and immediately, others tend to take things with levity, allow things to cool down or sort out themselves. Some people do not like to be saddled with responsibilities that may not be apparent to yield immediate or personal benefits, while some people like things to be done orderly and could not tolerate chaos, and they are willing to take on responsibilities without the consideration of personal gratification. Changes to sociocultural attitude of certain people group and individuals shouldered with some responsibilities may be necessary to ensure successful implementation and operation of a circular economy system. Such changes would generally require steady consistent
general public or special education. The framework for such education and its funding would need to be enshrined in the supportive circular economy policies/regulations.

3.4 Operational/techno-economic conditions
Required operational procedure for day-to-day efficient running of a circular economy system would vary from one economic sector to another. For example, the requirement for the successful operation of CE based agricultural and agri-allied sector would be different from that of CE based oil and gas industry as well as from CE based aviation industry. Similarly, CE operational requirements will also vary from one sociopolitical system to another. In addition, the level of technological development and market development of economic sector in a locality/region would need to be considered when designing system’s operational procedure. Furthermore, the value system and disposable income of the people group that would consume the products resulting from the CE operation have to be factored into the design. Moreover, availability and reliability of network of reusable retired components/parts suppliers, efficiency of takeback/reverse logistics infrastructure, availability of established stakeholder’s consultative forum, and availability of self-adjusting/improvement/succession plan or structure are other factors that are essential to the smooth running of a circular economy system. All these require adequate legislative backing, public education, and proper training of professionals that would be able to run and improve the system from time to time [Dunmade, 2018].

4 Nigerian resource use and exploitation policies and practices
There is a wide range of natural resources laws, legislations and subsidiary instruments in Nigeria. Some of the natural resources laws include various sections in the 1999 Nigerian Constitution; National Agricultural Policy of 1988 in which the Forestry Policy is subsumed; Petroleum Act; Associated Gas Reinjection Act; The Electric Power Corporation Act; Nigerian Mining Corporation; Water Resources Act; Oil Pipelines Act; Nigeria Liquified Natural Gas (Fiscal Incentives, Guarantees and Assurances) Act; International Convention for the Prevention of Pollution from Ships, 1973 and the 1978 Protocol (Ratification and Enforcement) Act No. 15, 2007. These instruments assign varying levels of responsibilities to the Federal and State governments while the private sectors are responsible for day-to-day exploitation of these resources in ways stipulated in the laws and regulations. Within these legislative framework, we have certain government departments and special agencies that are vested with the responsibilities of licensing, operating in some kind of partnership, supervising, implementing, monitoring and enforcing compliance of the private sector with regulatory rules. For example, section 44(3) of the 1999 Constitution vested the Federal government with the ownership of all natural resources in Nigeria. Section 44 of the 1999 Constitution also entitles State Governors with the power over land use for overriding public interests. However, sometimes conflicts arise in the interpretation/enforcement of these laws and regulations especially some of provisions in the constitution that protects the interests of licensees. Consequently, such complexity limits the capability of oversight agencies to operate effectively, especially when it comes to the protection of the environment. Situations like this have defeated the purpose of these policies aimed at ensuring effective and sustainable use of these resources in a way that benefits the society and protect the environment. This has raised a lot of concerns regarding the management of our natural resources. For instance, Ladan (2014) stated that “environmental and natural resource concerns rank highly in both continental and national priorities in Africa.” Such lapses in various norms and regulations promulgated could be observed right from the colonial era to the present time. Consequently, “African countries have suffered
excessive exploitation of natural resources”. Poor formulation of some policies and regulations, greed, corruption, and incompetence in monitoring and enforcement of private sector’s obligations made some members of the private sector to engage in dubious activities such as careless oil and gas exploitation, illegal mineral mining, and fraudulent/illegal felling of logs that has resulted in various environmental problems such as water contamination, loss of arable farmlands, deforestation and serious soil degradation. Other flaws in our policies include inconsistent record keeping of resources exploitation by the states, which makes sustainable management of these resources pretty difficult [Aruofor, 2001; Bayode et al, 2011; Ite et al, 2013; Mfon (Jr) et al, 2014; NSRP, 2017; Oyedepo et al, 2017; Ukwayi et al, 2012].

According to Gutti et al (2012), “Natural resources exploitation, exploration, mining and processing have caused different types of environmental damages which include ecological disturbances, destruction of natural flora and fauna, pollution of air, water and land, instability of soil and rock masses, landscape degradation, desertification and global warming.” The situation makes transition from linear to circular economy an urgent matter. It provides an opportunity for the society to evaluate its values, priorities and to think of other manufacturing/business models that would facilitate resource use optimization and minimize ecological footprint. As earlier highlighted, current rules and regulations have defective elements in them. It would be necessary to review/improve current Nigerian natural resources policies and regulations. The purpose of the review would not only be to eliminate those clauses that are currently hampering effective monitoring and enforcement of obligations, but to incorporate clauses that would foster implementation of circular economy in a collaborative manner [Ite et al, 2013; Oyebode, 2018].

5. Nigerian engineering training and practices

Education can be described as the process of gaining new knowledge and acquiring new values and skills for the purpose of becoming civilized to decide how best to live and to function effectively in the society. Nigerian education policies have undergone several changes since pre-independence till date. Among the changes are the changes of primary, secondary, advanced level (also known as higher education certificate) and university education from 8-5-2-3 education policy to 7-5-2-3, then to 6-3-3-4 years respectively. Daniel-Kalio (2018) observed that most of the policies and their amendments were generally reviews of the existing policies. She opined that no attempt was made to formulate education policies that are “original and indigenous to Nigeria”. It was also observed that there are disparities between Nigerian education policies and their implementation in terms of their contribution to national development. Education ownership and administration have also changed several times from private, missions, regions/states to national, then to private-state-federal. All these changes have had both positive and negative effects on the availability and quality of education in Nigeria. Trending changes in education policies and administration have significantly impacted Nigerian tertiary education (including engineering and technology). These impacts include severe shortage in funding levels and inadequate infrastructural facilities. Consequently, changes in education policies and administration are affecting the quality of engineering training in Nigeria. Since quality of training affect outputs derivable from the graduates, engineering practices are also being affected. Although significant efforts are being made to improve the quality of engineering education in Nigeria through activities of various government agencies and professional bodies such as National Universities Commission, Council for the Regulation of Engineering in Nigeria, Nigerian society of engineers, and others; impacts of their activities are yet to be significantly seen
in national development, especially where it really matters such as in infrastructure development like quality and stable energy and water supply, transportation, and many others.

Effective and successful implementation of circular economy require adequate manpower to at least operate, maintain and possibly improve various logistic infrastructure needed for the smooth running of the system. Since the current training has been unable to cope with the requirements of the existing less technically demanding linear economy system, it is no brainer to know that the current training and practices would not be able to help Nigerian in transitioning from linear to circular economy. Current engineering practices rely heavily on imported technology that are designed for climate, society and culture that are different from Nigeria. Nigerian infrastructure development is also dependent on expatriate support. Sustainable circular economy would not thrive well under such scenario [Dunmade, 2001, 2002 and 2017].

6. Necessary changes in government policies and engineering training and practices for Nigeria’s successful transition to a circular economy

Current regulations are heavily tilted in favour of the private sector participation with the believe that market forces would help in fostering innovations and lead to overall improvement in standard of living. While that is good to some extent, circular economy system model that would enable us to achieve sustainable development cannot thrive under market conditions alone. Successful implementation of circular economy in Nigeria would require regulatory muscle that does not only stifle private participation but also encourage community involvement and governmental support in various ways. It will also involve progressive changes from fossil fuel use to renewable energy development and utilization [Dunmade, 2015, 2016a & b; Dunmade et al, 2016; Oyedepo et al, 2019].

There would also be a need to tailor our educational policies and their implementation to the needs of our nation. The policies would need to be either freshly crafted or the existing/imported policies reasonably adapted to ensure continuous and consistent national development. Such policies would need to take cognizance of and harness the strength of our culture and tradition while eliminating the inherent weaknesses. It is particularly important that our educational policies identify current and future manpower needs for our country’s transition from linear to circular economy and provide structures that would enable the country to meet the needs as they arise. Consistency in policies and stable institutional system are also necessary to attain the desired change from linear to circular economy. Moreover, our engineering education and practices would need to incorporate modern engineering content such as lifecycle engineering, sustainable design, and many others [Dunmade, 2010; Dunmade et al, 2018; Dunmade and Fayomi, 2018]. Harmonization of all this principles will facilitate attainment of near zero waste in resource cycling exemplified in Fig. 2.

7. Conclusion

This paper highlighted historical changes in government policies on natural resources and engineering education and practices. It also discussed some of the defects in and impacts of those policies on Nigeria’s current state of national development. Among the necessary changes that would assure successful and sustainable transition from linear to circular economy are: elimination sections of the constitution that makes effective monitoring and enforcement difficult. There is also the need to harmonization/streamline various regulatory instruments and implementation agencies for effectiveness. In addition, there is a need for urgent revision and implementation of
engineering curriculum to incorporate sustainable/lifecycle engineering courses such as lifecycle analysis, industrial ecology, sustainable design, sustainable manufacturing and many others in the Nigerian engineering curriculum right from bachelor degree level to doctoral level. Such locally trained engineers and technologists would be able to develop both the infrastructure and circular economy models that are community relevant. They would also be able to consistently improve the system as the experience increases. In addition, taking the aforementioned steps would facilitate the needed changes from the current linear economy to sustainable circular economy. Ultimately, it would lead to elimination of environmental pollution, avoidance of resource depletion, improved public health, higher standard of living for the populace, and an overall sustainable national development that the citizens would be proud of.

Fig 2. Near zero waste resource cycling model pathways

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