Indigenous Technology Development and Africa's Competitiveness

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Abstract
With increasing economic integration and trade liberalization, convergence is becoming a mirage for countries with little or no breakthroughs in modern technology. Unfortunately, Africa is distressed in modern technology. But, before the emergence of modern states, African indigenous societies have relied heavily on the natural endowments in their community for their sustenance. They harnessed resources needed for economic activities from the local environment, while native knowledge were developed and used for production purposes. This paper therefore argues that the path to competitiveness for African countries is to revitalize African indigenous knowledge for production structure transformation which will satisfy local demands as well as meet global acceptance. Most importantly revitalization of African indigenous will promote social inclusion in line with the key guiding principle of the Sustainable Development Goals of - 'leave no one behind'. This paper undertakes a comparative qualitative approach. Relevant data were collected for African countries and some of the countries that have recorded positive results in the area of this research concern; and tables, graphs and charts were used to analyze the data collected. The researchers are optimistic that the results from the study will be pragmatically useful in this era of renewed interest of sustainability in production and consumption.

Keywords: *Indigenous technology, glocalisation, competitiveness, natural endowments*

Introduction

Technological advancement is central to economic development. It is recognised in Schiller, (1997); Smith and Todaro (2003); and UNCTAD, (2018), as the largest contributor to productivity growth. United Nations Conference on Trade and Development, UNCTAD, (2007), equally posits that technological advancement is the primary determinant of nations' international competitiveness. Following Scott (1985) and OECD (1992) definitions of competitiveness, a nation that the standard of living of its citizens continues to rise because it enjoys a favourable terms of trade, is deemed internationally competitive. Sachs (2005), identified enablers of competitiveness to include: education, health care, and public safety are other aspects of the overall social infrastructure. Competitiveness hence, will requires among other things, set of institutions that will ensure effective mobilization of both human and material resources, efficient allocation of these resources as well as introduce dynamism in policy issues, to sustain increases productivity and better socioeconomic outcomes.

Unfortunately, Africa has over the years been discredited as the worst continent in terms of technological advancement. However, today, there are overlapping challenges facing humanity resulting from the way we use the environment in order to advance technology. Modern technological advancement is a leading cause of environmental pollution, global warming and depletion of natural resources. With the current global sustainability developmental aspirations, appropriate technologies are required to achieve social inclusion and conserve the environment for intergenerational existence.

One of the basic requirements for sustainable development is cultural diversity. According to UNESCO (2010), cultural diversity builds social resilience, required for restructuring of the production process especially in developing economies to accommodate the use of local resources in a manner that will satisfy global needs appropriately, and equally serve as an antidote to the homogenizing impacts of globalisation. Restructuring in this manner have been described in the literature as glocalisation (see for instance Roudometof, 2015). Moreover, the guiding principle of the 2030 Agenda, 'leave no one behind', is a declaration of the plurality of the globe and the underlying demand to achieving global diversification.

It is in regards of the above sets of demand that the idea and advocacy to pursue indigenous technology development situates. The advocacy is imperative because indigenous technology requires mainly the use of resources in the surrounding environment to adopt those processes that are capable of ensuring socio-cultural and environmental security in the system. So, since every society

has its own fair share of natural resources, indigenous technology development potent multiple realities with similar socioeconomic and psychological results.

The researchers therefore argue that with the current accessorization of local knowledge development in the 2030 Agenda, the revitalization of indigenous technology in our local economies is fundamental to African to achieve competitiveness. Based on the foregoing, the rest of the paper is organized thus - section two covers the literature review by: explaining key conceptual issues in the paper, presenting the underpinning theories, and briefly exploring empirical facts, specifically on the effect of colonialism on African indigenous technology. Section three discusses the methodology. Data used for the study were presented and analysed in section four. Some policy recommendations are offered in section five while section six concludes the paper.

Literature Review

Conceptual Issues

Indigenous Technology

Bhagavam (1979), classified technology into two - indigenous (endogenous) and foreign (exogenous). Further in the literature, indigenous technology has been referred as technology that is: native, (Kim and Berry, 1993); unique to a given culture or society (Warren, Brokensha, and Slikkerveer, 1995; and Grenier, 1998); and transmitted by indigenous communities to their young in their cultural contexts (Siyanbola *et al.*, 2012). More concisely, the Asia Indigenous Peoples Pact (AIPP) submission to the 9th Session of the UN Permanent Forum on Indigenous Issues in April 2010, aptly described the principles behind indigenous technology and techniques as: 'do no harm' (conservation), 'take only what you need' (conservation), 'harvest only certain species' (selective), 'let nature decide' (in harmony with nature), and 'food security first' (well-being of community).

World Bank (2004) posits that, indigenous knowledge remains the foundation for decision making in all activities in the local communities and particularly in management of natural resources, preparation of food, health care delivery and education system, agriculture; and constitutes therefore part of the global knowledge for addressing the challenges of the poor (World Bank, 1997). Lovejoy (2013), holds that what is often considered to be modern science has to a large extent, developed in isolation from bodies of knowledge that were developed in non-western locations. Thus, what is referred to as modern technology could be said to be the resultant of a gradual transformation of indigenous technology.

Today the development of indigenous technology has resurged as a matter of urgent global imperative because the knowledge which constitute the modern technology applications have large detrimental

effects on human existence. In fact, Adefemi, Ilesanmi, Omohimoria, and Afolabi (2015), referred to indigenous technology knowledge as an engine for sustainable development. Thus, the concept of indigenous technology and techniques is rooted in indigenous communities' stewardship to nature - ensuring the sustainability of resources and being sensitive to community needs.

Glocalisation

Robertson (1997), defined glocalisation as the co-presence of both universalizing and particularizing tendencies. In a similar conception by Kraidy (1999), glocalisation is defined as the blending of global and local elements and perspectives. Since the introduction of this concept into the social and scientific discourse, substantial debate has continued to surround its suitability in describing production and other activities that manifest local complexes that intersect global networks.

Ritzer (2004) for instance, argues that the process targets at unilateral homogenization via overwhelmed local production. In Ritzer's view, any product that has global effect is better thought of as a mix of global and local, that is, as 'glocal'. Hence, his interpretation is that glocalisation is subsumed under globalisation. But Alexander (2003), argument for cultural autonomy, favours glocalisation. He analyzed the autonomy of glocalisation as a means of providing a foundation for using the concept vis-a`-vis other related concepts. In another argument for glocalisation, Roudometof (2015), explained that the emergence and the adoption of the concept is proper to ensure that local processes are not absorbed or destroyed by globalisation, rather, that it operates mutually with globalisation to shape the end result. He defined glocalisation as globalisation refracted through the local, in a manner that the mingling of global and the local nodes results in heterogeneous end state.

The above conceptualization by Roudometof (2015), fits in to describe glocalisation in relation to the current sustainable development concerns - a development process that underpins diversity so that no country will be left behind - hence the appropriateness of indigenous technology development. Glocalisation is seen in the efforts by multinational conglomerates to make their products suit local tastes and this will require local input to blend properly. On the other hand, countries will improve their competitiveness if local technologies are harnessed and developed to produce goods that can serve both local and global tastes adequately.

Theoretical Considerations

The study hinges its analyses on two theories: the endogenous growth theory and the sustainable development theory. Romer (1986), who pioneered the new growth theories asserts that endogenous technology, when added to physical

capital and labour, are the important factors contributing to economic growth; further that, continuous technological innovation and inventions are the strongest antidotes to the limits-to-growth literature.

Based on the endogenous growth theory, the United Nations Framework Convention on Climate Change (UNFCCC) in 2017, puts forward a perspective in the development context approaches, the endogenous development. The model is based mainly on generating and developing locally available resources, local knowledge, culture and leadership. It equally considers specific components such as openness to integrate traditional as well as external knowledge and practices; and considers important too, mechanisms for local learning and experimenting in order to build local economies and retain benefits in the local area.

This study equally considers sustainable development theory anchored in the Brundtland Commission Report of 1987 - a systems-based approach that seeks to understand the interactions which exist among the three pillars of development upheld by the Commission - (environment, social, and economic). In Klarin (2018), the core principles of sustainable development are outlined to include among other things, the rational use of natural resources, using renewable energy and innovative technologies to reduce the negative impact on the environment. Klarin's view is in line with Hawken (1993) natural principles that, nature depends on diversity, thrives on differences, and perishes in the imbalance of uniformity.

With regards to the underlying principles of the theories considered here, the study is concerned that: empowerment of local communities to take control of their own development process via revitalizing ancestral and local knowledge and innovations can help local people build their technological capabilities; selecting external resources that best fit the local conditions can help local economies attain international competitiveness.

African Indigenous Resources and Technology: A Historical Exploration

Before the colonial experience, indigenous technology was well expressed in Africa's local systems. Indigenous technologies such as craftsmanship, blacksmithing, weaving, basketry, pottery, art, aesthetics, and paintings were very crucial in defining history of ancient African society.

Gerdes (1994), studied the history of Mathematics in sub-Saharan Africa and found out that topics such as counting and numeration systems, mathematical games and puzzles, geometry and graphs are some of the evidences of early mathematical activities in Africa. In an exploration of past African indigenous knowledge and sciences by Emeagwali, and Shizha, (2016), they found out that the solar calendar that we use today

evolved from the Egyptian calendar of twelve months, calibrated according to the day on which the star Sirius rose on the horizon with the Sun. Ancient Egyptians also engaged in geometric problem solving including the principle of progressive doubling, the concept of square root, and quadratic equations.

Emeagwali (2016), studied African traditional medicine and observed that some common patterns and trends in medicine, such as: hydrotherapy, heat therapy, spinal manipulation, quarantine, bone-setting and surgery that are still relevant today have cultural and traditional ancestral links, some of which have undergone change over time. Emeagwali and Shizha (2016), equally identified some legumes, grain, vegetables, tubers, or, wild or cultivated fruits, that have medicinal implications for Africans and were used as anesthetics or pain killers, analgesics for the control of fever, antidotes to counter poisons, and anthelmints aimed at deworming, that today are being integrated within the contemporary pharmaceutical systems.

Childs and Killick (1993), study on indigenous African metallurgy identified various spheres of metal production, specific techniques and scientific principles were applied including: excavation and ore identification; separation of ore from non-ore bearing rock; smelting by the use of bellows and heated furnaces; and smithing and further refinement. Today, some of these various metal products still serve a wide range of purposes, including: armor (as in some northern Nigerian city-states), jewelry (of gold, silver, iron, copper and brass), cooking utensils, cloth dyeing, sculpture, and agricultural tools. The technical know-how and expertise of blacksmiths and goldsmiths still help to enhance their income status and otherwise.

On the other hand, Traub-Merz (2006), in his study of African textile and clothing industry, observed that the history of the African textiles industry dates back to pre-colonial times. Some city-states and empires became famous for particular types of cloth and product design. Interestingly, interactions with the prevailing value systems have helped to facilitate innovative techniques and product designs in textile production, such that some of the various types of indigenous African cloths are very much adorned within and outside Africa. Some of these cloths include: Sotiba (Senegal), Kente (Ghana), Adinkra (Ivory Coast and Ghana), Adire (starch resist fabric) and Aso Olona, title cloths of the Ijebu.

The foregoing shows that creativity and resilience characterised precolonial African communities. Sadly, colonial domination brought with it a shift in Africans understanding of production and consumption. The Europeans destabilized some of the existing processes of technical growth, undermined the indigenous manufacturing capability existing as at that time, and shifted agricultural

activities to cash crop production in order to facilitate European exports. Boahen, (1985) and Emeagwali, (2016), were specific that there were deliberate laws aimed at suppressing African indigenous technological development; such, the failure to recognize African contributions to science and technology according to Lovejoy (2013), demonstrates that conceptions that scientific knowledge have been racialized and that discoveries bear some correlation with the color of skin.

Some of the Asian countries have become famous through indigenous innovations. Kim (2011) for instance, while extoling the economic transformations in Korea and China, noted that, it was through putting adequate attention to local knowledge, Korea transited from imitating to innovating, while China made it to rank among the largest economy in the world today by developing the nation's indigenous technology. Today, the world is at a historic crossroads because, some policies to promote integration have resulted to excessive use of our natural resources. Hence, instead of depending solely on the market for solutions, African economies can become more innovative, by making some of the local products that are still in use become competitive, then efforts will be doubled to resuscitate effective indigenous practices that have become moribund, and the power of everyone in every society will be harnessed for sustainable resource management. In other words, it is envisaged that, rejuvenation of indigenous technology will play a major in achieving efficiency and equity goals in resource management with special regard to protecting the environment; while redistribution of wealth will lie in controlling land and resources, in controlling money creation, and in owning enterprise, technology and knowledge (not by raising taxes, increasing transfers, and implementing minimum wages).

Methodology

The paper adopts a comparative qualitative method. Data used for the study are collected from the following sources: firstly, the World Economic Forum (WEF) data for assessing overall competitiveness known as the global competitiveness index. The index is established on twelve pillars. These pillars are presented in table 1 below.

Table 1: The Global Competitiveness Index

Determinants	Enabling Environment	Human Capital	Markets	Innovation Ecosystem
Compass	*Pillar 1* Institutions	*Pillar 5* Health	*Pillar 7* Product market	*Pillar 11* Business dynamism
	Pillar 2 Infrastructure	*Pillar 6* Skills	*Pillar 8* Labour market	*Pillar 12* Innovation capability
	Pillar 3 ICT adoption		*Pillar 9* Financial system	
	Pillar 4 Macroeconomic stability		*Pillar 10* Market size	

Source: World Economic Forum, 2018

Secondly, data on Human Capital Index (HCI), sourced from the recently developed World Bank Human Capital Project were equally used because, investment in human capital is central to the development of any nation. Moreover, of all the twelve pillars identified in table 1 above, skills, innovation capability, business dynamism as well as ICT adoption are recognised as factors that will grow in significance as the paradigm of development continues to unfold for any country to be competitively relevance (World Economic Forum, 2018). But fundamentally, innovation, agility and resilience are further pushed by the skills acquired by the people of a nation. The Human Capital Index is a cross-country metric grounded on three pillars of - survival, health and school - to measures how much capital each country loses through lack of education and health (World Bank, 2018). Data on human development index as well as regional trade in Africa compared to other regions in the world equally constitute data used for analyses in this study.

The paper thus evaluates the performance of African countries on the above measures among others, bearing in mind that positive link between labour and technology in the endogenous growth model. It is argued here that, as much as the rising needs for global competitiveness remain technological, globalisation does not limit the chances of low income countries to become competitive if human capital within a nation is developed. UNCTAD (2003), equally emphasized that countries do not need to depend entirely on free markets to be more globalised; while Lall (2001) and Stiglitz (2002), maintain that in an innovation-driven global economy, competitive success requires strong domestic competencies. The following are analyses assesses some of African economies efforts towards attaining competitiveness.

Data Presentation and Analyses

State of Africa's Competitiveness

Africa Technology Hub Landscape

The Global System for Mobile Communication Report of 2018, records that there are 442 active tech hubs across Africa, with South Africa (59 active hubs), leading, Nigeria follows with 55, Egypt (33), and Kenya (31). This represents a 41% jump from 2017 to 314 tech hubs. Democratic Republic of Congo, Zambia, Cote d' Ivorie, Togo and Nigeria are among the fastest growing ecosystem between 2016-2018 with +200, +200, +160, +150 and +139 hubs respectively. Kenya's the Silicon Savannah, is home to the most cutting-edge startups on the continent. Africa's lack of formal infrastructure has served as a catalyst for the country's technological explosion. As one of the fastest growing economies in Sub-Saharan Africa, Kenya has laid out an ambitious plan to become an upper middle-income country by 2030. Ghana and Cote d'Ivoire have experienced a significant growth in the number of active tech hubs. Since 2016, the Ghanaian ecosystem has grown by 50% (from 16 to 24). Similarly, Abidjan in Cote d'Ivoire has gradually positioned itself as the new catalyst of innovation across Francophone Africa and has seen its number of active tech hubs double. Zimbabwe (13) and Uganda (16) led the way in 'tier 2' ecosystems in Southern and East Africa respectively.

Competitiveness Index

Unfortunately, despite these notable technological breakthroughs in Africa, the Global Competitiveness Report of 2018 shows that African countries continue to perform poorly. Sub-Saharan Africa, with an average score of 46.2, has the lowest GCI score among all regions and demonstrates the weakest average regional performance on 10 out of the 12 pillars as indicated in table 1 below.

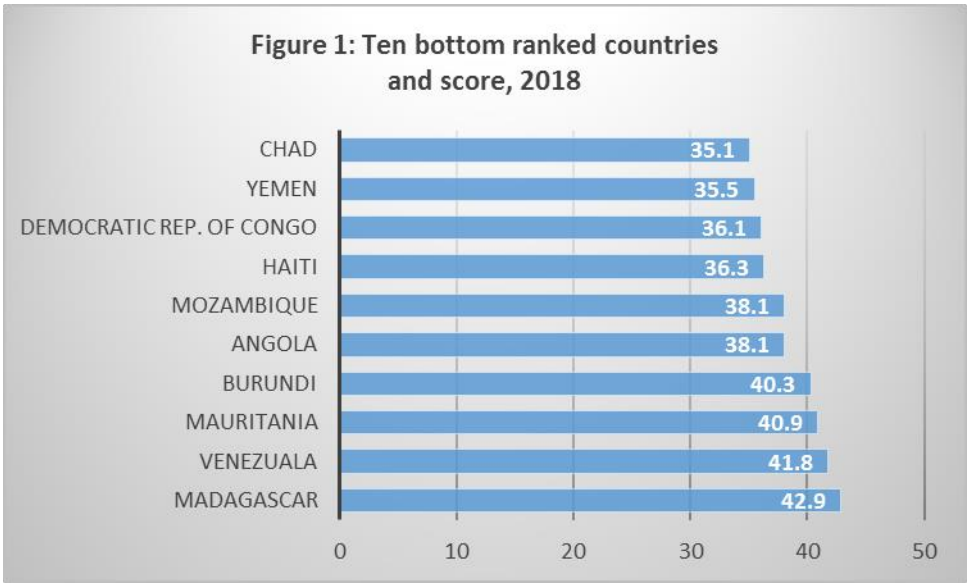
Table 2: Regional performance, by pillar Average score (0–100)

	Enabling Environment				**Human Capital**		**Markets**				**Innovative Ecosystem**	
Region	Institutions	Infrastructure	ICT Adoption	Macroeconomic Stability	Health	Skills	Product market	Labour market	Financial System	Market size	Business Dynamism	Innovative Capabilities
East Asia and the Pacific	61.6	74.3	67.3	88.9	84.3	66.9	62.2	65.9	72.8	67.2	65.7	52.9
Eurasia	53.0	66.3	57.1	71.7	73.4	65.6	57.1	61.6	50.8	49.8	60.1	34.8
Europe and North	64.5	78.7	68.0	91.8	90.7	74.2	62.0	66.2	69.5	59.6	68.3	58.1

America												
Latin America and the Caribbean	47.8	61.1	46.4	74.0	82.7	57.5	53.9	55.3	59.5	52.5	52.4	33.8
Middle East and North Africa	54.3	69.0	54.1	79.6	80.0	61.4	54.7	52.3	61.8	60.3	56.7	39.9
South Asia	50.1	59.6	33.0	74.1	68.4	49.7	47.3	51.7	59.0	66.9	56.5	36.4
Sub-Saharan Africa	47.5	46.3	29.6	66.9	48.0	43.4	50.4	53.8	50.4	38.8	51.1	28.4

Source: World Economic Forum analysis, 2018

Mauritus and South Africa at 52nd and 60th positions respectively are the most competitive economies in Africa. Nigeria is at 116th with 48.3%. Figure 1 below equally shows that seven out of the least competitive economies in the world are in sub-saharan Africa.



Source: World Economic Forum analysis, 2018

The Forum equally noted that even the best performers in low-income countries in Africa are still lagging behind. Kenya, for instance, underperforms on most of the five sub-pillars (World Economic Forum, 2018). The Forum maintained that innovation requires stable conditions—such as well-established institutions, extensive ICT adoption, domestic market competition and a favourable education system. In other words, technological breakthroughs will be achieved and sustain

when there are strong institutions to develop human capital and markets that will spur innovations.

Human capital index for selected countries

Table 3 below is on human capital index. It presents a comparative analysis for some selected countries: the top three performing countries, the best performing countries in Africa and the overall least performing countries, all in term of HCI.

Table 3: Human Capital Index of Selected Countries (2018)

Rank	Country	Score
1	**Singapore**	**0.88**
2	**South Korea**	**0.84**
3	**Japan**	**0.84**
43	Seychelles	0.68
52	Mauritius	0.63
93	Algeria	0.52
154	Mali	0.32
155	**Niger**	**0.32**
156	**South Sudan**	**0.30**
157	**Chad**	**0.29**

Source: World Bank, 2018

The Human Capital Index ranges between 0 and 1. It measures the human capital that a child born today can expect to attain by age 18, given the risks to poor health and poor education that prevail in the country where she lives. Obvious from table 2, only the Island of Seychelles was the only African country that came out in the top 50 countries with an index of 0.68. Mauritius is at the 52nd position with an index of 0.63. In fact, the two countries are the only African countries that rank above the worldwide average of 0.57. The next African country closest to these countries are Algeria and Kenya, at 93rd (0.52) and 94th (0.52) respectively. Eleven sub-Saharan African countries were positioned from 146th to 157th, to rank lowest. Nigeria was at the 152nd position while Chad was the lowest at 157th.

The facts above are comparable to the human development index assessment contained in the Human Development Report of 2019. The report shows that the three countries that ranked top in the HCI equally are ranked in the category of the countries with very high human development. Specifically, out of 189 countries assessed, Singapore is ranked 9th with an index of 0.935; Japan 19th (0.915) and the Republic of Korea (North Korea and South Korea), 22nd (0.906). The only African country with very high human development was

Seychelles with human development index of 0.801 and at 62nd position. All the African countries with the least HCI also are countries with low human development (UNDP, 2019).

State of regional trade in Africa

Nationality of a product

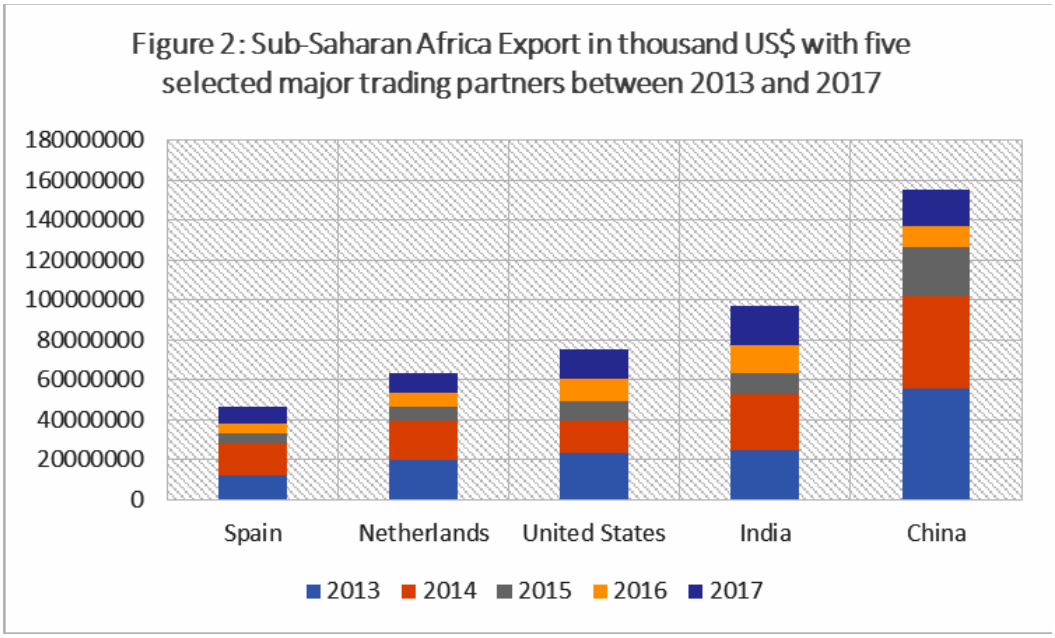
In trade, there are evidences that Africa's productive base still lags behind most of the regions. For instance, the Economic Development in Africa Report by United Nations Conference on Trade and Development (UNCTAD), tagged 'rules of origin'- the criteria needed to determine the nationality of a product- presents improvements in Africa's trade relations as compared with other regions. The summary is presented thus

- Total trade from Africa to the rest of the world averaged US$760 billion in current prices in the period 2015–2017, compared with $481 billion from Oceania, $4,109 billion from Europe, $5,140 billion from America and $6,801 billion from Asia.
- Intra-African exports were 16.6% of total exports in 2017, compared with 68.1% in Europe, 59.4% in Asia, 55.0% in America and 7.0% in Oceania.
- Intra-African trade, defined as the average of intra-African exports and imports, was around 2% during the period 2015–2017, while comparative figures for America, Asia, Europe and Oceania were, respectively, 47%, 61%, 67% and 7%.
- In 2016, intra-regional economic community trade was highest in SADC ($34.7 billion), followed by CEN–SAD ($18.7 billion), ECOWAS ($11.4 billion), COMESA ($10.7 billion), AMU ($4.2 billion), EAC ($3.1 billion), IGAD ($2.5 billion) and ECCAS ($0.8 billion).
- With regard to the share of intra-regional economic community trade in total trade in Africa, in 2016, there were deeper levels of integration in SADC (84.9 per cent), followed by COMESA (59.5 per cent), CEN–SAD (58.4 per cent), ECOWAS (56.7 per cent), AMU (51.8 per cent), IGAD (49.0 per cent), EAC (48.3 per cent) and ECCAS (17.7 per cent). (UNCTAD, 2019).

Sub-Saharan Africa Export

In another result on Sub-Saharan Africa Export to selected major trading partners in figure 2 below, it is evident that among the five Sub-Saharan major trading partners selected, the volume of exports from the region's exports to China within the period under review was highest on both the annual and cumulative basis. However, this volume of export continued to decrease from 2013 to 2017. The Chinese rekindled interest in their indigenous technology could be used to explain this. This is a sign that the

utilization of potential indigenous technology in the continent is bound to place it in vantage position for global competiveness.



Source: UNCTAD, 2018

Policy Recommendations

To inform policy decision to African government and other relevant stakeholders, the study recommends the following:

i. Institutional reforms are urgently needed in African economies for effective mobilization and efficient use of resources. Weak institutions in Sub-Saharan African countries equally subjugates good governance, which dearth in African democratic States. Institutional reforms needed should be elastic to encourage people to avail economic opportunities that could further lead higher standard of living. The rules of the game in the desired institutional reforms should be sacred, so that incentives are given to individuals as well penalties are slammed at defaulters on the same scale irrespective of their status or societal class.

ii. Urgent reforms are needed in African education system, to transform African communities. Sustainable development issues should be mainstreamed into teaching and learning process in the region. In this regard, education curricula at all levels of education in the continent

should be prepared to place indigenous principles at the centre of learning especially in the core subject of science, engineering and mathematics to equip students with knowledge, skills, values and behaviours needed to shape the future we want. Particularly, indigenous African languages will serve as important tools for communication, dissemination of information, sharing of knowledge, and acquisition of skills to ensure that people at all levels participate appropriately in the development process. For instance, in the informal African economy, which is dominated by rural dwellers who are mostly illiterates, using their own languages for agricultural, commercial and other economic activities is crucial to revive potent indigenous practices in their field of endeavour, and develop such practices in a manner that will meet global standards.

iii. Well-developed infrastructure should be put in place to provide the platform for technological capabilities that will generate indigenous innovations. Infrastructure such as inter alia good road networks and access to affordable energy sources are key to transforming African rural communities into technological hubs.

Conclusion

Technology drives competitiveness, but the current position of Africa is unappealing. Although colonial experiences of African countries may have impeded technological development in the region, indigenous technology and innovation today have been centralized as suitable antidotes for the damaging effects of unsustainable technologies. More importantly, some of the countries that have attained international competitiveness today achieved that by setting up machineries that promote their indigenous innovations. Particularly, strong institutions and formidable infrastructure, create the enabling environment in such countries for human capital to drive innovation for socioeconomic successes these countries continue to record. So, efforts made by African countries to attain international competitiveness have not produced significant results because of the prevailing low level human capital that is requisite for effective mobilization of resources and innovation in the region. The low level human capital obviously results from the absence of strong institutions that will galvanize other pillars of competitiveness. Drawing from these, the development of indigenous technology no doubt will promote the use of local resources and launch African economies into the global market for increased competitiveness. However this will be made possible when existing institutions that promote effective

mobilization of local resources for production are strengthened and reforms to adopt policies and rules that will lay emphasis the local production using local resources are pursued.

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