Regional Peace through Collaborative Engineering driven by the African Union Aspiration 2063

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***Abstract* -The African Union Agenda 2063 is a strategic framework for the socio-economic transformation of Africa over the next 50 years that seek for a peaceful, prosperous and integrated Africa. Africa has largely been successful in solving its political conflicts using African peace keepers; however, Africa has not been able to use her engineers in solving Africa infrastructure challenges and developmental problems. About 32% of active African Higher Education Institutions run engineering programmes but they hardly work together on African infrastructure and developmental issues.**

As identified in the African Engineering Dean's Council (AEDC) Summit in 2017, Africa must solve Africa problems but there seems not to exist specific policy framework to encourage African engineers' collaboration to solve African infrastructure and developmental problems which promotes regional peace. The little collaboration that exists are divided alone their national languages of English, French, Portuguese and Arabic.

This paper brings in the context of the African Union Aspiration 2063 in regional collaborative engineering research that promotes regional peace and recommends proactive agenda for accelerating sustainable development in a systematic and self-reliant manner through collaborative engineering.

Keywords—Peace Engineering; Collaboration; Higher Education Institutions; Community Development, Africa Union Agenda 2063

I. INTRODUCTION: THE AFRICAN UNION AGENDA 2063 ASPIRATION

The African Union Agenda 2063 is a strategic framework for the socio-economic transformation of the continent over the next 50 years. Its builds on and seeks to accelerate the implementation of past and existing continental initiatives for growth and sustainable development. Some of the past and current initiatives it builds on include: the Lagos Plan of Action, the Abuja Treaty, the Minimum Integration Programme, the Programme for Infrastructural Development in Africa (PIDA), the Comprehensive Africa Agricultural Development Programme (CAADP), the New partnership for Africa's Development (NEPAD), Regional Plans and Programmes and National Plans. It is also built on national, regional, continental best practices in its formulation [1] [2].

Of the 17 United Nations Sustainable Development Goals (SDG), goals No 3, 6 to 9 addresses sustainable development of resilient infrastructure for agriculture, water, sanitation, health and modern energy [9]. Similarly, the first aspiration of the African Union (AU) in their Africa 2063 Agenda is to be a prosperous Africa based on inclusive growth and sustainable development [1]. The Agenda believes that this will be achieved using African resources and Africa driving its own development, for a high standard of living, sound health and well-being, well-educated citizens with skills underpinned by science, technology and innovation with Africans having access to necessities of life including shelter, water, sanitation, energy, public transport and ICT as well as modern agriculture for increased productivity.

II. METHODOLOGY

In the "Webometrics Ranking of World Universities" of January 2017, the Cybermetrics Laboratory, a research group belonging to the *Consejo Superior de Investigaciones Científicas* (CSIC) listed 1,522 active Higher Education Institutions (HEI) for Africa [7]. Through visit to each of the 1,522 HEIs' websites listed as well as direct contacts of African Deans of Engineering, the universities offering engineering programmes were identified and analysed. To identify the reasons for low industry-academia partnership in Africa, an online survey, supported by the Manufacturers Association of Nigeria, was conducted between January and June 2017 on the *"Actualising Industry-Academia Partnership in Africa"*[5]. Also, interviews and discussion with some African leaders and Deans during the AEDC 2017 summit and interviews with North African Engineers during a conference in Morocco were conducted to get a consensus on collaboration between African Engineers. Secondary data were obtained from various financial and social statistics for Africa [12].

III. RESULTS

Africa is divided in five groups politically and economically, namely, North Africa, Western Africa, Central Africa, Eastern Africa and Southern Africa and three grouping by language, namely, Anglo-phone, Franco-phone and Portuguese speaking (figure 1). Training of Engineers and

engineering collaborations appears to be divided along language lines.

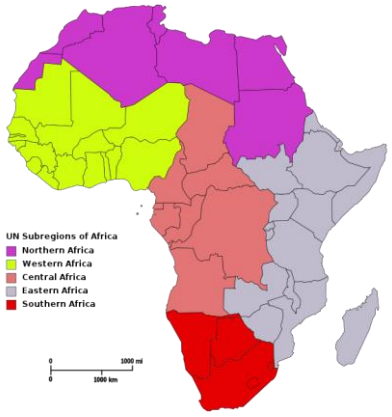

Figure 1: Economic and Political Grouping of Africa

The summary of engineering universities and Gross Domestic Products for the five African sub regions are shown in Table 3 and 4 while the grouping based on language is shown in Table 5. Profile of respondents to the online survey is shown in the Tables 1 and the survey can be accessed from [5]. Table 2 lists the major reasons identified for low industry-academia partnership in Africa.

Table 1: Profile of Online Questionnaire Respondents to the Actualisation of Industry-Academia Partnership in Africa

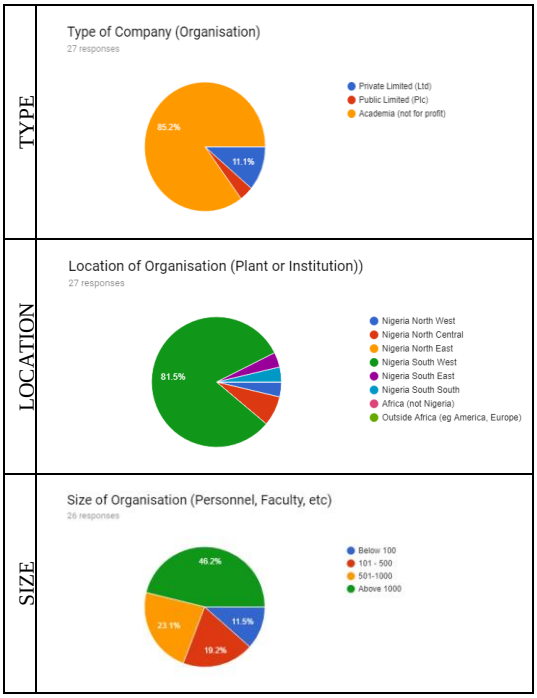

Table 2: Reasons for low industry-academia partnership in Africa

Questions on Areas of Concern	Reasons with highest Agreement
a. What is your opinion on lack of relevance of University research?	• Research topic selection not driven by relevance
b. What is your opinion on research methods of University for Industry?	• Running a flexible research project/method is challenging • Research in its nature is risky
c. What is your opinion on lack of training, experience, and skills of University Graduates?	• Deficiencies in skills of practitioners to work with the research solution
d. What is your opinion on lack or drop of interest/commitment?	• Lack of commitment to invest money
e. What is your opinion on mismatch between industry and academia?	• Different interests and objectives
f. What is your opinion on human and organizational factors?	• Difficulties in training practitioners due to high training cost and lack availability of time due to market pressure
g. What is your opinion on management-related issues?	• Lack of willingness to put high investment in time/effort
What is your opinion on resource-related issues?	• Lack of resources due to high investment in terms of resources (people's time and effort) both from industry and academia side
h. What is your opinion on contractual, and privacy concerns?	• Intellectual property rights and privacy limit access to data
i. Human Capital Development: In scale of 1-5 what will the following actions do to develop a strong educational system that will produce technical skills required by the manufacturing sector?	• Effective funding of research institutions (both tertiary and specialised) by government. • Outcome-based engineering education with emphasis on Industry & Innovation

Africa today, largely depend on the support of donor institutions such as the world Bank and countries such as China. In their study, [8], theorises on funding of African projects through the exploit-or-avoid duality. Their inductive study examines a duality in the design of organisations in emerging markets by grounding their research on a sample of project organisations set up to develop basic public transportation assets in Sub-Saharan Africa and India. All capital projects were financed by loans provided by development agencies - the institutional intermediary between the state and the contractors. When the intermediary is a "traditional" donor (e.g., World Bank), the project organisation grows step-by-step and transparently. When an "emerging" donor is involved (e.g., China Eximbank), the growth of the project organisation is fast-tracked and opaque. Project financing by China in some African countries is presented in Table 6.

TABLE 3: NUMBER OF ENGINEERING UNIVERSITIES IN AFRICA, 2017 [4]

Africa Region	HEI Offering Engineering Programmes	Engineering Programmes	HEI Offering Engineering Programmes	Engineering Programmes
Central Africa	15	90	3.17%	3.72%
East Africa	86	404	18.18%	16.68%
North Africa	201	959	42.49%	39.60%
Southern Africa	75	394	15.86%	16.27%
West Africa	96	575	20.30%	23.74%
Engineering Total	473	2422		
Africa Universities	1522	31.08%		

TABLE 4: NUMBER OF ENGINEERING UNIVERSITIES IN AFRICA, 2017 [4]

Africa Region	Countries	Engineering Universities	GDP ($Billion)	GDP Percentage
CENTRAL AFRICA	4	13	202	9.46%
EAST AFRICA	10	92	308	14.44%
NORTH AFRICA	6	218	655	30.75%
SOUTHERN AFRICA	7	71	420	19.73%
WEST AFRICA	13	96	546	25.62%
ENGINEERINGTOTAL	40	**490**	2131	**100.00%**

TABLE 5: NUMBER OF ENGINEERING UNIVERSITIES IN AFRICA, 2017 [4]

Africa Regions	English	French	Portuguese & Arabic
CENTRAL AFRICA	0.00%	69.23%	30.77%
EAST AFRICA	94.57%	5.43%	0.00%
NORTH AFRICA	7.80%	88.07%	4.13%%
SOUTHERN AFRICA	92.96%	7.04%	0.00%
WEST AFRICA	88.33%	16.67%	0.00%
Total	**51.02%**	**46.33%**	**2.66%**

TABLE 6: LARGE CHINESE FINANCED ENGINEERING PROJECTS IN AFRICA [6]

Country	Projects
Angola	**Lobito-Luau railway in Angola**: In February 2015, a 1,344-kilometers railroad project spanning Angola was completed and put into operation. The line, built by China Railway Construction Corporation Limited, boasts the fastest traveling speed in Angola and serves as a significant economic corridor in the country. The railway, linking the coastal city of Lobito in the west and Luau city that borders the Democratic Republic of Congo, is the second longest railway built by a Chinese company for Africa after the Tanzania-Zambia Railway.
Ethiopia	**Addis Ababa Light Rail Transit (AA-LRT) in Ethiopia**: The electrified AA-LRT was the first light railway in Africa with two lines with a total length of 34 km. The project, built by China Railway Group Limited, became operational in September 2015. The rail service, estimated to transport about 60,000 passengers per day, helps ease people's travels in the Ethiopian capital.
Tanzania	**Kigamboni Bridge in Tanzania**: The bridge, built by China Railway Construction Engineering Group and China Railway Major Bridge Group, was inaugurated in the commercial capital of Dar es Salaam. The 680-meter-long bridge, the first of its kind in eastern and central Africa, connects Dar es Salaam's business district with Kigamboni Creek. The bridge, 32 meters wide, has six lanes, three in each direction. It also has two 2.5-meter-wide pedestrian and cyclist lanes, one on each side. The $135 million project funded by the Tanzanian government and the National Social Security Fund is expected to contribute to the country's economic growth.
Nigeria	**Abuja-Kaduna railway in Nigeria**: The railway, built by China Civil Engineering Construction Corporation, covers 186.5 km and

	links the capital city of Abuja and the northwestern state of Kaduna. It has nine stations and a designed speed of 150 km per hour. Built in 2011, the railway became operational in July 2016. It is part of Nigeria's railway modernization initiative aimed at replacing the existing narrow-gauge system with the wider standard gauge system while allowing high-speed train operations on the railway network.
Kenya	**Garissa power plant**: To encourage renewable energy and support the alleviation of poisonous gas emissions, China and Kenya jointly launched the construction of a 50-megawatt PV power plant in Northeast Kenya's Garissa County in September 2016. The project was financed by the Export-Import Bank of China, which provided a concessional loan of 13 billion KES ($135 million) for the largest PV power plant in East Africa. According to the project's Chinese contractor, China's Jiangxi Corporation for International Economic and Technical Cooperation (CJIC), the plant, upon completion, will generate more than 7,600 kilowatt-hours of power each year and reduce a yearly carbon dioxide emission of 64,190 metric tons.

IV. DISCUSSION

There is strong relation between creation of a critical mass of educated and skilled engineering and science graduates and economic and social development. It is therefore very important that efforts should be made to build these capacities in developing countries, Africa inclusive. This is one of the conclusions reached by both UNESCO and the World Federation of Engineers (WFEO) [10]. Paradoxically, the embrace of engineering education in Africa is abysmally low. Out of the 1,522 HEIs studied only 473 or 31% offer engineering programmes. North Africa has the highest density of HEIs with Engineering programmes. North Africa has 201 (42%) of the engineering universities in Africa, followed by the West Africa with 90 (20%) and East Africa with 86 (18%). African countries with over 50 engineering HEIs are Tunisia (64), Morocco (63), Nigeria (58) and South Africa with (56). See Tables 1.

There are several issues that are militating against regional collaboration of Engineers in Africa. Firstly, facilities for teaching and research in Engineering are expensive and limited. There are limited industries for hands-on training of engineering students and cost of procuring foreign exchange for laboratory equipment in African countries is usually high. This discourages African Governments and Educational Proprietors in establishing engineering programmes in their HEIs. Less than a third of the HEI in Africa run Engineering Programmes

Secondly, Industry-Academia partnership and by extension Government-Academia partnership is almost non-existent for government projects. In fact, in many countries, the academia and government are always at log ahead with resulting strikes and lockouts. In some countries Universities are shut down by Governments for months with consequent disruption to academic activities. Major projects in Africa have very little participation of the academia in the implementation.

Thirdly, Africa is riddled with so many languages from the colonial past. Apart from the several hundred African languages, Africa is fragmented into English, French, Portuguese and Arabic clusters of countries with little economic and technological integration (see table 3)

V. CONCLUSION AND PROACTIVE ACTION

In concluding, to foster regional peace through collaborative engineering driven by the African Union aspiration 2063 Africa must pursue regional engineering collaboration between HEIs, Industry-Academia partnershps, give priority to technology and engineering education and language integration.

The African Union Agenda 2063, echoes" the *Pan African call that Africa must unite to realise its Renaissance. Present generations are confident that the destiny of Africa is in their hands, and that we must act now to shape the future we want".* This implies effective collaboration in capacity building, research and development in Africa, the multiplicity of languages notwithstanding. Today we see very little joint university engineering education, research and development in African HEIs as we have in Europe and the Americas.

The aspiration of the African Union Agenda 2063, *that Africa shall be a prosperous continent and that cities and other settlements must be hubs of cultural and economic activities, with modernized infrastructure, and people have access to all the basic necessities of life including shelter, water, sanitation, energy, public transport and ICT*, requires dedicated focus on the adoption of technology in agriculture, water quality management, housing and healthcare delivery.

For a proactive action, the following recommendations are presented. They are:

- From the colonial past Africa has four main European languages, namely, English, French, Portuguese as well as Arabic. English in the Western, Eastern and Southern sub-regions, French in the Western and Central sub-region,

French and Arabic in North African sub-region and Portuguese in Central and Southern sub-regions. All HEIs must include mandatory learning of at least two of these four languages.

- HEIs should encourage joint research and development across language zones. For example, in West African sub-region very little international education and research exists between the Franco-phone and Anglo-phone countries. Student exchange must be a compulsory feature of engineering education in Africa. The African Union must play a crucial role in creating the enabling environment to actualise these through Grants and Protocols.

- The shift from input-based to outcome-based education in favour of technology based programmes should be implemented. In Africa out of the 1,522 HEIs studied only 473 or 31% offer engineering programmes. Industry-Academia partnership and Government-Academia partnership must be strongly encouraged and, in many cases, mandatory in the training and execution of public projects.

- Specifically, regional collaborative application of engineering practices in agriculture, water management and healthcare delivery, must be made a priority in the African Union pan-African programmes.

    - In Agriculture, engineering advances is contributing in tackling some agricultural production including optimizing the use of inputs by selective delivering at very high precision, long-term autonomy and navigation in the farm, orchard, crop production, nurseries and greenhouses.

      African countries like Egypt, Morocco, Ethiopia, and Algeria were known to produce wheat. Nigeria, South Africa, Tanzania, Burkina Faso, Ethiopia, Egypt, Mali produced coarse grains. Countries like Malawi, Zambia, Kenya, Uganda, Egypt, Ethiopia, Nigeria, Zimbabwe and South Africa were recognized for corn production. Ethiopia, Morocco, Algeria, Tunisia, South Africa produced barley. Oat production was peculiar to Algeria, Morocco and South Africa. Sorghum production was popular among most countries in Africa. Only three Africa countries namely Egypt, Madagascar and Nigeria were known for rice production [10]. Despite having best climatic condition, Africa has not been able to produce agricultural products enough to eradicate food insecurity and hunger in the continent. Engineers from various fields should come together and treat the problem of food insecurity and hunger in Africa as continental challenge rather than country level challenge.

    - In the water industry, we have that: Engineers design, integrate, construct and test the technological, electrical and mechanical components to produce a working system, such as a water pumping or treatment plants. Engineers are responsible for ensuring the proper functioning of a control and monitoring system to guarantee 24-hour, 7-day maintenance of water quality.

    - In healthcare delivery, mechatronics has become important in the efficient delivery of primary, secondary and tertiary healthcare delivery systems. Recently, the scourge of the deadly Ebola virus in West Africa has activated lots of research and innovation in the containment of deadly infectious diseases, such as development of tele-operated semi-humanoid robot for disease containment [3].

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