

Developing Countries and the Need for Building Engineering Capacity

Emmanuel Emem-Obong Agbenyeku, Edison Muzenda and Innocent Mandla Msibi

Abstract— In the global fight for additional world security, stability and sustainability, the need for enhancing human, institutional and infrastructure capacity in developing countries is insistently of dire concern. To enhance the respective capacities, a concrete structure of technologically equipped people to efficiently advance their economies, quality and standard of living are drastically required. Such type of structure will enable the mixture of foreign capital via pulling in transnational corporations and establishments to invest in the developing country, aid in making the most of international aid funds, and offer a basis for business development by indigenous entrepreneurs. For these reasons, the United Nations Educational, Scientific and Cultural Organization (UNESCO) and World Federation of Engineering Organizations (WFEO) are intensifying key efforts in developing countries as a synchronized approach towards technical capacity building. The paper therefore unpacks some basic attempts and outcomes by UNESCO and WFEO in empowering competent engineering and science graduates/ engineers towards building a sustainable circular economy.

Keywords— Education, Capacity, Infrastructure, Sustainability

I. INTRODUCTION

IT is generally accepted that building the technical capacities of developing countries through engineering education programs and flagships can efficiently enhance the quality of their workforce and effectively gear the countries towards a path of sustainable economic growth and development. Numerous pathways channeled towards sustainable economic growth and development can be provided by a capable and knowledgeable technical workforce base via;

- a) Attracting technically inclined transnational and multi-national establishments who can invest successfully and enormously in the developing country in question once a team of qualified local employees are available.
- b) Effectively employing foreign aid funds and discharging a legacy of appropriate infrastructure

projects, and technically proficient people to operate and maintain them.

- c) Introducing and engaging small business initiatives by technically inclined entrepreneurs.

As such building a circular economy together in today's global economic stance, a very crucial platform is to be laid on an existing foundation which says; "Give a person fish: you have fed the person. Teach a person to fish: you have fed the person for a lifetime". This may not be sufficient in today's dynamic world. Therefore, the added platform says; "And: teach the person how to process, package, export and market fish: and you have triggered a sustainable economic growth and development".

A. Capacity Building

In the struggle for building a circular economy, the need for capacity building cannot be overlooked as this is a commitment to the solidification of economies, governments, institutions and individuals through education, training, mentoring, and the nexus and infusion of resources. The key purpose of capacity building is to develop secure, stable, and sustainable structures, systems and organizations, with specific importance on using motivation and inspiration of/ for people to progressively and positively advance the standard and quality of their lives. The perceptions and expectations on engineers is myriad and differs from place to place. Nevertheless, engineers are a vital component of any society as they play a major role in the overall economic development of countries and regions, particularly, in today's global economy.

In first world countries, the role of engineers and their contributions to economic growth and development is well understood, utilized and appreciated. However, in much of the developing/ third world countries, the vast numbers of available and ideal engineers/ engineering talents are characteristically below acute mass. The economic development and even important basic societal needs that rely on engineering such as; clean water supply, power supply, energy conservation, waste management and sanitation lack the technical capacity to deal with them. Therefore, technical capacity building efforts are pointed at developing and equipping an adequate number of well-educated and certified engineering graduates in

Manuscript received March 0, 2016; revised March 0, 2016; submitted for review April 15, 2016.

Emmanuel Emem-Obong Agbenyeku is a research student at the University of Johannesburg, South Africa (phone: +27 11 559 6396; e-mail: kobitha2003@yahoo.com; emmaa@uj.ac.za).

Edison Muzenda is a Professor of Chemical and Petroleum Engineering and Head of Department of Chemical, Materials and Metallurgical Engineering, College of Engineering and Technology, Botswana International University of Science and Technology, Private Mail Bag 16, Palapye, Botswana, as well as

visiting Professor at the University of Johannesburg, Department of Chemical Engineering, Faculty of Engineering and the Built Environment, Johannesburg, P.O.Box 17011, 2028, South Africa (phone: +27 11 559 6817; e-mail: emuzenda@uj.ac.za; muzendae@biust.ac.bw).

Innocent Mandla Msibi is Group Executive of Innovation and Impact, Water Research Commission, Pretoria; Research and Innovation Division, University of Johannesburg, South Africa (phone: +27 12 330 0344; e-mail: mandlam@wrc.org.za).

developing countries towards achieving desirable results such as:

- i. Engaging efficiently through technical capacity in the global economy; direct overseas investment, international trade, mobility of graduate engineers, and the flow of work to countries with cost-effective talent.
- ii. Insuring that foreign aid funds are employed effectively and resourcefully towards initial project implementation, long-term operation and maintenance, and for the development of capacity to execute future projects through indigenous science and technology capacity. Such that, an adequate number of engineers can assist a developing country in effectively addressing the United Nation's Millennium Development Goals (UN's- MDGs), i.e., poverty alleviation, food security, safe water, waste management and sanitation amongst others.
- iii. Providing platforms for job creation in developing countries through a number of technical workforce composed of people specifically educated, trained and prepared to entrepreneurs as well as engage in entrepreneurial initiatives in order to satisfy local demands.

More so, the WFEO through its Committee on Capacity Building, is dedicated to assisting developing countries to engage effectively in the global marketplace via technical capacity building.

II. PREVIOUS ATTEMPTS AND OUTCOMES

A study of the outcomes of international aid to developing countries in yesteryears as recorded by [1] highlights the following:

- a. Previous attempts have made efforts to utilize international aid, investment in machines, fostering education at the primary and secondary levels, controlling population growth, and giving loans and debt relief, conditional on reforms to trigger and propagate economic growth and development in these countries while allowing them be self-sustained and -sufficient.
- b. Unfortunately, most if not all of these attempts and efforts for many years have remained futile in all ramifications, including in the much needed economic growth and development.
- c. More to this, the enormously costly inputs have been unsuccessful due to failure to address the essential human behavioral chord that "people respond to incentives".

Furthermore, the author noted a few points which are most plausibly to work, considering that previous attempts and efforts geared towards encouraging economic growth in developing countries have failed. The author posits two areas that can possibly trigger and propagate the much needed

economic growth in developing countries while permitting economic self-sustenance and -sufficiency:

1. Utilization of advanced technologies, and
2. Education that leads to high technological proficiencies.

Nevertheless, the pursuits on health and basic relief needs must continue while critically looking for ways and strategies to end the cycles of poverty via propagating developmental and stronger competitive economies that can key into world business stage. Building and empowering an adequate number of locals from every society in developing countries with quality education in science, technology and engineering can foster economic growth and healthy economies.

For instance, a look at South Korea and India show the positive impact of intensive efforts to improve the education of engineers and technology graduates which invariably affect their economic growth and development. During the meeting of the American Society of Civil Engineers in 2004, the South Korean delegation to the Capacity Building Forum presented the outcomes of South Korea's investment over a period 30 years to be resultant of the quality and number of engineering graduates/ engineers. It is therefore pertinent to note that in 1970 South Korea had about 6,000 engineering graduates which increased to 14,000 in 1980, and by 1990 the number had risen to roughly 80,000 as recorded by [2]. Plotting this number against South Korea's per capita Gross National Product (GNP) growth shows that the number of engineering graduates is almost directly proportional to the growth of the South Korean economy, counterbalanced by a few years. This data is somewhat a clear indication showing the direct relationship between input and output which in this scenario reveals that investing in producing well-qualified and adequate numbers of engineers lead to sustainable economic growth and development.

There is no argument that China is clearly a major economic power. It is important to note that according to [3] in 2001, the proportion of first science and engineering degrees to all bachelors-equivalent degrees was 59% as against roughly 33% in the USA. Also, a report by [4] stated that: "Excellence in science and engineering higher education helps a country to be technologically innovative and economically competitive."

Whereas, in India there has been a long-term effort to increase the numbers of engineering graduates and the quality of their education. Although from years ago, most of these graduates pursued greener pastures abroad. Presently, most of them in diaspora are returning and newer graduates are staying to work in India. This trend is highly noticeable in the software and design industries, and often to high-tech cities where lucrative and attractive career opportunities and vast experienced numbers of indigenous employees are contributing immensely to India's economic growth. The insistent growth and empowerment of large pools of technically competent and well-educated specialists has placed India at a point where it has become a major setting for outsourcing technical support by the leading global technology corporations.

III. UNESCO AND WFEO TOWARDS A CIRCULAR ECONOMIC GROWTH

Considering the dire need to build a crucial pool of educated and competent engineering and science graduates/ engineers particularly in Sub-Saharan African countries and generally in developing countries, intense efforts are to be invested in technical and capacity building. This basically one of the mandate of both UNESCO and WFEO. The WFEO was initiated under the umbrella of the UNESCO in 1968 in Paris and is a non-governmental international organization that brings together national engineering organizations from over 90 nations and represents some 8,000,000 engineers from around the world [2]. WFEO is the worldwide leader of the engineering profession and co-operates with national and other international professional institutions in evolving and applying engineering to the benefit of mankind. In line with WFEO's mandate, it formed its Standing Committee on Capacity Building at the WFEO General Assembly in Tunis in 2003. The Committee on Capacity Building held its first organizational meeting in Washington, DC in June 2004 which was supported by the USA National Science Foundation. As of 2006, the Committee comprised of about 44 members from 29 countries. Therewith and –from, a number of priority projects have been identified to include the following:

- African Initiatives- where many of the societal, human and economic needs identified in the MDGs and other comparable accounts of the situation in developing countries are present in sub-Saharan Africa. The WFEO Committee on Capacity Building is charged with the responsibility to develop programs and flagships for dealing with the substantial subdivision of those needs, i.e., in areas of its strength and expertise. The flagships and programs include activities such as; engineering education workshops, development of accreditation systems, entrepreneurial training with great specificity for women, encouragement of internship programs, electronic delivery of courses/ programs, extension of cells of Engineers Without Borders, and faculty and student exchange programs.
- Electronic Initiatives- The Committee on Capacity Building was charged with organizing an e-conference in combination with the American Society for Engineering Education/ Rio Colloquium scheduled for Brazil in September 2006 which was to mark the beginning of the use of an e-colloquium towards enabling engineering educators/ facilitators from developing countries faced with financial challenges and those who could basically not afford to attend international conferences to participate by submitting papers and discussion in advance of the livestream meeting and deliberations, and then have a summarized presentation of their work/ contribution.
- Engineering for the Americas- This project, being carried out in conjunction with the Organization of American States, is focused on developing plans for enhancing engineering education and practice throughout Latin American and the Caribbean.

- Additional Activities- The Committee on Capacity Building is also working on other activities, including the following:
 - a. Gender issues
 - b. Engineers without borders
 - c. UNESCO/WFEO Expert Conference
 - d. International Federation of Consulting Engineers (FIDIC)
 - e. Black Sea University Network
 - f. South-south interactions.

IV. THE WAY FORWARD TOWARDS A CIRCULAR ECONOMIC GROWTH

The need for capacity development in developing countries cannot be overemphasized. However, it is clearly in dire need of attention such that, a large and adequate number of high quality, accredited engineering graduates/ engineers is required in developing countries in order to stimulate and actualize similar outcomes as the cases expressed for South Korea, China and India. Also, it is vital to stress the fact that there will be some losses of graduates/ engineers to white collar jobs overseas in developed countries. Nonetheless, with a more attractive and comfortable environment, including family ties and cultural demands, many educated and well-trained candidates will prefer to stay back, with many more returning home to add value to the system via their contribution to the economic growth and development of the country. Nevertheless, the basic need is the provision of good jobs in the home country. There will be increased demand for engineers when there is an adequate number of well qualified graduates to entice direct external investment, offshore corporation operations, international outsourcing from developed countries (as in the case of India with global technology firms), and entrepreneurial initiatives. Hence, leaders, government officials and facilitators in developing countries must ensure the pursuit of effective and efficient economic development, job creation stratagems and correspondingly, avail the needed investments to improve the standard, quality and quantity of engineering graduates/ engineers.

Engineering education in developing countries should be given more attention as is the case in the developed world, and should include significant coverage of entrepreneurship. It is important to emphasize that USA companies like Hewlett-Packard, Microsoft, and Yahoo all started small by enterprising young people with technical resolve. Engineering graduates/ engineers should be empowered and equipped to have a mindset of creating jobs rather than seeking one if they wish to do so as such, they should be trained on how to start, run and grow and sustain a small business. Furthermore, as technology based economies grow in developing countries, one vital source of top talent in addition to new engineering graduates is the return of intellects in diaspora. A number of fast developing countries in recent years have benefited from the return of well-trained and experienced previous emigrants who see new opportunities in their home countries, and return with foreign experience and web of contacts all to the benefit of their respective home societies and countries.

More so, growing the number, standard and quality of engineering graduates/ engineers, and employing schemes of having good and attractive jobs available for indigenous engineers, developing countries require mechanisms in place to apply outcomes of research and development from domestic universities, institutes of learning, industries and companies towards economic advantage. For instance, South Africa engage in incubation and small-medium-enterprise development financing towards building a circular economy and enhancing capacity development for economic growth and stability.

V. CONCLUSION

The study posits that in the global fight for world security, stability and sustainability, the need for enhancing human, institutional and infrastructure capacity in developing countries require technical capacity building as this is a handle for self-efficient and -effective economic and social development which is at present acknowledged as an imperative urgency in the global engineering community. As such among other comparable bodies, the UNESCO and WFEO Committee on Capacity Building is investing drastically to ensure that developing countries become self-sustained and -efficient through the education and training of more engineering graduates as well as setting out mechanisms to create attractive jobs while graduates are rightly placed to be sought after by the much developed world.

ACKNOWLEDGMENT

The Authors appreciate the University of Johannesburg where the paper was put together.

REFERENCES

- [1] E. William, "The Elusive Quest for Growth. *In: MIT Press*, 2002.
- [2] C.J. Russel, Engineering Capacity Building in Developing Countries. *In: 3rd African Regional Conference on Engineering Education*, September 2006, Pretoria, South Africa.
- [3] Science and Engineering Indicators. 2004.
- [4] National Science Foundation, National Science Board. 2004.