

## **On the Inadequacy of Engineering Faculty in the Advancement of Engineering Education.**

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### **Abstract**

Engineering Education should be of grave importance to any nation that aims to be vibrant in the knowledge economy. Proper implementation and management of engineering education builds viable human capital needed to develop and manage the technologies that are required to drive all sectors of the economy. The training of engineers in ivory towers across Nigeria is hampered by the inadequacy of engineering faculty in these institutions. This dearth of teaching staff has thus created a bottleneck in the advancement of engineering education. This paper seeks to address issues on the competency and numerical strength of academics that are available in specialized areas existing within traditional and emerging fields of engineering. In particular, issues dealing with non-involvement of experienced hands from the industry in the academia, low doctoral students' turn out from graduate studies, inadequate motivation of faculty members and poor government commitment to engineering education will be considered. Some of the solutions provided to mitigate the effect of this challenge include revamping of engineering postgraduate programs and a renewed commitment to building human capital in engineering faculty in order to develop sufficient faculty for the future.

**Keywords: Advancement; Emerging fields; Engineering Education; Faculty Members; Inadequacy; Sufficiency**

### **1. Introduction.**

The role of engineering in the overall socio-economic and political development of any nation cannot be undermined as no nation can provide a virile economy and viable social infrastructure for its citizens without a strong engineering workforce. (Nwohu, 2011) asserted that engineering education should be able to equip young engineers with adequate technical ability and sound engineering judgment, having acquired a strong background in mathematical and other scientific tools that are required to solve engineering problems. The training is equally expected to prepare them to have a holistic view about engineering problems and to develop pragmatic approaches in providing solutions.

However, universities offering engineering programs designed to train graduate engineers to meet vital national needs of developing human capital towards the advancement of science and technological and achieving breakthroughs in communications, health and environment are found to be grossly inadequate in faculty members who have the ability to accomplish this challenging task. Today, qualified and competent lecturers are difficult to attract to the engineering education industry (Nwohu, 2011), owing to poor implementation of government policies in science and engineering education, and a weak economy which has continually resulted in underfunding of the nations' ivory towers. These and other sundry issues have left various engineering programs in a state of academic inadequacy. Inadequacy used in this sense refers to the volume and competence of members of the academia in various specialized areas within existing and emerging engineering fields. This paper thus attempts to assess common trends faculty inadequacy has created over the past decade in Nigeria.

Engineering education at university level started in Nigeria as far back as 1955 in the Ahmadu Bello University with three courses, specifically, Civil, Electrical and Mechanical engineering. As at the year 2000, the number of accredited engineering courses in the Nigerian universities had risen to seventeen (Ajimotokan et al., 2010). During the last ten years, the number of engineering programs being run by universities across the nation have increased significantly. With over five decades in the study of engineering disciplines, there still exists a gross inadequacy of engineering faculty to meet the present demand for quality teaching, learning and research. Suffice to say that some of the first generation universities which have been running engineering programs for a number of years are yet to commence graduate programs as a result of shortages in staffing of senior academic faculty members who should normally oversee teaching and supervision activities at this level.

Most engineering departments in various universities across the country are inadequately staffed both qualitatively and quantitatively, with Doctor of Philosophy (PhD) being the minimum statutory requirement to qualify to be a faculty. Uwaifor asserted that, the proportion of members of staff without PhD outnumbers those with PhD (Uwaifor, 2010). He further stressed that it is difficult to get people who are trained to the level of PhD because the proceeds from academics is not commensurate with the efforts and resources that are applied into obtaining the degree in the long run.

### **1.1 Inadequacy in Specialized areas.**

On close examination, some of the more traditional specializations in engineering such as Agricultural, Mechanical, Chemical, Civil and Electrical Engineering, as well as some emerging engineering fields, reveals that there is a high deficiency of academic manpower distribution across these fields. In Nigeria, fields like: image processing, biosystems engineering, multivariable control, channel coding, computer vision, machine learning, computational fluid dynamics, petrophysics, nanotechnology, renewable energy and bioinformatics, just to mention a few, have little or no competent academics to train students and carry out research. What is observed is that where there are courses to be taught in these fields at both undergraduate and postgraduate levels, faculty who do not have core competence or requisite qualifications in these areas are left to instruct these courses, hence, making them to operate outside their own areas of expertise. In effect, these course areas are not well taught and this state of affairs is most likely to discourage those who might be interested in undertaking further research work.

In certain instances where we find students who are willing to carry out studies in specialised areas and some of these emerging fields at the postgraduate level, the problem of quality supervision is often experienced as there is relatively limited faculty to lead active research work. Also, in a situation where a faculty is acting as a major supervisor in a research work at graduate level outside the spheres of his or her

core strength, poor results are usually recorded (from such research work). Apart from the above, the few available faculty in the areas faced with the challenge of low research throughput are battling with problems ranging from inadequate resources required for active participation in graduate research work and student's willingness to explore opportunities inherently present in these human capital deficient areas.

## 1.2 Numerical Inadequacy

With the proliferation of universities in Nigeria over the past decade, Nigeria now has about 129 universities (NUC 2010), out of which the number of universities currently running engineering programs is fifty-two (52), while number of engineering courses totalled about 30 in 2010. (NUC, 2010). The significance of the effect the inadequacy in the volume of engineering faculty members is having on the nation's universities was revealed in the 1999/2000 round of accreditation exercise. Out of the 129 Engineering departments of Nigerian Universities running engineering programs, only twenty-one (16.28%) had full accreditation, 69 (53.49%) were awarded accreditation in the interim, while 39 (30.23%) failed the accreditation (Ajimotokan et al, 2010).

On scrutiny of the COREN criteria for accreditation of any engineering program, staffing is a core requirement which must be met. Aspects considered under staffing include academic staff-to-student ratio, staff distribution, professional status, among other things. Over time, it has been observed that COREN places high premium on academic staffing for programme accreditation. Figure 1 shows the distribution of the overall program assessment score for different COREN criteria made use of in accreditation exercises.

Of the total number of criteria to be assessed for programme accreditation, staffing carries the highest score of 32%. This validates the priority the regulatory body placed on faculty adequacy. The dearth of qualified senior academic faculty leads to the problem of understaffing which characterises most universities running engineering programs in Nigeria. This state of affairs is exacerbated by chronic shortfalls in the number of engineering teaching staff with Ph.D. Figure 2 shows the percentage staff distribution of various academic staff in engineering departments as required by COREN. It is mandatory that the most senior academics in the professorial cadre should constitute 20% of the total faculty, 35% should be senior lecturers while the remaining 45% of faculty positions should be for lecturer I and below. It is rather unfortunate then that many engineering departments do not meet up with this minimum criterion for teaching staff ratios.

A common measure adopted by most Nigerian universities in order to counter this present challenge, and to ensure the continuous existence of engineering programs at all levels for engineering departments that are highly deficient in teaching personnel is to recruit adjunct lecturers en masse. A cyclical situation thus exists whereby an engineering faculty in a particular institution holds multiple adjunct positions in other higher institutions across the nation.

Yet again, retired professors who by virtue of age should no longer be active in teaching and research are often offered contract appointment in order to make up the required number of teaching staff as required by the National Universities Commission (NUC) and (COREN) for the purpose of course accreditation. Thus, we find out that almost the same set of senior engineering faculty are being recycled in the teaching of engineering in Nigerian universities, either as visiting, adjunct or contract lecturers.

In addition to the foregoing, we find many instances where a faculty is required to teach about four to five undergraduate courses in a semester, excluding postgraduate taught courses, and also participate in project supervision. This situation tends to reduce the overall efficiency of faculty members.

In circumstances where qualified personnel are not available to carry out teaching activities, some engineering departments employ either fresh bachelors degree holders without any form of experience to teach at the upper level in the undergraduate program. Consequently, we have a case of the blind leading the blind (Nwohu 2010). The cumulative effect of these scenarios is that there is incidence of a high faculty-to-

student ratio in each of the engineering programs in universities which tends to reduce the quality of engineering graduates turned out of various ivory towers.

## **2. Inadequacy Issues in the Advancement of Engineering Education**

### **2.1 Inadequate Motivation**

The priority given to faculty members involved in advancing the course of engineering education in Nigeria is very low. This is confirmed by a serious lack of motivation on the part of government towards academics in engineering fields. Nigeria is blessed with young and brilliant minds who, in many cases, do not find the pursuit of a career in academics attractive and rewarding compared to what is obtainable in the industry. It is noted that a conducive atmosphere has not been provided for members of academia in engineering to thrive and compete favourably with their counterparts in other parts of the world. Grants are not adequately provided to fund research work, learned conferences are not being fully sponsored or subsidized for engineering faculty members and scholarships funds are not sufficiently provided for the academic staffers that are on Ph.D programmes in home institutions and abroad. This limited funding implies that universities and technical institutions, can only provide limited learning and research resources (Ojiako, 1986).

### **2.2 Commitment of Government in the Development of Engineering Education.**

Unlike what is obtainable in some other parts of Africa and in America where governments continually have shown strong commitment towards the development of engineering education especially at the graduate level, the Nigerian government has shown little commitment in this regard. In South Africa National Research Foundation (NRF) was established to promote and support research through funding and provision of research grants towards creating viable knowledge and development of human capital (NRF 2013). In America, concerted efforts are continually made to bring engineering education to the forefront globally, and the achievement of this objective has been realised by the institution of legal and infrastructural frameworks. Part of these frameworks include the creation of a centre for the advancement of engineering education in 2003. This centre is committed to exploring all possible avenues to ensure the overall success of engineering education (Atmanetal, 2010). Furthermore, the National Science Foundation (NSF), which is also committed to the overall advancement of science and technology, provides grants and funding in part or in full to a significant number of graduate researches both at Masters and Doctoral levels across engineering disciplines as well as a number of independent researches by members of the academia, [all these being done in order to promote the overall success of engineering education.]

### **2.3 Low PhD Outputs in Engineering Graduate Programs**

A close look at postgraduate education in Nigeria reveals that the number of PhD students graduating on a yearly basis in each engineering department is significantly low. Some of the engineering programs in first generation universities in Nigeria do not produce even a single PhD in a year as against what is obtainable in the United States of America, where a faculty graduates an average of one PhD student per year (Ananth, 2008). Contributory factors to this challenge include non-availability of supervisors in the area of research interest, inadequate facilities for bench work, quality of students on the program and availability of funding, among others. With the ongoing implementation of the relatively new regulation allowing for creation of private universities and the recent instituting of more federal universities, a number of which are running engineering programs, one wonders where these newly established schools will recruit engineering faculty given the fact that existing schools are experiencing acute shortage of faculty with PhD qualification. The problem of low PhD outputs in engineering is taking its toll on staffing in these institutions as a sizeable number of faculty positions are vacant.

The NUC position paper which proposed a statutory requirement for a PhD degree to teach in the Nigerian university system from the Lecturer Grade II position and above should be embraced and implemented with all seriousness in engineering programs. While a 2009 deadline was set for the implementation of this policy, perhaps a shift to 2015 will be more realistic in allowing those who are currently running their doctoral programmes to complete it. In addition, extant programmes by NUC and universities in general to support and train young academics for PhD would have sufficiently flowered from 2012. A shift for enforcement of this policy to 2015 should be the last recourse since the minimum standard of PhD was agreed to by the Nigerian university system as far back as 1989 (Maihankuri 2012).

The quality of engineering PhD outputs is another issue that has generated much concern among stakeholders in the academia, particularly because of matters relating to non-availability of funds, competent supervisors and well equipped research laboratories for experimentation. The rampant incidence of non-commitment on the part of graduate students to research work is also of concern. Ordinarily, PhDs in engineering disciplines are associated with intensive research and require specialized equipment and software, sometimes with a high degree of sophistication, to carry out experimentation and simulation. Regrettably, most Nigerian institutions are highly deficient in making adequate provisions for advanced research and are poorly positioned to integrate globally (Salihu & Zubair 2012). Thus, most of the fresh PhD outputs from many institutions in recent years have been observed to show poor delivery in teaching and research in their areas of specializations.

#### **2.4 Non Participation and Involvement of Experienced Hands from the Industries in Engineering Education**

One of the approaches that can be adopted in reducing the chronic understaffing and quality issues that has characterised Nigerian engineering programs is the active involvement of qualified persons in multinational organizations and industry, who by virtue of their vast wealth of experience and adequate academic qualifications, can be recruited into the classroom as adjunct or research professors as is obtainable in developed countries. This area needs to be urgently looked into with the intention of mitigating the adverse effect of shortfalls in teaching personnel.

Intensifying efforts in this direction is particularly desirable because these industry gurus can actually bring in the teaching and application of latest trends in technology, having been exposed to training and retraining on sophisticated equipment and facilities. Additionally, they can collaborate with existing faculty members to lead major research work, teach and supervise research students and also attract funds from large corporations in a concerted bid to increase PhD outputs in terms of quality and quantity.

### **3. The Way Forward**

#### **3.1 Commitment to Human Capital Development in Engineering Education**

There is an urgent need to begin to build engineering capacity in tertiary institutions to remove the bottlenecks expounded previously in the training of graduate engineers. One of the most important aspects of building engineering capacity is human capacity development. Nurturing requisite faculty for the future is core to meeting the increase in demand for engineering education. Currently, the proportion of those applying for research degree in engineering is very low as sufficient efforts are not being made by government and other stakeholders towards encouraging enrollment into graduate programs.

Young brilliant minds with first degrees and masters degree holders should of necessity be absorbed into the system as this will provide a platform for further enrollment. Furthermore, existing faculty need to be trained and retrained from time to time in order for them to catch up with recent advances in their various areas of specialization. This will improve their research capabilities and further increase the viability and

employability of their graduate students. Uwaifo opined that this training should be two-fold. First, training to acquire the requisite qualification (PhD) to teach and second, continued professional training (Uwaifo, 2010).

Development opportunities need to be made available for faculty to further increase their capabilities and this can be in the form of overseas postdoctoral training, facilitation of short fellowship programs in related engineering departments within regional and overseas institutions, provision of conference support grants for improved attendance of engineering faculty in either local or international learned conferences, etc.

### **3.2 Revamping the Post graduate Engineering Education.**

The current structure of postgraduate engineering training programs in Nigeria today does not augur well for dedication, innovation and fulfillment on the part of research students. Ordinarily, graduate engineering research programs should serve as a rich resource for attaining sufficiency in engineering faculty. This has however been found not to be the case in most Nigerian universities. Many research students in engineering have been known to spend an indeterminable number of years on researches that had no clear-cut focus and that quite possibly did not yield any meaningful result.

To attain the desired level of faculty adequacy, it is imperative that the research degree program structure should be totally overhauled such that it can attract more willing individuals who want to establish careers in the academics. The full assurance that once enrolled, research activities will be completed in record time while maintaining the required quality will serve as a big boost for postgraduate engineering programs and staffing issues. The curriculum should also be broadened to include research degrees in emerging fields.

First generation universities with an appreciable number of faculties in recognised areas of specializations should be encouraged to concentrate more on graduate training in these identified areas, so that they can produce lecturers for newly established universities and the other existing ones. In addition, facilitation of exchange programs for graduate degree students should be strongly implemented. This will enable research students to spend part of their program period at their home institutions, while the other part will be spent for bench work in foreign higher institutions of learning that have attained sufficiency in manpower and facilities.

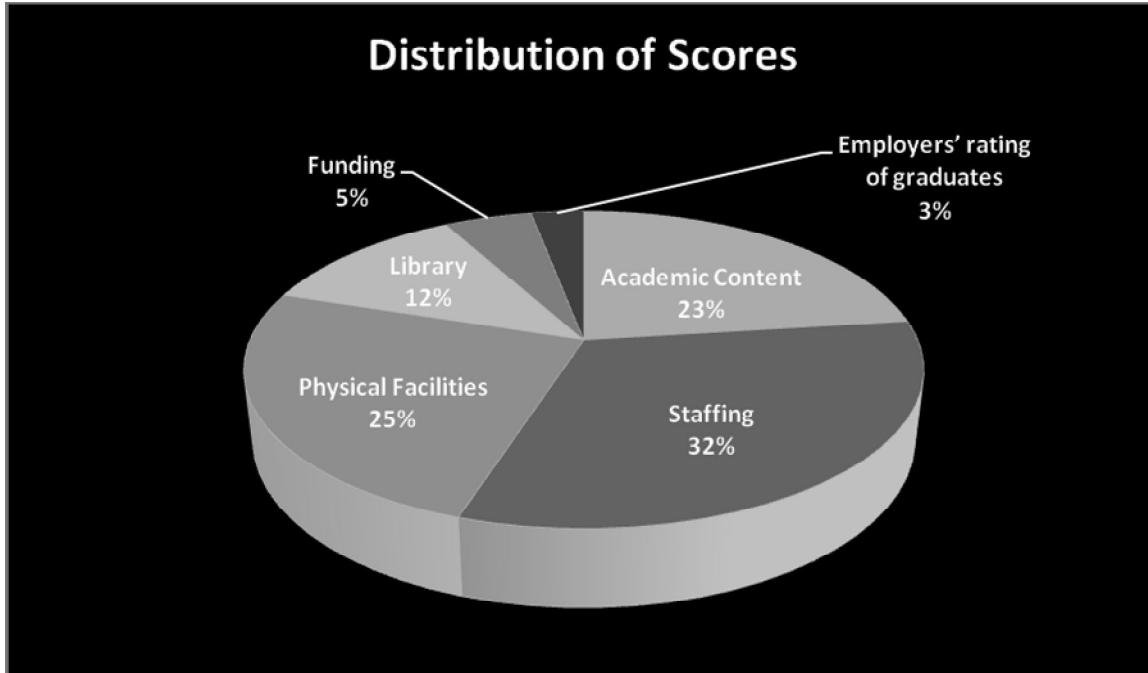
## **4. Conclusion**

As Nigeria strives to attain sufficiency and competence in her technological manpower outputs so as to drive equitable participation in globalization and the rapid development of a knowledge base economy, concerted efforts should be made towards creating a viable platform in the engineering education sector through which this vision can be realized. The problem of dearth of engineering educators who are required to train the manpower needs of the nation must be addressed earnestly and urgently as it is a core issue that can jeopardize the realization of the national vision for technological independence. Proper implementation of the solutions prescribed in this paper will go a long way to mitigate this present challenge of faculty insufficiency and to also produce adequate faculty for the future that are required in the advancement of engineering education.

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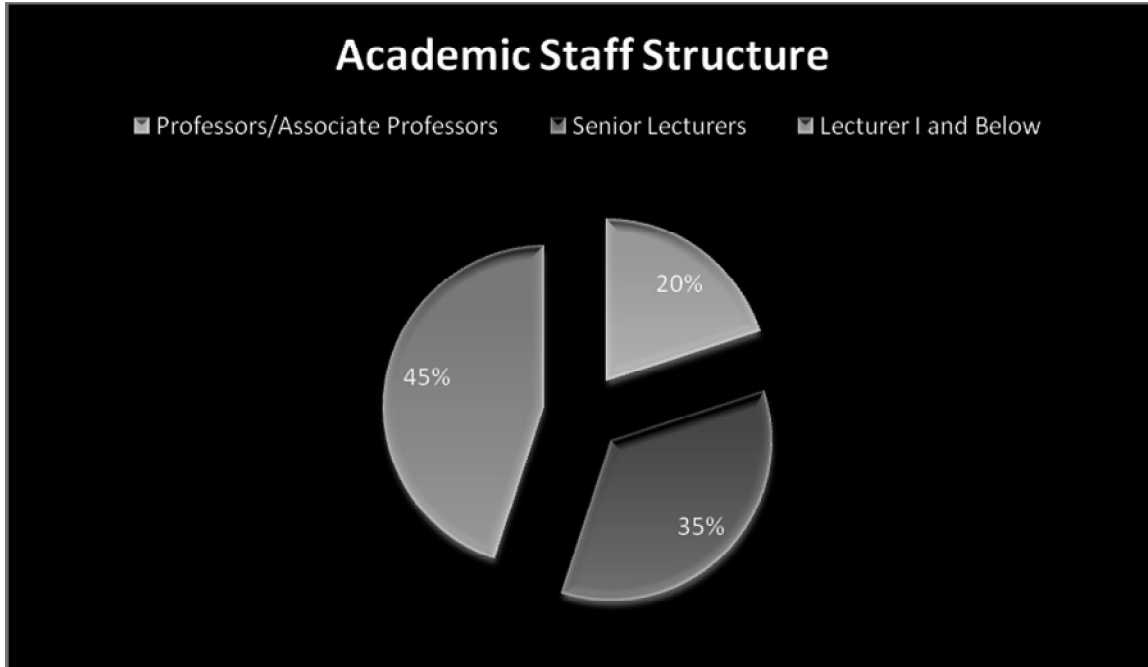
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**LIST OF FIGURES**



Source : Authors' illustration with data from Falade:(2009)

Fig. 1: COREN's distribution of programme assessment score.



Source:Authors' illustration with data from Falade: (2009)

Fig. 2: Required Staff Distribution in Engineering Programs