Engineering Education in Kenya: The Human Resource Challenge and its Implications

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Abstract

Kenya has been offering Engineering Education since the colonial era. Up until the turn of the millennium the expansion of Engineering Education was fairly moderate. However, with the formation and establishment of the second and third generation universities in the Country and the concomitant establishment of engineering schools in a number of these institutions, significant challenges have emerged some of which are threatening to be intractable if necessary steps are not taken and in good time. Key among these challenges is the issue of academic staffing. A relatively low ratio of engineers entering university teaching careers and the rapid growth in institutions offering engineering education has increased demand on available manpower. The present study established that in just only the last 20 years over 20 universities are offering engineering courses compared to only 4 universities for the period 1956-2000.This may have the undesirable result of often not securing the right quality and quantity of staff for many of these institutions.

The practice of engineering in the country is regulated by an Act of Parliament and therefore educational training in engineering is closely monitored. While all forms of formal education in one way or another operate under a certain legal framework, it is noteworthy that the special place occupied by engineering because of the serious ramifications of malpractice in the profession renders it special attention. Proper training is therefore at the core of the profession and this naturally points to, among others, right quality and quantity of engineering faculty.

This article broadly looks at the prevailing situation with respect to engineering faculty across the country and presents the case of Kenyatta University with the hope that certain successes registered by Kenyatta University can be borrowed from. The article further proposes strategies that can be considered as part of the effort towards ameliorating the situation.

Keywords:

Engineering education, faculty, human resource, profession

1.0 Introduction

Engineering practice and, by extension, engineering education, anywhere in the present world, are indispensable. Development, in all of its many facets, contains a thread of engineering. Engineering education and professional development are vital for Kenya's development as it strives to compete in an increasingly globalized world (Cannon, 2016). The practice of engineering is therefore critically important in all sectors of the Kenyan economy. As a matter of fact, all the national development blue-prints, with the Vision 2030 being at the centre, are anchored in engineering and their success depends, to a large extent, on sound and robust engineering services which in turn call for adequate engineering training locally.

The Government of Kenya has developed Vision 2030 whose main objective is to turn Kenya into a globally competitive and prosperous nation with a high quality of life by the year 2030. Vision 2030 is anchored on three key pillars: Economic, Social and Political. Each pillar has a number of strategies designed to deliver different components of the Vision. Engineers are expected to play a key role in the delivery of the vision, especially in the realization of the necessary infrastructure, the industrialization process, and development of new technologies led by the ICT sector. All these

activities will be key serving as a catalyst for wealth creation in 'Kenya's quest to become a middle-income country by 2030 (Engineers Board of Kenya, 2014).

Kenya's engineers bring a variety of skills that are fundamental to the success of not only many large and small enterprises, but to the nation. Cannon (2016) notes that there is an acute lack of qualified engineers in Kenya possessing the requisite skill sets. He identifies this as a systemic problem, encompassing government, the private sector, universities, technical training institutions and professional bodies – all of which share some of the blame.

At the end of the day the making of sound engineers and therefore a contribution to robust engineering services in any society will begin at the training ground. Good training calls for a good training ground. It is, indeed, against this background that this article explores the challenges associated with academic training, more specifically academic staffing, in engineering programs at Kenyan Universities.

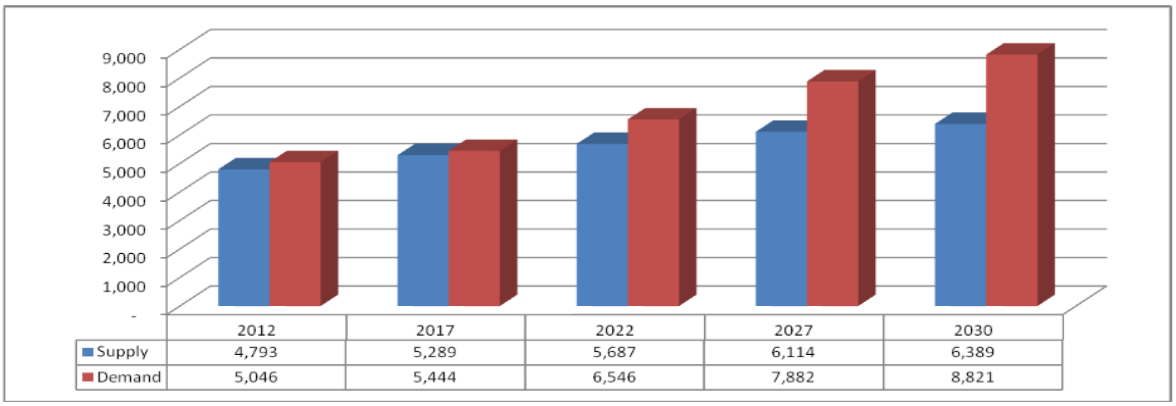
For purposes of this article, Kenyan Universities have been categorized as follows with respect to the date of establishment;

1) First generation- University/Universities established in the period 1963 – 1980
2) Second generation- University/Universities established in the period 1980 – 2000
3) Third generation - University/Universities established in the period > 2000

2.0 Engineering Manpower Needs in the Country and Regulation

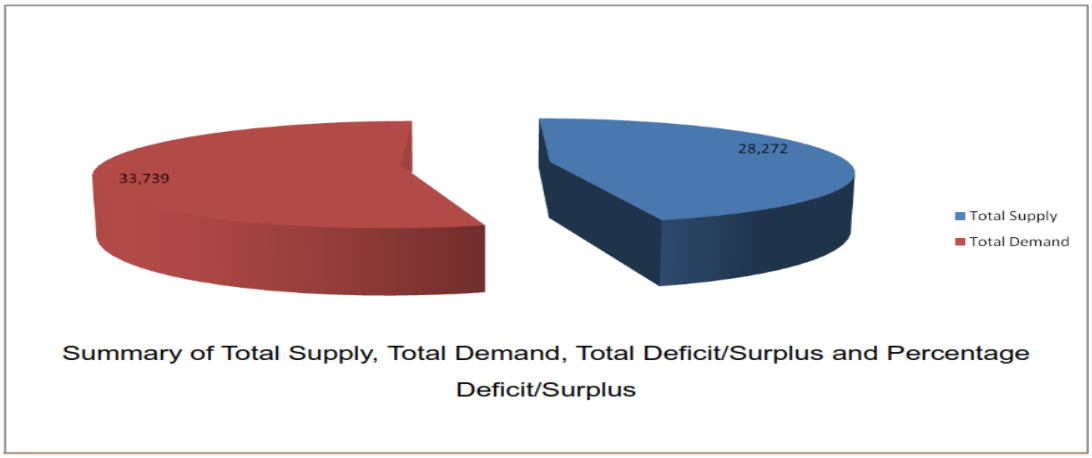
The study on engineering manpower needs assessment conducted on behalf of the Engineers Board of Kenya (EBK) by Ernst and Young in the period 2013-2014 with the overall scope of the study being a comprehensive analysis of supply and demand for trained engineering manpower – especially numbers and skills mix required for Vision 2030- speaks to us with unmistakable clarity on the need for proper and adequate engineering education in the country. While this study by the EBK has been discussed ad nauseam, it is as relevant as ever.

One of the key findings of the study is that there is a particular need for training that is demand-driven and adaptable to the changing needs of the economy. The study then compared supply and demand of all engineering disciplines in each medium term. The trend shows an upward increase in demand of all engineering disciplines in each medium term to 2030 as depicted in figures 1 and 2.



	2012	2017	2022	2027	2030
Supply	4,793	5,289	5,687	6,114	6,389
Demand	5,046	5,444	6,546	7,882	8,821

Fig 1: Demand and Supply of Engineers; Fig 2 (below): Total Deficit/Surplus of Engineers (source: EBK)



The deficit in the supply of engineers is a natural call for more training and an opportunity to be taken by the relevant training institutions. A number of institutions, especially the third-generation universities have grabbed the opportunity but the question crying out, rather loudly, is 'are these universities meeting the threshold?'- where accreditation of their engineering programs by the relevant bodies is taken as indication of meeting the threshold.

2.1 Legal and institutional framework

To ensure professionalism and upholding of ethical behavior in the engineering practice the Government of Kenya and other key stakeholders have established various structures and institutions which are legally mandated to provide oversight and related services to all strategic players in the economy.

The main legal instrument with regard to engineering matters in the country is the Engineers Act, 2011. This instrument has provided for the creation of a key institution, The Engineers Board of Kenya. The Engineers Board of Kenya is a statutory body established under Section 3(1) of the Engineers Act, 2011. The Board is responsible for the registration of engineers and Engineering firms, regulation of engineering professional services, setting of standards, development and general practice of engineering. The Act allows only registered engineers to engage in professional engineering work and/or services. Registration is thus a license and the only way of ensuring that one is professionally qualified to practice engineering. To qualify for registration in the categories of professional engineer one has to acquire adequate professional competence and experience in areas specified by the Board.

The EBK is a critical partner in the accreditation process of engineering programs in the universities. The two cardinal areas for accreditation of an engineering program are staffing and physical facilities. This underscores the critical role played by the Board in engineering training.

3.0 The Meteoric Rise in Number of Universities Offering Engineering Education

Engineering education at the University level began at the Royal Technical College of East Africa (RTCEA) in 1956. RTCEA became the University of Nairobi in 1970. Up until the turn of the millennium the expansion of Engineering Education was fairly moderate. However, with the formation and establishment of the second and third generation universities in the Country a meteoric expansion in engineering education has been witnessed. Has this expansion been met with a commensurate provision of necessary requisites? A question for another day. A single look at table 1 would show a more than quadruple increase in the number of universities offering engineering education since the year 2000. While the expansion is welcome, challenges abide. **We need more engineers and therefore more universities could be a linear thinking model.** One of the challenges that closely associates itself with this rise is accreditation of these programs. The present study established that at the baccalaureate level, Kenya has at least 30 public universities offering engineering courses.

Table 1: Number of universities offering engineering education over time

Period	**No. of Universities Offering Engineering Education**
1970s	1
1980s	3
1990s	4
2000-2020	>20

3.1 Accreditation dilemma; consultation or confrontation?

"Accreditation" means the procedure by which the Commission for University Education (CUE) or any other competent authority formally recognizes an institution or an academic programme of a university.

Table 2: Engineering Programs Recognized by the EBK

S/N	University	No. of Engineering Programs	Accredited Programs (EBK)
1	University of Nairobi	6	6
2	Moi University	6	13
3	JKUAT	11	8
4	Egerton	4	1
5	Dedan Kimathi	3	4
6	Kenyatta	7	3
7	Technical University of Mombasa	5	3
8	Masinde Muliro	3	3
9	Multimedia University	3	2
10	Technical University of Kenya	6	2
11	University of Eldoret	3	3

The key stakeholders, as already noted, in the accreditation of any engineering programme in the country are the Commission for University Education (CUE) and the Engineers Board of Kenya. Previously, before the CUE was established by an Act of Parliament, Universities Act, No. 42 of 2012 as the successor to the Commission for Higher Education which was established under Universities Act Cap 210B of 1985, the EBK was solely responsible for the accreditation process courtesy of the Engineers Act, 2011 and the repealed Engineers Registration Act of 1969. It is interesting to note that section 7(1)(l) gives one of the functions of the board as to 'approve and accredit engineering programs in public and private universities and other tertiary level educational institutions offering education in engineering. However, this function has been taken over by the CUE vide the CUE Act amendment of 2016 that supersedes the former in the matter of accreditation. While that is the situation in law, the two institutions must work hand in hand in matters of accreditation of engineering programmes. The dilemma is how the 2 institutions are going to share this responsibility. None wants to play second fiddle; none wants to be subservient to the other even when the law is apparently clear on this matter. The impasse created in this matter in the recent past can be well understood from Cannon (2016).

Why are we 'detouring' by looking at accreditation in this article? One key consideration during accreditation of an engineering program is staff. In fact, staff and laboratory resources form the bulk of requirements for purposes of a program's accreditation. No wonder that for over 20 universities offering engineering education in Kenya, only 11 have some of their engineering programs recognized by the Board and this, to an appreciable degree, because of staffing issues. Accreditation associates itself with the human resource challenge under discussion in this article in a variety of ways. The most important nexus here is that future academic staff will be expected to be products of accredited programs!

4.0 Engineering Academic Staffing

4.1 The CUE's Requirements; The elephant in the room

The CUE's Universities Standards and Guidelines, 2014, has guided on this matter, rather exhaustively, in the Third Schedule under University Staff, PROG/STD/17. The provisions of the guideline with respect to academic staff for any particular programme include;

i) An academic programme shall be supported by adequate full-time staff holding requisite academic qualifications.
ii) The ratio for full-time to part-time academic staff members for the support of any given programme shall be 2:1;
iii) The recommended full-time staff: student ratio for Applied Sciences is 1:10

Very few institutions, if any, are fulfilling ii) and iii) above.

4.2 Paucity of academic staff unearthed

That there is a dearth of academic staff for engineering programs may not be news. A relatively low ratio of engineers entering university teaching careers and a rapid growth in institutions offering engineering education has increased demand on available manpower.

A study funded and undertaken by the Kenya Education Network (KENET) titled **'Baseline survey of engineering departments** 2015' unearthed a serious staffing problem in engineering degree programs. Data captured for each engineering department included:

1. Engineering student enrollment and graduates (undergraduate and post-graduate) over a period of three academic years starting from AY 2012/2013 to AY 2014/2015).

2. Faculty data (full-time and part-time) per department and their academic and professional qualifications

3. Masters and PhD throughput of each department over five academic years and associate research output

The study found out that there were a total number of 437 full-time engineering faculty members, 152 of them with doctoral degrees. This number excludes a total of 48 tutorial fellows employed by engineering departments. Only 107 indicated they were registered with the Engineers Board of Kenya. About 66.4% of the engineering faculty members with PhD degrees were employees of University of Nairobi (UoN), Moi University or JKUAT. In addition, all the PhD students were enrolled at either UoN or JKUAT. Overall, only about 30% of the full-time faculty had a PhD and about 25% were registered with EBK.

In addition, anecdotal data before the survey suggested that there was a shortage of engineering doctoral faculty and the number of post-graduate students pursuing Masters and Doctoral studies was relatively low. The results confirmed that there was indeed a shortage of doctoral faculty in nine out the 12 universities offering degree programs and the post-graduate students in engineering were very few.

The study brought to the fore the grim picture on the throughput of engineering graduates at the postgraduate level who may end up joining university faculty. In summary, the findings reveal the following interesting scenario;

i) The throughput of postgraduate students is extremely low. Few engineering graduates are enrolling for masters and PhD and even among the enrolment much fewer end up graduating.
ii) As a consequence to i) above, a scarcity of faculty is inevitable since it's the masters and PhD holders who are eligible to teach.

The study found out that JKUAT had the highest number of full-time faculty at 116, followed by University of Nairobi with 92 full-time faculty members and Moi University at 81. JKUAT also had the highest number of engineering with PhDs at 41 followed by UoN with 33 and Moi University with 27. This data was surprising considering that UoN had the oldest engineering departments started in 1971, followed by Moi (1984) and then JKUAT (1986).

It turns out that only UoN, JKUAT, and Moi had the necessary concentration of both junior and senior faculty members per department. This could have a negative impact on research and innovation output of the different universities.

The KENET study further shows that only seven universities and 12 departments were offering post-graduate degrees at Master level as of November 2014. Table 3.6 shows that there were two universities offering Master's degree in Electrical & Electronic engineering and seven in Mechanical & Mechatronic Engineering. **It should be noted that even in cases where a good number of graduates is recorded very few are willing to join academia because of better opportunities in the industry and other non-academic institutions.**

Table 3: Master's student enrollment and graduates in period 2012-2015(Electrical and Electronic Engineering

University	Total Masters Students (2012-2015)	Total Masters Graduates
1. Jomo Kenyatta University of Agriculture & Technology	42	**9**
2. University of Nairobi	34	**4**
Overall	**76**	**13**

Table 4: PhD enrollment and graduates (2012-2015)

University	PhD Engineering Programs	Total PhD students (2012-2015)	Total PhD graduates
1. Jomo Kenyatta University of Agriculture & Technology	PhD Civil Engineering	19	14
1. Jomo Kenyatta University of Agriculture & Technology	PhD Electrical and Electronic Engineering	1	1
2. University of Nairobi	PhD Electrical and Electronic Engineering	4	3
2. Kenyatta University	PhD Sustainable Energy Engineering	0	0
3. Moi University	PhD Mechanical Engineering	18	0

The information contained in tables 3 and 4 simply confirms another problem facing engineering faculty- that graduate supervision in Engineering is a rarity and remember that it forms a key ingredient in staff progression and/or promotion. Stagnation often leads to lack of motivation and unpleasant turnovers. Securing sufficient and quality teaching staff in Engineering could therefore be insurmountable without focused interventions in place.

5.0 The Case of Kenyatta University

We realize that there are more established universities offering engineering education in the country with many accredited engineering programs than Kenyatta University. While this is the situation, and without any over-amplification, there is certainly something to be learnt from Kenyatta University. Kenyatta University's School of Engineering and Technology was established during the 2007/2008 Academic Year and so far, runs 7 engineering programs. These programs were mounted before being accredited. As such, the school found itself in trouble in due course. However, university management fathomed the problem in good time and made provisions. Firstly, the University worked very closely with the regulator of engineering practice in the country (EBK) as well as the Institution of Engineers of Kenya (IEK) for guidance. Secondly, the university entered into a number of collaborations with academic and non-academic institutions relevant to engineering education for support in ways such as access to facilities that the university could not secure. Thirdly, the university engaged 28 adjunct and visiting professors from around the world to complement its regular staff especially in areas with gaps. Finally, the university went into an extraordinary recruitment drive which employed, among others, a headhunting strategy.

6.0 Implications

Failure to secure requisite academic staff in any of the universities would have manifold implications. Ultimately, however, is the threat of suspension or even closure of engineering programs that will not meet the threshold on account of lack of adequate staffing amongst other requirements.

7.0 Strategies and/or Recommendations

1. Tailor-made policies to attract and retain staff are necessary for engineering schools at the universities.
2. Universities should avoid a universal application of promotions policy and craft specific criteria given the situation surrounding engineering faculty.
3. A non-practicing allowance should be considered as an incentive to lure engineers from industry to academia
4. Ringfencing of top engineering graduates by provision of reasonable postgraduate scholarships to be upscaled.
5. Professional practice should be given a relatively higher weighting for engineering staff in the promotion criteria.

References

1. Cannon B. J.: The State of Engineering Education in Kenya, Kenya Engineer, Intercontinental Publishers, Nairobi, Kenya (2016)
2. Engineers Act, 2011
3. Engineers Board of Kenya: Study on Engineering Manpower Needs Assessment, Nairobi, Kenya (2014).

4. Kenya Education Network: Baseline Survey of Engineering Departments 2015, KENET, Nairobi, Kenya (2015).
5. Universities Act, 2012