EXECUTIVE SUMMARY

Motivation for the Baseline Survey

This baseline survey of engineering departments of Kenyan universities was part of the e-readiness survey of universities research series (http://ereadiness.kenet.or.ke). The e-readiness of an educational community (e.g., a university or a school of engineering) is a *diagnostic* assessment of the overall potential of the community to use Information and Communications Technologies (ICTs) to transform and enhance teaching, learning, research and innovation. The assessment is based on an e-readiness assessment framework was developed by the researchers specifically for higher education institutions and universities in developing countries like Kenya. It is based on a set of 17 indicators that are staged on a scale of 1 (unprepared) to 4 (ready). The 17 indicators are in turn derived from over 90 sub-indicators.

In order to conduct an e-readiness survey of a higher education institution or academic department, detailed data is required. These data includes student enrolment, full-time faculty members and their qualifications, institutional financial health data in addition to ICT access and affordability data. This would normally data required by management of a university or by external accreditation bodies. For example, one of the 17 indicators is titled **ICT Research and Innovation** and aims to measure the ICT research and innovation output of a university. Over the years, the researchers have observed that the data required was not easily available from senior administrators such as the DVC for Academic Affairs or the Academic Deans or Directors of ICT.

The engineering departments' baseline survey therefore collected detailed data from the heads of the departments that could be used to measure the research and innovation of the departments. The heads of departments were directly responsible for the educational and research outcomes of their respective department and were expected to collect and have access to relevant data. The engineering departments survey was combined with a survey of ICT departments (i.e., departments of computer science, information systems or business IT systems). The data collected was similar to the data required by the Commission for University Education that regulates university education or by Engineers Board of Kenya, the professional body - that is also mandated by Kenya to accredit engineering degree programs.

Research Methodology

The data was collected over a period of 14 months from November 2014 to January 2016 using a detailed questionnaire developed by the researchers (see questionnaire at http://ereadiness.kenet.or.ke/engineering). The questionnaire collected the following data for each department:

1. **Engineering students' enrolment** data over a period of three academic years (AY) starting from AY 2012/2013 to AY 2014/2015.
2. **Faculty numbers** (full-time, part-time) per department and their rank and academic and professional qualifications in the AY 2014/2015
3. **Institutional support** levels in terms of departmental budgets for supporting teaching, research, learning environments and labs, and faculty development

4. **Research and innovation output** of departments as measured by participations of students in engineering design competitions and exhibitions, Masters and PhD degrees awarded, publications and other scholarly works.
5. Perceptions of the engineering department heads and deans on the **impact of ICT** on engineering education and research

The directed questionnaire was completed by heads of engineering departments assisted by the research assistants (one per for every participating university). Most of the research assistants were junior ICT or engineering faculty members from the participating universities. Data was analyzed at both the departmental level and in aggregate form for all the 12 universities that were offering engineering degree programs in November 2014. In order to simplify the analysis all of the engineering departments and/or degree programs were grouped into three main categories:

a. Civil and Structural Engineering (CSE) departments or degree programs
b. Electrical and Electronics Engineering (EEE) departments or degree programs
c. Mechanical and Mechatronics Engineering (MME) departments or degree programs (it includes agricultural engineering or bio-systems engineering)

Appendix 1 contains the details of the groupings for all degree programs offered by the participating universities.

Key Results

This baseline survey has found that there were **12** fully-fledged universities offering 54 undergraduate engineering degree programs in a total of 44 different engineering departments as shown in Table E.1.

Table E.1: Engineering Students Enrolment per university in the AY 2014/2015

	University	**Number of Departments**	**Total Enrolment AY 2014/2015**
1	Dedan Kimathi University	4	534
2	Egerton University	4	428
3	Jomo Kenyatta University of Agriculture & Technology	6	2,844
4	Kenyatta University	5	1,163
5	Masinde Muliro University of Science & Technology	3	149
6	Meru University of Science & Technology	1	90
7	Moi University	5	1,211
8	Multi Media University	1	65
9	Technical University of Kenya	4	1,765
10	Technical University of Mombasa	4	226
11	University of Eldoret	3	70
12	University of Nairobi	4	1,798
	Total	**44**	**10,343**

All of the engineering degree programs had a total undergraduate student enrolment of **10,343** in the academic year (AY) 2014/2015 and represented about **2.6%** of the total university undergraduate student enrolment of **394,048** students in all Kenyan universities in the Academic Year (AY) 2014/2015 (http://ereadiness.kenet.or.ke/enrolment). Figure E.1 shows the growth in enrolment over three academic years and shows that there had been a dramatic increase in the AY 2014/2015.

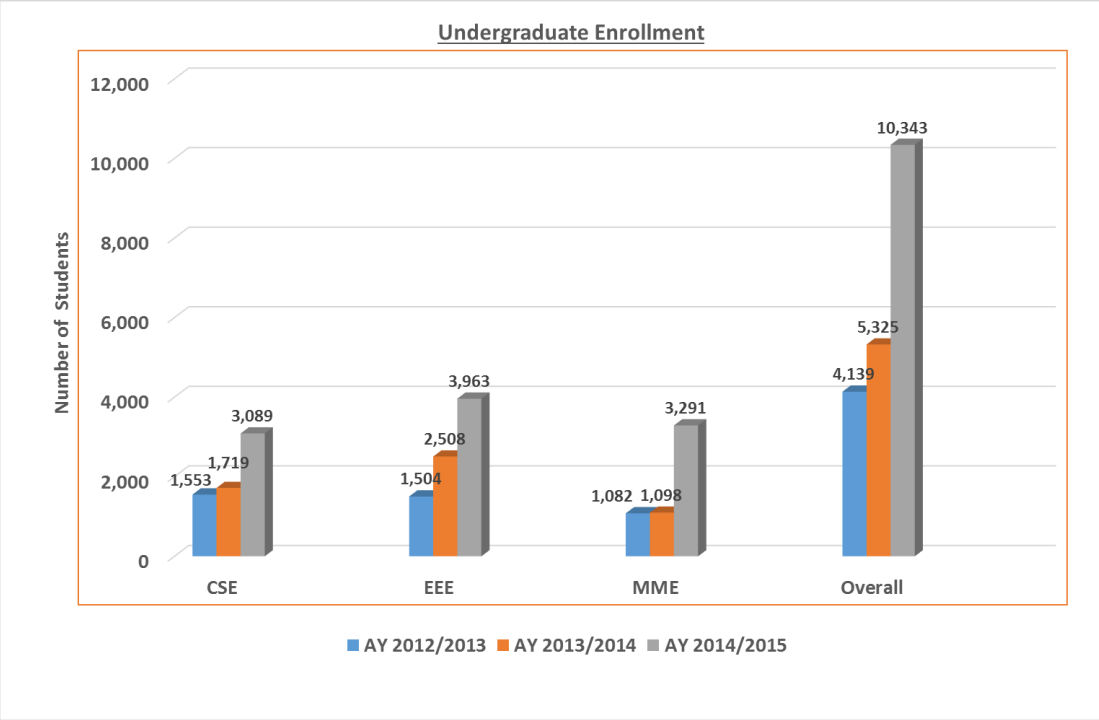

Figure E.1 Undergraduate enrolment AY 2012/2013 to AY 2014/2015

Moreover, there were only **288** Masters and **35** PhD students enrolled in the AY 2014/2015, most of them in the three universities that had been offering engineering degree programs for at least 20 years (i.e., Jomo Kenyatta University of Agriculture and Technology, Moi University and the University of Nairobi).

There were a total number of **503** full-time engineering faculty members, **193** of them with doctoral degrees (i.e. 38% full-time faculty had PhD degrees). The total number of engineering faculty members excluded a total of **88** tutorial fellows employed by some engineering departments but includes the full-time **108** assistant lecturers. Only **337** indicated they were registered with the Engineers Board of Kenya (EBK). About **63%** of the engineering faculty members with PhD degrees were employees of the three universities that traditionally offered engineering degree programs.

One of the observations was that the faculty to student ratio was quite low with the average being only one faculty member per **21** students. Only EEE departments had a faculty to student ratio of **26** students per faculty member as shown in Table 3.4. It therefore appears that engineering departments in Kenya do not have a shortage of faculty when data was aggregated. However, this

faculty-to-student ratio could be distorted by the large number of engineering degree programs (54) and departments (44). It means that faculty could be thinly spread in different departments and were teaching in multiple degree programs. This shall require further study to establish if universities have the capacity to support the large number of engineering degree programs offered by the very many departments.

Table E.2 – Overall Faculty to Student Ratios per Department

Department name	Total full-time faculty	Total part-time faculty	Full-time faculty with PhD	UG Student enrolment AY 2014/2015	Full-time Faculty-to-student ratio
CSE	142	56	53	3089	22
EEE	150	110	51	3963	26
MME	211	70	89	3291	16
Overall	**503**	**236**	**193**	**10,343**	21

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Figure E.2 below shows the number of graduates at the undergraduate level over a period of three academic years (AY 2011/2012 – AY 2013/2014). This shows that there were a total of only 1,625 engineering graduates in the AY 2013/2014. This was expected to increase with the increased enrolment in the AY 2014/2015.

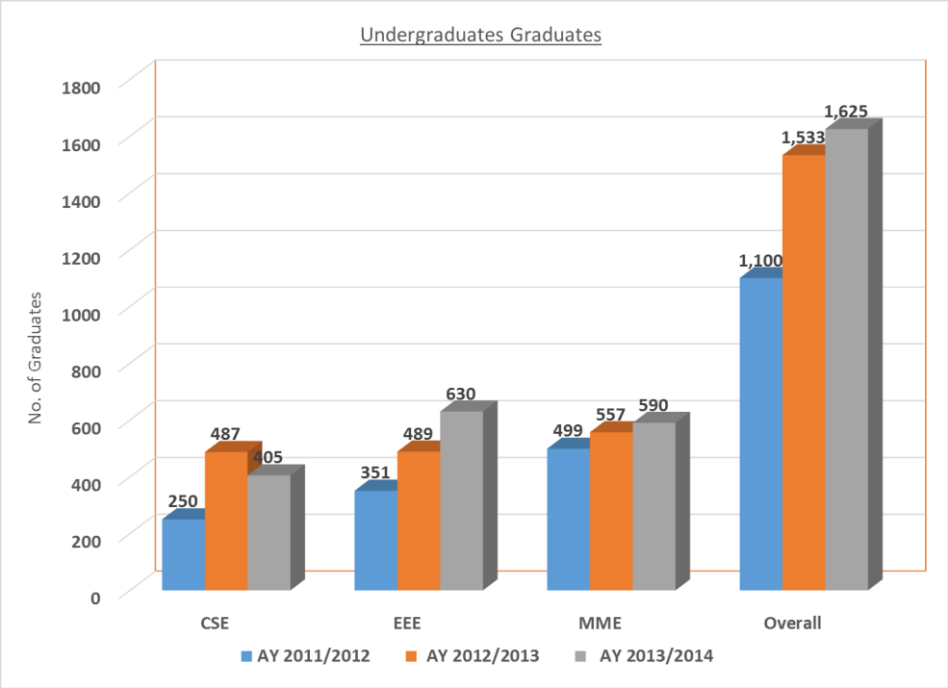


Figure E.2: Engineering graduates at undegraduate level

The 193 doctoral-level engineering faculty members have the potential to support a large number of undergraduate and post-graduate students at both Masters and PhD levels if they were concentrated in a few universities and fewer critical departments. At the same time, given that the faculty student ratio is acceptable at an aggregate level means that we have adequate faculty in Kenya for the all the enrolled engineering students. This has two key policy implications:

1. If the engineering programs were concentrated in a few universities and departments, Kenya could offer better quality engineering education
2. The three universities with a critical mass of faculty (i.e., UoN, MU and JKUAT) should serve as centers of faculty development and also focus on post-graduate studies in order to increase the number of PhD level faculty in Kenyan universities.

There were a total of only 35 PhD students enrolled in all engineering degree programs in the AY 2014/2015 compared to the total undergraduate enrollment of 10,343 at undergraduate level. Most of the PhD students were enrolled in only four of the 12 universities.

The number of engineering graduates at Masters and PhD levels was very low with only **195** Masters degrees and **36** PhD degrees awarded over the three academic years from AY 2011/2012 to AY 2013/2014. This number of Masters' degree graduates was only **4.6%** of the 4,258 graduates at undergraduate level. The PhD graduates over the same period were only **0.8%** of the graduates at undergraduates. This shows low graduation rates at post-graduate levels.

The results also show that about 50% of the Masters and PhD degrees were awarded by JKUAT and most of the PhD degree were in the MME catagory of degree programs. Moreover, only three universities had awarded PhD degrees in engineering over the three year period, namely, Egerton, JKUAT, and University of Nairobi. That means post-graduate education in engineering is concentrated in only three universities.

Engineering departments had very low budgets allocated for infrastructure, research or teaching as shown in Figure E.3 with an average of only Ksh 2 million per department allocated for recurrent cost of teaching in the FY 2014/2015. Moreover, over 50% of heads of department were unable to provide data on departmenetal budgets, even for the recurrent teaching budgets. This suggests that heads of departments were not involved in institutional budgeting.

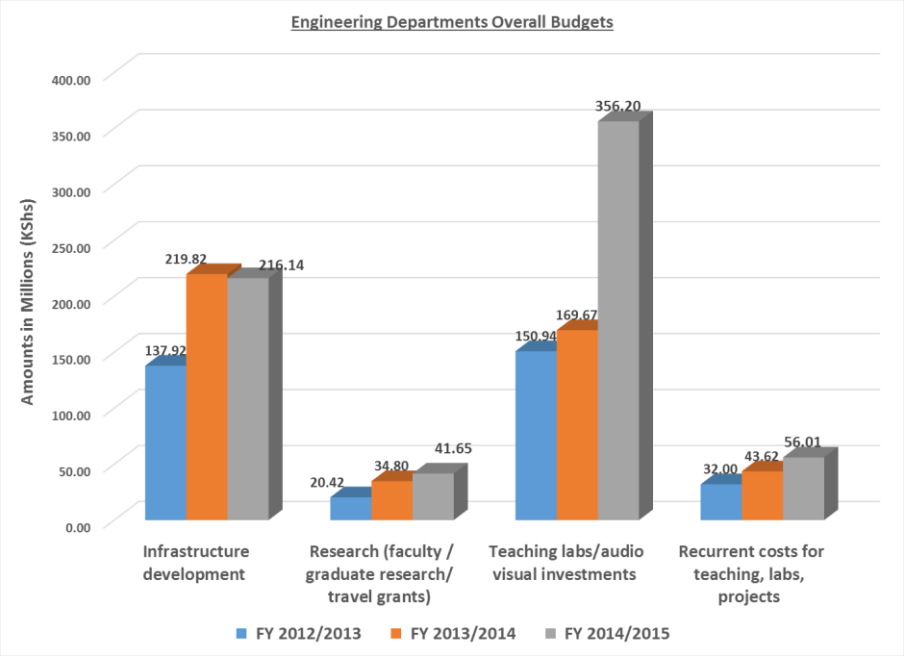
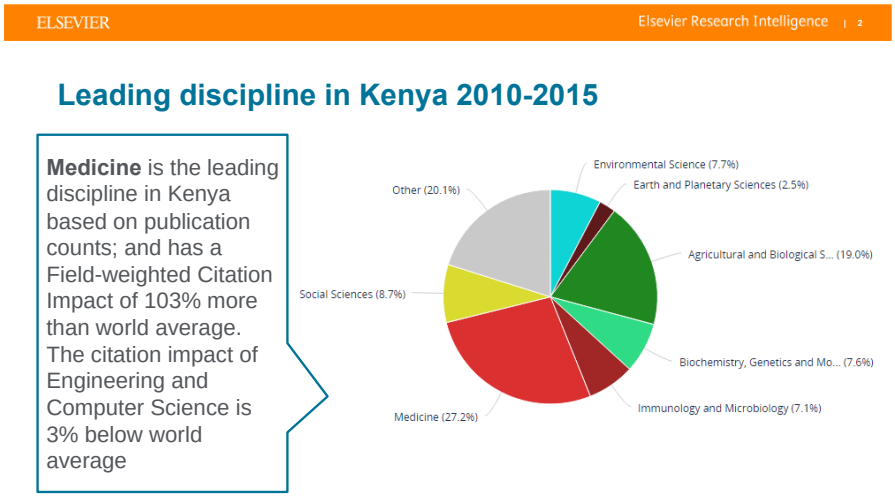


Figure E.3: Budgets allocated to engineering departments

The data on publications per faculty per year shows that faculty in the three categories of departments were publishing between 0.8 (CSE) and 0.4 (EEE) per year per faculty. This was over a 3-year period from 2011-2014. This means that on average, a faculty member in EEE will take more than two years to produce a single paper, which is a low research productivity rate. Data from Elsevier's SciVal confirms that engineering faculty in Kenya have a low publication record when compared to say faculty in Medicine as shown in Figure E.4 over a period of five years from 2010 to 2015 (The data was derived from Elsevier's Scopus Database of research publications in refereed journals).



Discipline	Publications	Citations	Authors	FWCI
Medicine	5,148	51,062	5,387	2.03
Engineering	339	770	511	0.97
Computer Science	32	310	314	0.97

Source: SciVal

Figure E.4: Comparison of the publications of medicine and engineering disciplines in Kenya

Conclusions and recommendations

Undergraduate engineering students represent only about **2.6%** of the total undergraduate student and only **3.6%** of the total enrolment of the 12 participating universities. Although 503 full-time engineering appear adequate when measured in terms of the overall faculty-to-student ratios (e.g., overall 21 students per full-time faculty member), it seems the students and faculty were spread over very many degree programs in different universities. It is therefore possible that the engineering faculty workload was quite high but this shall be a subject of future research.

The 1,625 engineering graduates in the AY 2013/2014 and this was expected to increase because of increase in enrolment in the AY 2014/2015. However, anecdotal evidence suggests that engineering graduates remained unemployed even after two years from date of graduation. That means that engineering departments and universities needed to work much more closely with industry and Engineering Board of Kenya to establish the optimum number of graduates the industry needs.

The results have shown that heads of departments are not on the whole involved in allocation of institutional resources and did not seem to be measuring the research and innovation outputs of their respective departments. On the whole, engineering departments did not appear active in research as measured by Masters and PhD graduates as well as papers published per full-time faculty per year. There was therefore a need for an indepth assessment of the reasons for the low research productivity of engineering departments.

This report highlights the need for engineering departments to collect and maintain academic and research data for planning and decision making. It could also be used to justify the need for increased institutional support for engineering and also university and industry collaboration. It further suggests the need to consolidate departments in order to increase productivity.