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Kenya Education Network

Baseline Survey of Engineering Departments 2015

A STUDY FUNDED BY THE KENYA EDUCATION NETWORK

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The survey required detailed and sometimes confidential data from all participating universities and engineering departments. It therefore could not have been completed without support from the vice chancellors, heads of engineering departments, and deans of schools of engineering. I thank them sincerely for their support.

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EXECUTIVE SUMMARY

Rationale 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 survey is based on an e-readiness assessment framework that 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. The data includes student enrollment, full-time faculty members and their qualifications, institutional financial health data, in addition to ICT access and affordability. This would normally be data required by the management of a university or by external accreditation bodies. For example, one of the 17 indicators, titled **ICT Research and Innovation**, 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 Deputy Vice Chancellor for academic affairs, the academic deans, or directors of ICT.

The engineering departments' baseline survey therefore collected detailed data from heads of the departments that could be used to measure individual department's level of research and innovation. 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 the Engineers Board of Kenya (EBK), the professional body mandated to accredit engineering degree programs.

Research methodology

The data was collected over 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). It was used to collect the following data for each department:

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

4. **Research and innovation output** of departments as measured by participation of students in engineering design competitions and exhibitions, master's 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 research assistants (one for every participating university), most of whom were junior ICT or engineering faculty members. Data was analyzed at both the departmental level and in aggregate form for all the 12 universities that were offering engineering degree programs by November 2014. To simplify the analysis all 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 (including 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

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

Table E.1: Engineering student enrollment per university in AY 2014/2015

	University	Number of departments	Total enrollment AY 2014/2015
1	Dedan Kimathi University	4	534
2	Egerton University	4	428
3	Jomo Kenyatta University of Agriculture and Technology	6	2,844
4	Kenyatta University	5	1,163
5	Masinde Muliro University of Science and Technology	3	149
6	Meru University of Science and Technology	1	90
7	Moi University	5	1,211
8	Multimedia University of Kenya	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 the engineering degree programs had a total undergraduate student enrollment of **10,343** in AY 2014/2015, representing about **2.6%** of the total university undergraduate student enrollment of **394,048** students in all Kenyan universities, during this academic year (http://ereadiness.kenet.or.ke/enrollment). Figure E.1 below shows the growth in enrollment over three academic years implying a dramatic increase in AY 2014/2015.

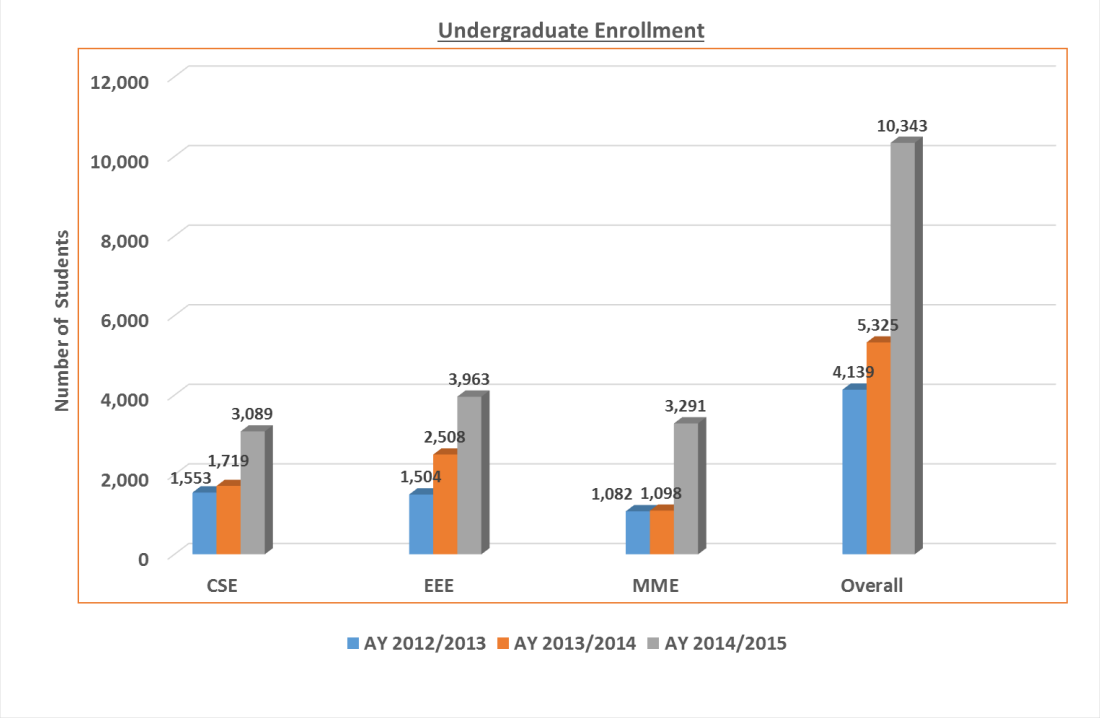

Figure E.1: Undergraduate enrollment AY 2012/2013 to AY 2014/2015

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

There were **503** full-time engineering faculty members, **193** with doctoral degrees (i.e. 38% full-time faculty had PhD degrees). The total number of engineering faculty members excluded **88** tutorial fellows employed by some engineering departments, but included 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.

Another observation was that the faculty to student ratio was low with an average of 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 E.2. 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 members were 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 numerous 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	Undergraduate Student enrollment 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 undergraduate level over three academic years (AY 2011/2012–AY 2013/2014). There was a total of 1,625 engineering graduates in AY 2013/2014. This was expected to grow with increased enrollment in AY 2014/2015.

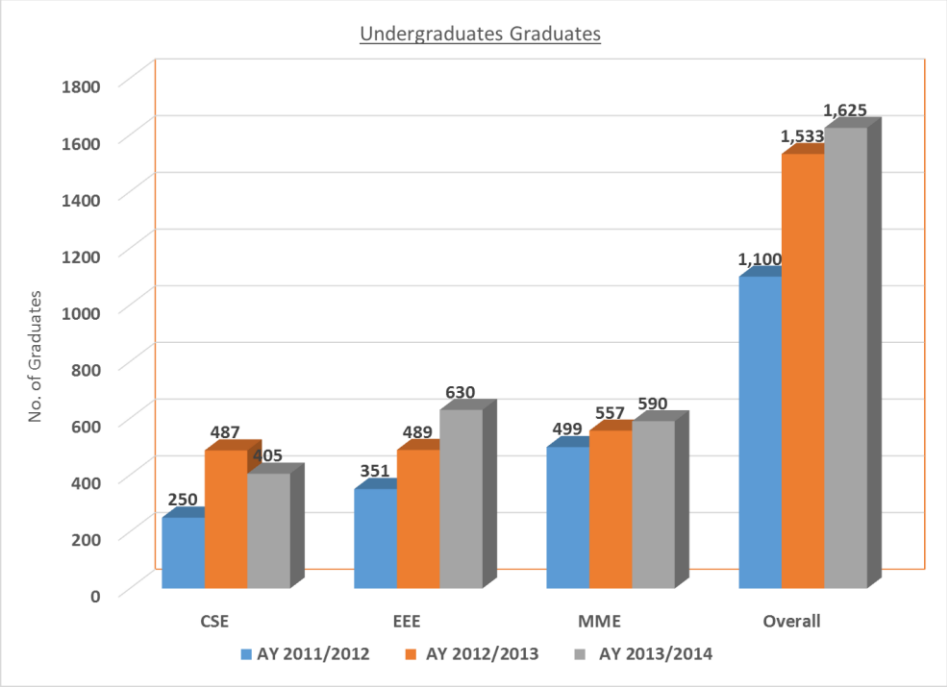

Figure E.2: Engineering graduates at undegraduate level

The 193 doctoral level engineering faculty members have the potential of supporting a large number of undergraduate and postgraduate students at master's and PhD levels if they were concentrated in a few universities and fewer critical departments. The faculty student ratio, which is acceptable at an aggregate level, may also indicate that there is adequate faculty in Kenya for all enrolled engineering students.

This has two key policy implications:

1. If 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 postgraduate studies in order to increase the number of PhD level faculty in Kenyan universities.

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

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

The results also show that about 50% of the master's 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 awarded PhD degrees in engineering over the three year period, namely, Egerton, JKUAT, and University of Nairobi. This implies that postgraduate 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 for teaching in 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.

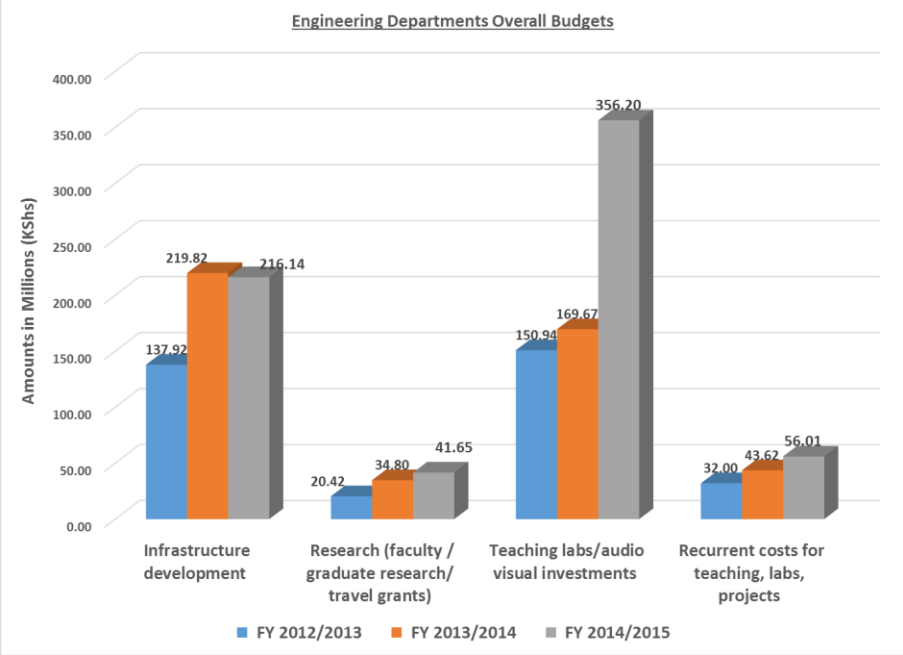

Figure E.3: Budgets allocated to engineering departments

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 over a three year period from 2011 to 2014. This means that on average, a faculty member in EEE takes 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 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).

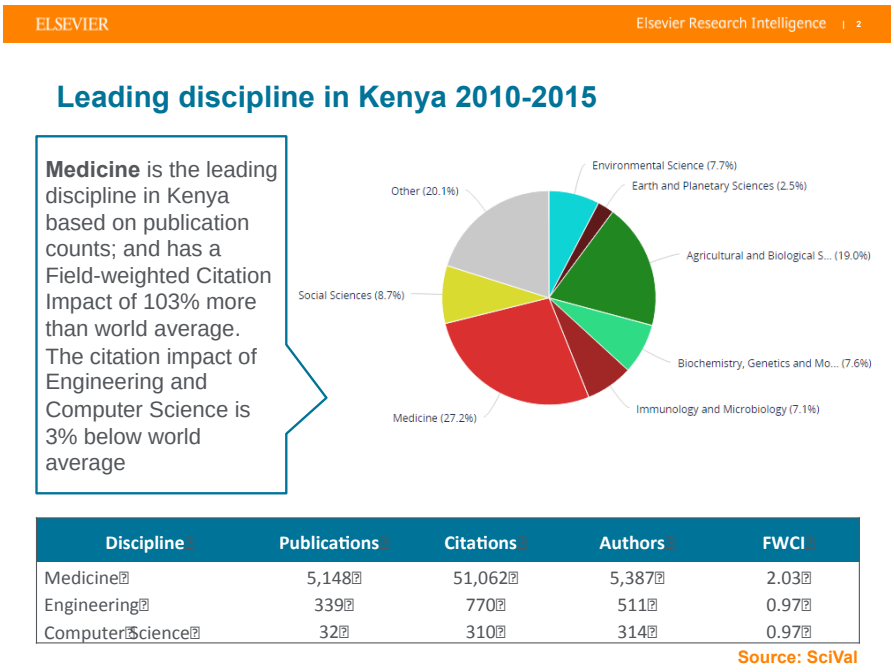

Figure E.4: Comparison of the publications for medicine and engineering disciplines in Kenya

Conclusions and recommendations

Undergraduate engineering students represented about **2.6%** of total undergraduate students and only **3.6%** of the total enrollment of the 12 participating universities. Although 503 full-time engineering faculty appeared adequate when measured in terms of the overall faculty to student ratios (e.g., overall 21 students per full-time faculty member), it seemed that 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 requires futher research.

There were 1,625 engineering graduates in AY 2013/2014 and the number is expected to grow because of the increased enrollment in AY 2014/2015. However, anecdotal evidence suggested that engineering graduates still remained unemployed two years after graduation. This indicates that engineering departments and universities need to work much more closely with industry and the Engineering Board of Kenya to establish the optimum number of graduates the industry could absorb.

The results also show that heads of departments were not 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 master's and PhD graduates, as well as papers published per full-time faculty per year. There is 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 advocate for increased institutional support for engineering, as well as university and industry collaboration. It further suggests the need to consolidate departments in order to increase productivity.

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ABBREVIATIONS

AY	Academic year
EB	Engineering Board of Kenya
CUE	Commission for University Education
CSE	Civil and Structural Engineering
DKUT	Dedan Kimathi University of Technology
EEE	Electrical and Electronic Engineering
EU	Egerton University
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KENET	Kenya Education Network
KU	Kenyatta University
MME	Mechanical and Manufacturing Engineering
MMUST	Masinde Muliro University of Science and Technology
MMU	Multimedia University of Kenya
MUST	Meru University of Science and Technology
MU	Moi University
NREN	National Research and Education Network
SIG	Special Interest Group on Engineering Education and Research
TIE	Telecommunication Information Engineering
TUK	Technical University of Kenya
TUM	Technical University of Mombasa
UoE	University of Eldoret
UoN	University of Nairobi

Chapter 1: Introduction

Kenya Education Network (KENET) has supported institutional e-readiness survey research since 2006 using an e-readiness assessment framework developed by the authors of this report (http://www.ubuntunet.net/sites/default/files/kashorda&timothy.pdf). E-readiness research aims to measure the degree of institutional preparedness of universities in Kenya and East Africa to take advantage of opportunities presented by information and communication technologies (ICTs) to transform education and research.

Institutional e-readiness is measured using 17 indicators that include network access indicators such as Internet bandwidth affordability and Internet availability (http://www.ubuntunet.net/sites/default/files/kashorda&timothy.pdf). From 2007, the e-readiness results have been used to communicate with the senior leadership of Kenyan universities on the need to increase investments in ICT infrastructure, systems and professionals in order to achieve their missions (see reports at http://ereadiness.kenet.or.ke:8080/ereadiness/). Anecdotal evidence suggests that most universities were using some of the 17 e-readiness indicators to make strategic decisions on ICT campus infrastructure investments, Internet bandwidth budgets, e-learning and other institutional ICT services.

The KENET Strategic Plan (2011–2016) identifies five priority academic disciplines that require detailed baseline and e-readiness surveys. These are agriculture, computer science and information systems, education, engineering and medicine. Since November 2014, the researchers have conducted baseline surveys of engineering, computer science and information systems departments, as well as medical schools in Kenyan universities.

The baseline surveys of departments in the priority academic discipline were expected to complement the institutional e-readiness surveys by providing additional data on the drivers of institutional accession to higher levels of e-readiness. The key motivation for baseline and e-readiness surveys was to promote effective and efficient use of ICT and institutional data to transform teaching, learning, research and administrative services in Kenyan universities. The survey results were also expected to influence national policies on ICT in higher education in Kenya.

The baseline survey questionnaires were completed by heads of engineering departments. This was different from institutional e-readiness surveys hard facts questionnaires that were completed by senior university administrators who often did not have data on departmental research output or innovations. It was the first comprehensive survey of engineering departments in Kenya known to the authors.

This baseline survey collected data in the following areas for each engineering department:

1. **Engineering student enrollment and graduates** (undergraduate and postgraduate) over a period of three academic years, from AY 2012/2013 to AY 2014/2015
2. **Basic engineering faculty data** (full-time and part-time) per department and their academic and professional qualifications

3. **Research and innovations output** as measured by publications and other scholarly works or participation in engineering exhibitions and design competitions by engineering students
4. **Institutional support levels** in terms of departmental budgets for teaching and research, learning environments, and faculty development
5. **Perceptions of the engineering department** heads and deans on the impact of ICT on engineering education and research

The detailed questionnaire used to collect the data is available at the baseline survey website at http://ereadiness.kenet.or.ke/engineering. Data was collected from all the universities offering engineering degree programs in Kenya from November 2014 to March 2015 and validated between November 2015 and January 2016.

One of the key findings was that there were 12 fully-fledged universities offering 54 undergraduate engineering degree programs in 44 different engineering departments. The degree programs were grouped into three categories for analysis, namely, civil and structural engineering (CSE); electrical and electronic engineering (EEE); and mechanical and mechatronics engineering (MME).

All the engineering degree programs had a total undergraduate student enrollment of **10,343** in AY 2014/2015 representing about **2.6%** of total university undergraduate student enrollment of **394,048** students in all Kenyan universities in that academic year (http://ereadiness.kenet.or.ke/enrollment). Moreover, there were **288** master's and **35** PhD students in AY 2014/2015, most of them in the three universities that had offered 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 **503** full-time engineering faculty members, **193** with doctoral degrees (i.e., 38% full-time faculty had PhD degrees). The total number of engineering faculty members excluded 88 tutorial fellows employed by some engineering departments but included the 108 full-time assistant lecturers. A significant number, 337 (57% of the total faculty, including tutorial fellows), 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.

This report is organized as follows: Chapter 2 describes the research methodology used to collect data and highlights the challenges of collecting data at departmental level. Chapter 3 presents data on trends in engineering student enrollment and full-time faculty in different engineering departments; while Chapter 4 contains data on institutional support of engineering departments in terms of budgets and faculty development. The results of the engineering research and innovations outputs of the departments are presented in Chapter 5. Chapter 6 contains conclusions and recommendations.

Chapter 2: Research Methodology

2.1 Participating universities and engineering departments

The engineering departments baseline survey was part of a broader 'engineering and ICT departments survey' conducted from November 2014 to March 2015 and validated from November 2015 to January 2016. It was an extension of the 2013 e-readiness survey of 30 Kenyan universities consisting of 20 public universities and 10 private universities. This included all the 17 universities that participated in the 2006, 2008, and 2013 e-readiness survey studies. However, only 12 out of the 30 universities offered engineering degree programs as of November 2014 when the survey was started as shown in Table 2.1 below.

Table 2.1: Universities and departments per university offering engineering programs

	University	Number of Departments
1	Dedan Kimathi University	4
2	Egerton University	4
3	Jomo Kenyatta University of Agriculture and Technology	6
4	Kenyatta University	5
5	Masinde Muliro University of Science and Technology	3
6	Meru University of Science and Technology	1
7	Moi University	5
8	Multimedia University of Kenya	1
9	Technical University of Kenya	4
10	Technical University of Mombasa	4
11	University of Eldoret	3
12	University of Nairobi	4
	Total	**44**

A total of **44** departments in the 12 public universities were therefore included in the survey since no private university offered engineering degree programs as of November 2014. A few other public university colleges offered engineering degree programs but were excluded because they were not part of the 2013 e-readiness survey. They had also not been chartered by the Commission for University Education (CUE), so their degree certificates were issued by the parent university (e.g., Taita Taveta University College had certificates issued by JKUAT).

Although the baseline survey was supposed to take one month, it was completed after six months in April 2015. This was because most department heads appeared not to have easy access to some departmental data required to complete the questionnaires. In addition, some of the department heads had not verified questionnaires that had been completed by their assistants and all the data had to be validated between November 2015 and January 2016. Thus, data collection was conducted over a period of 14 months.

2.2 Baseline survey process and data collection window

The preparations for the baseline survey started in September 2014 when letters of authorization to collect data were sent to Vice Chancellors of the 30 participating universities. The baseline survey included departments of ICT (i.e., computer science and information systems degree departments). A mailing list (and associated database) of all the deans and heads of engineering departments was created by the research coordinator at KENET.

The e-readiness 2013 survey research assistants, who were still employed by the universities, were retained to conduct the baseline survey. These research assistants were familiar with the survey process and had already established contacts with senior leadership of the participating universities. Each research assistant was given a copy of the authorization letters from the Vice Chancellors and an introduction letter from KENET.

During the engineering departments' forum to discuss the findings of the baseline survey held on **October 30 2015**, inaccuracies and gaps in the data were observed. The forum therefore recommended that all questionnaires be validated and that research assistants be selected from engineering departments. The validation process using the new research assistants was completed on January 13, 2016 when the last questionnaire was received.

All the survey questionnaires were sent to the main campuses via courier services and via e-mail to the research assistants. The first cycle of data collection commenced in the first week of November 2014 and closed in the last week of April 2015 (a six months window). The subsequent questionnaires validation period was closed on January 13, 2016. This baseline survey therefore took about 14 months to complete. However, this first baseline survey of engineering departments contained new and previously unavailable aggregated data that will be the basis of a policy brief on engineering education and research in Kenya to be prepared by the authors.

2.3 Data collection and analysis

Data was collected using a baseline survey questionnaire that had five sections as follows[1]:

1. **Section A** collected general data on the participating universities and departments, and the interviewee (i.e., the head of department).

2. **Section B** collected data on the engineering departments. This included student enrollment and graduation data for three academic years from AY 2012/2013 to AY 2014/2015. *This turned out to be complex because universities do not have a common academic year*. It also included faculty data for each of the departments.

3. **Section C** collected data on department budgets and gross salaries of engineering faculty for three fiscal years in AY 2012/2013 to AY 2014/2015. It appears that this data was not

[1] The survey instrument is available for download at e-readiness website(http://ereadiness.kenet.or.ke/engineering)

easily available at the departmental level. It therefore took long to collect it from finance and human resources departments of the universities.

4. **Section D** collected data on research and innovation outputs of the faculty and their departments. This data included the thesis and research project reports completed by postgraduate students, and conference and journal papers published by faculty. *Surprisingly, this data was not easily available at the departmental level or even at the institutional level and it took a long time to compile*. It is possible that most universities did not have a system that monitored their research and innovation outputs at departmental level. The data was collected on an *ad hoc* basis for purposes of reporting to different bodies, for performance contracting and other purposes, including Webometric ranking.

5. **Section E** collected data on faculty development programs over the three academic years from AY 2012 to 2015.

6. **Section F** was a perception survey of the department heads on the impact of ICT on engineering education and research.

All the completed survey questionnaires were sent back to KENET offices. University students were recruited for the data entry exercise. The data was then cross-checked by the researchers and KENET statisticians for accuracy and consistency. In some cases, the data was cross-checked with the departmental heads after data entry. The survey instrument is available for download at e-readiness website (http://ereadiness.kenet.or.ke/engineering).

Data captured by each of the above sections of the questionnaire was analyzed at the departmental level for each of the 44 departments that had completed the questionnaire, at university level for each of the 12 universities that participated, and at aggregate level for each of the three categories of engineering departments. Most of the data in this report is at the aggregate level but analyzed data on each department is available in Excel format from the researchers.

As explained earlier, all the undergraduate engineering degree programs were classified into three main categories of civil and structural engineering (CSE); electrical and electronics engineering (EEE) or mechanical and mechatronics engineering (MME) as shown in Appendix 1. The results of the analysis are contained in Chapters 3 to 5, while Chapter 6 presents the conclusions and recommendations.

Chapter 3: Engineering Student Enrollment and Engineering Faculty Data

3.1 Trends in engineering student enrollment in Kenyan universities

The baseline survey revealed that **12** Kenyan universities were offering engineering degree programs as of November 2014. There was a total of **54** different undergraduate engineering degree programs offered in **44** departments. The degree programs were classified into three main categories for analysis namely, civil and structural engineering (10); electrical and electronics engineering (13); and mechanical and mechatronic engineering (21). The details of how the classification was done are presented in Appendix 2. It was noted that **26** undergraduate engineering degree programs, offered in eight universities, had not been accredited by the Engineering Board of Kenya (EBK) as of August 2015.

Table 3.1a shows the student enrollment growth in the 12 universities over three academic years: AY 2012/2013, AY 2013/2014 and AY 2014/2015. There were **10,343** undergraduate engineering students enrolled in the AY 2014/2015, representing only **3.6 %** of the of **289,336** total undergraduate student enrollment in the 12 universities. The highest enrollment was in the EEE category at 3,963. We note that there were 21 departments offering MME category of degree programs representing close to 50% of engineering departments. We noted a growth of close to 100% in engineering student enrollment from 5,325 in AY 2013/2014 to 10,343 in the AY 2014/2015.

Table 3.1a: Trend in engineering student enrollment AY 2012/2013 to AY 2014/2015

Department	2012/2013	2013/2014	2014/2015	Number of Departments
Civil and structural engineering (CSE)	1,553	1,719	3,089	10
Electrical and electronics engineering (EEE)	1,504	2,508	3,963	13
Mechanical and mechatronic engineering (MME)	1,082	1,098	3,291	21
Total	**4,139**	**5,325**	**10,343**	**44**

Table 3.1b shows the undergraduate engineering students enrollment in each of the 12 universities. The top three universities in terms of enrollment were JKUAT (2,844), University of Nairobi (1,798) and Technical University of Kenya (1,765).

Table 3.1b: Engineering student enrollment per university in AY 2014/2015

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

At the end of the first survey window in March 2015, only **four** universities that were offering engineering degree programs had been accredited by EBK, namely, Egerton University, JKUAT, Moi University and University of Nairobi. This position had changed by August 2015 when an additional two universities had degree programs that were accredited by EBK (see http://www.ebk.or.ke for list of accredited degree programs). Table 3.2 shows the AY 2014/2015 total enrollments in degree programs accredited by EBK as of August 2015.

Table 3.2 shows that **6,131** students in the AY 2014/2015 were enrolled in EBK accredited degree programs in six universities out of the total of **10,343** students enrolled in all engineering degree programs in the 12 universities. That is, only **59%** of all engineering degree students were pursuing EBK accredited degree programs. There was therefore an urgent need for the universities with unaccredited degree programs to have their degree programs accredited by EBK for the benefit of the 4,212 students in these universities.

Table 3.2: Engineering student enrollment in AY 2014/2015 for EBK accredited degree programs

	University	Total enrollment EBK accredited degree	% students in EBK accredited degree programs
1	Dedan Kimathi University	534	100
2	Egerton University	80	18.6
3	Jomo Kenyatta University of Agriculture and Technology	1,608	56.5
4	Kenyatta University	900	77
5	Moi University	1,211	100
6	University of Nairobi	1,798	100
	TOTAL	**6,131**	**77**

3.2 Engineering faculty in Kenyan universities

The baseline survey collected data on faculty numbers (both part-time and full-time faculty), their qualifications, registration status with EBK, and highest degree qualifications. This data was used to calculate the faculty to student ratios based on full-time faculty only.

There was a total of **503** engineering full-time faculty members, **193** with PhDs and **108** at the rank of assistant lecturers. Table 3.3 shows the full-time faculty numbers and doctoral level faculty in the 12 universities, including the **236** part-time faculty members as of January 2016.

About 63% of the faculty members with PhDs were employees of three universities, namely, JKUAT, Moi University and University of Nairobi. These were the only universities with critical mass of engineering faculty and had the potential to focus on engineering research and doctoral programs. Overall, only about 33% of the full-time faculty had a PhD and about 57% of the total faculty members, including assistant lecturers, were registered with EBK.

Table 3.3 shows that JKUAT had the highest number of full-time faculty at 118, followed by University of Nairobi with 63 and Moi University with 56 full-time faculty members. JKUAT also had the highest number of engineering faculty members with PhDs at 46 followed by UoN with 44 and Moi University with 31. This data was surprising considering that UoN had the oldest engineering departments started in 1971, followed by MU (1984) and then JKUAT (1986).

Table 3.3: Engineering faculty numbers and doctoral qualifications in the 12 universities

	University	Full-time faculty (excluding tutorial fellows)	Part-time faculty	Full-time faculty with PhDs	Full-time faculty registered with EBK
1	Dedan Kimathi University	37	19	8	7
2	Egerton University	42	10	6	44
3	Jomo Kenyatta University of Agriculture and Technology	118	4	46	31
4	Kenyatta University	35	55	15	24
5	Masinde Muliro University of Science and Technology	32	16	15	18
6	Meru University of Science and Technology	7	15	2	4
7	Moi University	56	8	31	56
8	Multimedia University of Kenya	19	17	2	10
9	Technical University of Kenya	36	46	13	30
10	Technical University of Mombasa	45	28	9	49
11	University of Eldoret	13	18	2	15
12	University of Nairobi	63	0	44	49
	Total	**503**	**236**	**193**	**337**

3.3 Faculty to student ratios

The data was analyzed further to show the full-time faculty in each of the departments offering engineering degree programs as well as the faculty to student ratios. Table 3.4 shows that mechanical and mechatronic engineering category of departments had the highest number of full-time faculty at 211, followed by electrical and electronic engineering at 150 and then civil and structural engineering at 142.

Table 3.4: Overall faculty to student ratios per department

Department	Total full-time faculty	Total part-time faculty	Full-time faculty with PhD	Undergraduate Student enrollment 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**

Faculty student ratios were calculated per department as shown in Tables 3.4 (overall), 3.4a (CSE) 3.4b (EEE), and 3.4c (MME). The data shows that the overall faculty to student ratios for the different departments was relatively low with the highest in EEE departments at 26 students per faculty member, suggesting that there was an adequate number of engineering faculty members to support the 10,343 students enrolled in AY 2014/2015.

However, Tables 3.4a, 3.4b, and 3.4c show huge variations among the 12 universities. The following examples illustrate this disparity:

a) In CSE, the Technical University of Kenya had a faculty ratio of 74 students per faculty (Table 3.4a) against the overall ratio of 21 students to 1. At the same time, five universities had a faculty student ratio of 6 or less.
b) The University of Nairobi had a faculty ratio of 57 students to 1 faculty member in EEE department against an average of 26 (Table 3.4b) students per full-time faculty member. At the same time, three universities had a faculty student ratio of 5 or less.
c) Kenyatta University had a student ratio of 44 students to one faculty member for MME departments against a low average of 16 (Table 3.4c) students per faculty member. At the same time, four universities had a faculty student ratio of 6 or less.

This suggests that universities need to offer a limited range of engineering degree programs in fewer departments in order to ensure adequate faculty to student ratio per degree program.

Table 3.4a: Faculty ratios in civil and structural engineering departments per university

	University	Total full-time faculty	Total part-time faculty	Full-time faculty with PhD	Undergraduate Student enrollment AY 2014/2015	Full-time Faculty to student ratio
1	Dedan Kimathi University of Technology	18	14	1	74	4
2	Egerton University	9	3	3	25	3
3	Jomo Kenyatta University of Agriculture and Technology	27	0	6	876	32
4	Kenyatta University	15	5	10	321	21
5	Masinde Muliro University of Science and Technology	11	3	8	55	5
6	Moi University	14	3	6	297	21
7	Technical University of Kenya	11	13	2	812	74
8	Technical University of Mombasa	15	8	4	87	6
9	University of Eldoret	5	7	0	30	6
10	University of Nairobi	17	0	13	512	30
	Total	**142**	**56**	**53**	**3,089**	**22**

Table 3.4b: Faculty ratios in electrical and electronic engineering

	University	Total full-time faculty	Total part-time faculty	Full-time faculty with PhD	Undergraduate student enrollment AY 2014/2015	Full-time Faculty to student ratio
1	Dedan Kimathi University of Technology	13	0	5	370	28
2	Egerton University	7	2	0	295	42
3	Jomo Kenyatta University of Agriculture and Technology	28	4	11	1,015	36
4	Kenyatta University	11	34	4	449	41
5	Masinde Muliro University of Science and Technology	10	3	5	53	5
6	Meru University of Science and Technology	7	15	2	90	13
7	Moi University	15	1	5	510	34
8	Multimedia University of Kenya	19	17	2	65	3
9	Technical University of Kenya	11	30	3	187	17
10	Technical University of Mombasa	16	4	3	80	5
11	University of Nairobi	13	0	11	849	65
	Total	**150**	**110**	**51**	**3,963**	26

Table 3.4c: Faculty ratios in mechanical and mechatronic engineering departments

	University	Total full-time faculty	Total part-time faculty	Full-time faculty with PhD	Undergraduate Student enrollment AY 2014/2015	Full-time Faculty to student ratio
1	Dedan Kimathi University of Technology	6	5	2	90	15
2	Egerton University	26	5	3	108	4
3	Jomo Kenyatta University of Agriculture and Technology	63	0	29	953	15
4	Kenyatta University	9	16	1	393	44
5	Masinde Muliro University of Science and Technology	11	10	2	41	4
6	Moi University	27	4	20	404	15
7	Technical University of Kenya	14	3	8	766	55
8	Technical University of Mombasa	14	16	2	59	4
9	University of Eldoret	8	11	2	40	5
10	University of Nairobi	33	0	20	437	13
	Total	**211**	**70**	**89**	**3,291**	**16**

In conclusion, the 193 doctoral level engineering faculty members have the potential to support a large number of undergraduate and postgraduate students at both master's and PhD levels if concentrated in a few universities and fewer critical departments. The data also implies that the faculty to student ratio is acceptable at an aggregate level, meaning that there is adequate faculty in the country 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, universities 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 postgraduate studies in order to increase the number of PhD level faculty in Kenyan universities.

3.4 Engineering graduates at undergraduate level

The survey collected data on students who had graduated from different undergraduate engineering degree programs from AY 2011/2012 to 2013/2014.

Figure 3.1 shows there was an increase of about **39%** in the number of graduates from AY 2011/2012 to AY 2012/2013 and a **6%** growth in AY 2013/2014. We note that in AY 2013/2014, EEE category registered the highest number of graduates at 630, followed by MME at 590, while CSE had 405.

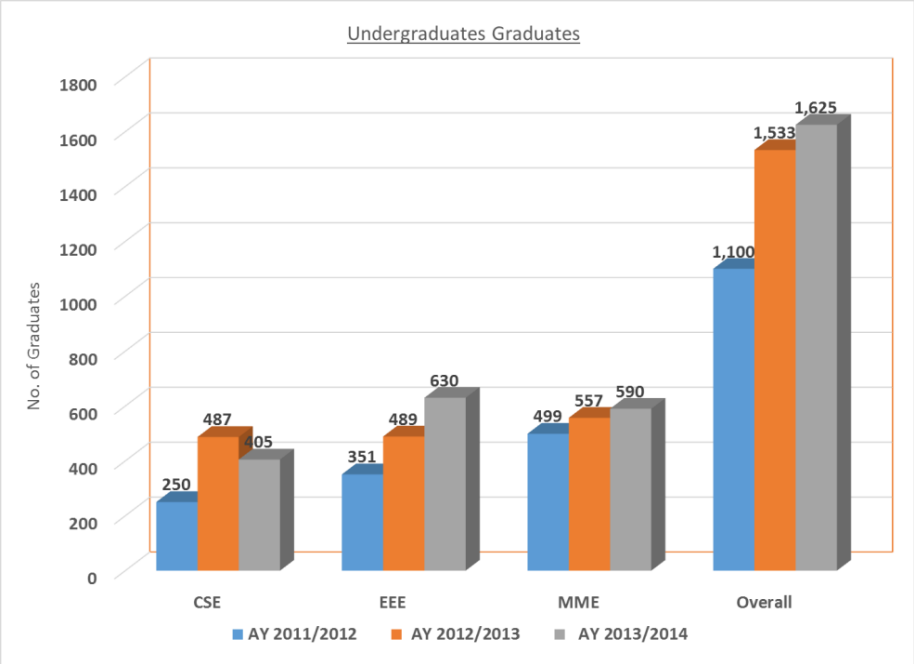

Figure 3.1: Graduates per degree program from 2011–2014

Tables 3.5a, 3.5b and 3.5c show the graduates in different degree areas for all 12 universities. Table 3.5b shows that the Technical University of Kenya had the highest number of EEE graduates in the AY 2013/2014, almost twice the number of graduates from University of Nairobi (99 graduates) or JKUAT (96 graduates). *This was a surprising result considering that TUK was a relatively new university having been accredited in 2013.*

Table 3.5a: Graduates per university from 2011 to 2014 in civil and structural engineering

	University	Graduates AY 2011/12	Graduates AY 2012/2013	Graduates AY 2013/2014
1	Dedan Kimathi University of Technology	0	115	68
2	Egerton University	84	53	49
3	Jomo Kenyatta University of Agriculture and Technology	79	106	85
4	Kenyatta University	0	0	0
5	Masinde Muliro University of Science and Technology	33	37	45
6	Moi University	34	48	44
7	Technical University of Kenya	20	38	38
8	Technical University of Mombasa	0	0	0
9	University of Eldoret	0	0	0
10	University of Nairobi	No data	90	76
	Total	**250**	**487**	**405**

Table 3.5b: Graduates per university from 2011 to 2014 in electrical and electronic engineering

	University	Graduates AY 2011/2012	Graduates AY 2012/2013	Graduates AY 2013/2014
1	Dedan Kimathi University of Technology	0	0	0
2	Egerton University	32	41	36
3	Jomo Kenyatta University of Agriculture and Technology	0	68	96
4	Kenyatta University	0	0	0
5	Masinde Muliro University of Science and Technology	44	33	41
6	Meru University of Science and Technology	0	0	0
7	Moi University	106	97	107
8	Multimedia University of Kenya	0	0	0
9	Technical University of Kenya	73	165	190
10	Technical University of Mombasa	0	0	61
11	University of Nairobi	96	85	99
	Total	**351**	**489**	**630**

Table 3.5c: Graduates per university from 2011 to 2014 in *mechanical and mechatronic engineering*

	University	Graduates AY 2011/12	Graduates AY 2012/2013	Graduates AY 2013/2014
1	Dedan Kimathi University of Technology	0	0	0
2	Egerton University	120	120	118
3	Jomo Kenyatta University of Agriculture and Technology	141	122	133
4	Kenyatta University	0	37	5
5	Masinde Muliro University of Science and Technology	35	40	41
6	Moi University	94	112	107
7	Technical University of Kenya	25	33	45
8	Technical University of Mombasa	0	0	19
9	University of Eldoret	0	0	11
10	University of Nairobi	84	93	111
	Total	**499**	**557**	**590**

3.5 Postgraduate enrollment and graduation rates

3.5.1 Master's degree enrollment and graduation rates

Only seven universities and 21 departments offered postgraduate degrees at master's level as of November 2014. Table 3.6 shows that 288 students were enrolled in AY 2014/2015 and there were 122 master's graduates in AY 2013/2014, almost four times the number of master's graduates in AY 2012/2013. We note that about 86% of the master's graduates were in the MME category of degree programs in AY 2013/2014. Thus the master's degree graduation throughput of the CSE and EEE degree programs was very small with only 6 and 11 graduates respectively in AY 2013/2014.

Tables 3.6a, 3.6b, and 3.6c show the master's students enrolment and graduates for the three categories of degree programs. Table 3.6c for MME category of departments shows that 74% of the graduates in AY 2013/2014 were from JKUAT. It was not possible to establish the reasons for the dramatic increase in master's students who graduated in AY 2013/2014 in the MME degree programs, particularly from JKUAT. Overall, the **195** master's graduates over three academic years were only **4.6%** of the **4,258** graduates at the undergraduate levels over the period. This means that the transition rates to master's degree programs was very low.

Table 3.6: Master's student enrollment AY 2014/2015 and graduates from 2011 to 2014

Department	Enrollment AY 2014/2015	Graduates AY 2011/12	Graduates AY 2012/2013	Graduates AY 2013/2014
CSE	83	6	1	6
EEE	71	2	5	11
MME	134	27	32	105
Overall	**288**	**35**	**38**	**122**

Table 3.6a: Master's student enrollment AY 2014/2015 and graduates from 2012 to 2014 in civil and structural engineering

	University	Enrollment AY 2014/ 15	Graduates AY 2011/12	Graduates AY 2012/13	Graduates AY2013/2014
1.	University of Nairobi	8	0	0	0
2.	Jomo Kenyatta University of Agriculture and Technology	53	1	1	2
3.	Moi University	6	5	0	4
4.	Masinde Muliro University of Science and Technology	16	0	0	0
	Total	**83**	**6**	**1**	**6**

Table 3.6b: Master's student enrolment AY 2014/2015 and graduates from 2012 to 2014 in electrical and electronic engineering

	University	Enrollment (2014/15)	Graduates AY 2011/12	Graduates AY 2012/13	Graduates AY 2013/14
1	Jomo Kenyatta University of Agriculture and Technology	46	1	2	4
2	Kenyatta University	14	1	1	2
3	University of Nairobi	11	0	2	5
	Total	71	2	5	11

Table 3.6c: Master's student enrolment AY 2014/2015 and graduates from 2012 to 2014 in mechanical and mechatronic engineering

	University	Enrollment AY 2014/15	Graduates AY 2011/12	Graduates AY 2012/13	Graduates AY 2013/2014
1	Dedan Kimathi University of Technology	0	0	0	7
2	Egerton University	1	8	3	3
3	Jomo Kenyatta University of Agriculture and Technology	74	10	19	78
4	Masinde Muliro University of Science and Technology	5	1	1	1
5	Moi University	13	1	2	8
6	University of Eldoret	7	0	0	2
7	University of Nairobi	34	7	7	6
	Total	**134**	**27**	**32**	**105**

3.5.2 PhD enrolment and graduation rates

Table 3.7 shows that in AY 2014/2015 students were enrolled in 14 engineering PhD degree programs, nine of them in the MME category. Only one university (JKUAT) had students enrolled in CSE PhD programs while three universities had students enrolled in both EEE and MME degree programs.

Table 3.8 shows that there were 35 PhD students enrolled in all engineering degree programs in AY 2014/2015, and only 15 PhD graduates in AY 2013/2014. *This data therefore confirms that the PhD throughput of engineering departments in Kenya was very low, especially if one compares 15 PhD graduates against the total graduates at undergraduate level of 1,625 in AY 2013/14.*

Moreover, all the PhD graduates in AY 2013/2014 were from three universities, namely, Egerton, JKUAT and UoN. The five PhD from Egerton University were in agricultural engineering, the three from JKUAT were in mechanical engineering, and the seven from UoN were in environmental and bio-systems engineering. Thus, all the 15 PhD graduates in AY 2013/2014 were from the MME category and none from CSE or EEE degree programs. There is therefore a need to establish what was different or unique about the MME degree programs, especially in the general area of agricultural engineering that graduated 12 of the 15 PhD graduates. This may be because these departments were attracting research grants to support doctoral research.

Table 3.7: PhD degree programs and universities with enrolled students in AY 2014/2015

Department	Number of PhD programs with students in AY 2014/2015	Number of universities with PhD students
CSE	1	1
EEE	4	3
MME	9	6
Total	**14**	**10**

Table 3.8: PhD in engineering enrollment and graduates AY 2011/2012 to AY 2013/2014

University	PhD engineering programs	Enrollment AY 2014/15	Graduates AY 2011/12	Graduates AY 2012/13	Graduates AY 2013/14
CSE					
1. Jomo Kenyatta University of Agriculture and Technology	PhD Civil Engineering	4	0	0	0
EEE					
1. Jomo Kenyatta University of Agriculture and Technology	PhD Electrical and Electronic Engineering	0	0	0	0
2. University of Nairobi	PhD Electrical and Electronic Engineering	2	1	0	0
3. Kenyatta University	PhD Renewable Energy Technology	2	0	0	0
4. Jomo Kenyatta University of Agriculture and Technology	PhD Telecommunication Engineering	1	0	0	0
MME					
1. Egerton University	PhD Agricultural Engineering	6	0	1	5
2. Egerton University	PhD Industrial and Energy Engineering	0	2	0	0
3. Jomo Kenyatta University of Agriculture and Technology	PhD Mechanical Engineering	3	4	3	3
4. Jomo Kenyatta University of Agriculture and Technology	PhD Mechatronic Engineering	1	0	0	0
5. Jomo Kenyatta University of Agriculture and Technology	PhD Biomechanical and Environmental Engineering	5	1	0	0
6. Kenyatta University	PhD Sustainable Energy Engineering	0	0	0	0
7. Moi University	PhD Mechanical and Production Engineering	0	0	0	0
8. University of Nairobi	PhD Environmental and Bio systems Engineering	11	4	5	7
9. University of Nairobi	PhD Mechanical Engineering	0	0	0	0
		35	**12**	**9**	**15**

3.6 Conclusions and recommendations

There were **10,343** undergraduate engineering students enrolled in the 12 universities offering engineering degree programs in Kenya, representing only **3.6%** of the total undergraduate student enrollment of **289,336**. Based on the student enrolment numbers alone, none of the 12 universities could therefore be considered to have a focus on engineering education and most have been building capacity in other non-engineering degree programs. It also means that if university resources were allocated in proportion to student numbers, engineering departments would be a very low priority in the 12 universities. This is a subject for further research.

In aggregate terms, the 503 engineering faculty members were adequate for teaching the 10,343 undergraduate engineering students (faculty ratio of one lecturer per 21 students). However, the faculty members were spread over the 44 different departments in 12 universities, and most of them were concentrated in three universities: JKUAT, MU and UoN. This means that most of the other nine universities offering engineering degree programs have neither adequate teaching nor research capacity.

There may be a justification for reducing the number of different engineering departments in the 12 universities in order to achieve a critical mass of faculty per department. 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 postgraduate studies in order to increase the number of PhD level faculty in Kenyan universities.

Chapter 4: Institutional Support for Engineering Departments

4.1 Assessing institutional support

Engineering education and research is capital intensive. In addition, anecdotal data before the survey suggested that there was a shortage of engineering doctoral faculty and the number of postgraduate students pursuing master's and doctoral studies was relatively low. The results presented in Chapter 3 confirm that there was indeed a shortage of doctoral faculty in nine out of the 12 universities offering degree programs and the postgraduate students pursuing engineering degree programs were very few.

In order to transform engineering education and research, institutional support in areas of infrastructure and faculty development was therefore crucial. This baseline survey therefore aimed to measure the institutional support using the following indicators:

1. Engineering departments' infrastructure budget and expenditure in the fiscal years (FY) 2012/2013 to 2014/2015 (three fiscal years);
2. Recurrent budget levels for instruction, laboratory exercises and undergraduate projects;
3. Departmental research budgets and grants; and
4. Remuneration levels for different ranks of engineering faculty and technical support staff.

The analysis of the data collected from 44 engineering departments in the 12 universities revealed that most heads of department did not have data on their departmental budgets. For example, only 11 of the 44 heads of department could complete the section on infrastructure budgets and only 20 could complete sections on research budgets. *This suggests that most of the departments were not directly involved in the budgeting process for their departments*. In this chapter, we analyze the incomplete data collected to reveal the level of institutional support to engineering departments.

4.2 Engineering departments budget support AY 2012/2013 to 2014/2015

Table 4.1 shows the total budgets for the different budget areas and the number of engineering departments that completed the section on departmental budget. We note that not all the department heads were able to provide data on departmental budget allocations. For example, only 11 heads of departments could complete sections on infrastructure budgets and even for recurrent teaching budgets. Only 31 out of the 44 heads of department could provide the required data. This suggests that heads of departments were not required to provide both academic and administrative leadership of their respective departments. Transformation of engineering education and research would require that heads of departments provide overall leadership of their respective academic areas, including budgeting and resource allocation.

In the next sub-sections, we analyze the data provided by the heads of department who were able to complete the different sections of institutional support for engineering education and research.

Table 4.1: Budget allocation for engineering departments (overall)

Budget Area	FY 2012/2013	FY 2013/2014	FY 2014/2015	No. of Departments
Infrastructure development	137,915,761.00	219,815,761.00	216,138,758.00	11
Research (faculty/ graduate research/travel grants)	20,421,000.00	34,797,340.00	41,649,340.00	20
Teaching labs/audio visual investments	150,936,696.00	169,671,190.00	356,203,060.00	25
Recurrent costs for teaching, labs, projects	31,999,932.00	43,623,787.00	56,007,924.00	31

4.2.1 Engineering departments infrastructure development budgets

Table 4.1 shows that only 11 of the 44 department heads were able to complete the section on infrastructure development (new labs, new classrooms, computer labs, WiFi for students/faculty). It was not clear why so many department heads were not aware of either the expenditure or budget of their departments over the three fiscal years.

The results suggest that average infrastructure development budget per department was about Ksh 19 million in FY 2014/2015 and Ksh 12.5 million in FY 2012/2013. This was a relatively low budget for upgrading or setting up new engineering labs, especially in the CSE and MME departments.

Tables 4.2, 4.3, and 4.4 provide data for the EEE, MME, and CSE categories of departments and again show low levels of infrastructure development budget allocations over three fiscal years. The data also shows that EEE category of departments benefited the least from infrastructure budget allocations with an average of Ksh 10 million per department per year for the four departments that provided data. This was inadequate for purchase of specialized electronic equipment, equipping electrical or power systems labs or even for the upgrade of classrooms.

Table 4.2: Budget allocation for electrical and electronic engineering departments

Budget area	FY 2012/2015	FY 2013/2014	FY 2014/2015	No of Departments
Infrastructure development	34,715,761.00	40,915,761.00	44,468,758.00	4
Research (faculty / graduate research/ travel grants)	4,721,000.00	4,040,000.00	4,042,000.00	6
Teaching labs/audio visual investments	31,006,696.00	29,321,190.00	35,875,060.00	8
Recurrent costs for teaching, labs, projects	6,722,851.00	7,451,831.00	9,298,856.00	10

Table 4.3 shows that the infrastructure development budget allocation for the three MME departments that provided data was higher than that for the four EEE departments (Ksh 109 million for three MME departments compared to only Ksh 44 million for four EEE departments in FY 2014/2015).

Table 4.3: Budget allocations for mechanical and mechatronics engineering departments

Budget area	FY 2012/2013	FY 2013/2014	FY 2014/2015	No. of Departments
Infrastructure development	103,200,000.00	104,500,000.00	109,500,000.00	3
Research (faculty /graduate research/travel grants)	1,420,000.00	14,977,340.00	15,127,340.00	7
Teaching labs/audio visual investments	118,430,000.00	112,200,000.00	220,153,000.00	10
Recurrent costs for teaching, labs, projects	23,650,433.00	22,505,308.00	25,222,420.00	13

Table 4.4 shows the infrastructure budget data for CSE departments was Ksh 62 million in FY 2014/2015 for the four departments that provided data. This was lower than for MME departments. At only Ksh 15 million per department, it was unlikely there was any large infrastructure project that was included in the budget allocation or expenditure.

Table 4.4: Budget allocation for civil and structural engineering departments

Budget area	FY 2012/2013	FY 2013/2014	FY 2014/2015	No. of Departments
Infrastructure development	-	74,400,000.00	62,170,000.00	4
Research (faculty / graduate research/ travel grants)	14,280,000.00	15,780,000.00	22,480,000.00	7
Teaching labs/audio visual investments	1,500,000.00	28,150,000.00	100,175,000.00	7
Recurrent costs for teaching, labs, projects	1,626,648.00	13,666,648.00	21,486,648.00	8

4.2.2 Research budgets and grants

Table 4.1 shows that 20 departments out of 40 that responded were able to provide data on research budgets or even research grants. Again, it was not clear why the data was not available to the other engineering department heads and this shall be an area for further research. However, the data once more suggests that engineering department heads may not be involved in the institutional budgeting process and probably were also not attracting external research grants. It appears that individual faculty members apply for research grants with little formal involvement of their departmental heads. Since systems for reporting research grants do not exist, heads of departments may not be informed of ongoing research projects by their faculty.

We note that even for the 20 departments, the level of research budget allocation was very low at about Ksh 42 million in FY 2014/2015. Low budgets (at about Ksh 2 million per department in FY 2014/2015, assuming equal distribution among the 20 departments), suggest that engineering departments were undertaking very little research. The disaggregated data in Table 4.2, 4.3 and 4.4 shows that in FY 2014/2015, CSE category of departments had the highest budget allocation for research (about Ksh 3.2 million per department in the FY 2014/2015), while EEE category had the least (at only an average of Ksh 0.67 million per department in the FY 2014/2015). Overall, the research budget allocations were relatively low given the capital intensive nature of engineering research projects.

4.2.3 Investments in teaching labs and classrooms

Table 4.1 shows that up to 25 of the 44 departments provided data on investments in teaching labs and/or classrooms (e.g., provision of audio-visual facilities). Figure 4.1 shows that in FY 2014/2015, the total budget allocation for investments was Ksh 360 million, translating to about Ksh 14 million per department in FY 2014/2015.

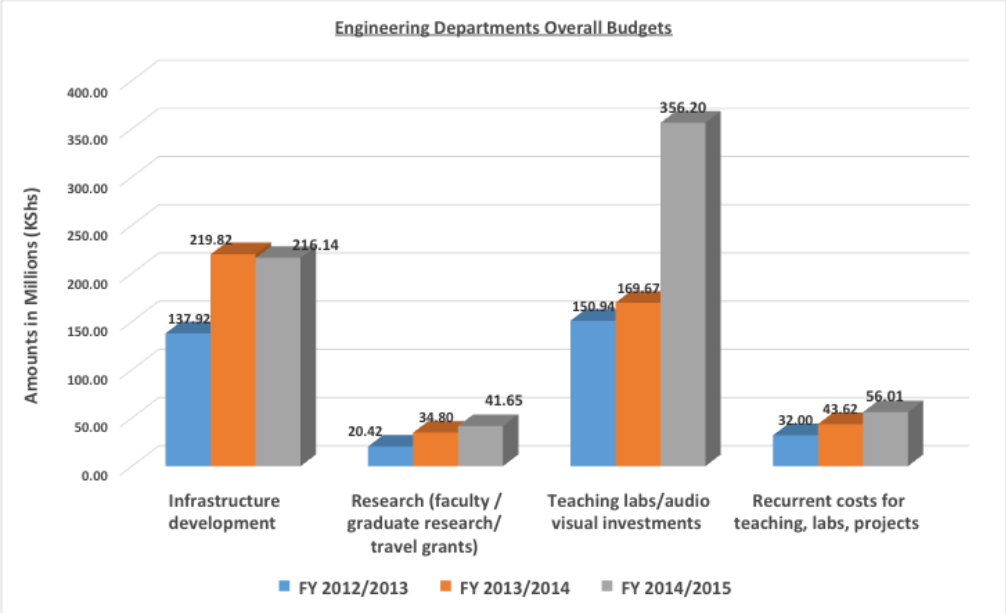

Figure 4.1: Budget allocation for engineering departments over three fiscal years

Table 4.2, 4.3 and 4.4 show that the highest budget allocation went to 10 MME departments at Ksh 220 million (i.e., Ksh 22 million per department), followed by seven CSE departments at Ksh 100 million (i.e., Ksh 14.5 million per CSE department) and lastly Ksh 36 million to eight EEE departments (Ksh 4.5 million per department). This was expected because MME and CSE labs tend to more capital intensive compared to EEE labs. It was not clear how much was allocated to upgrading teaching labs.

4.2.4 Recurrent budgets for instruction, labs and projects

Table 4.1 shows that 31 out of 44 department heads were able to provide data on recurrent budgets for instruction, labs and projects. This was the budget required for instructional materials, lab exercises and undergraduate engineering projects. *It was therefore not clear why up to 15 department heads were unable to fill the sections on recurrent budgets*.

The total recurrent budget allocation for the 31 departments was about Ksh 56 million in FY 2014/2015 (see Figure 4.1), translating to about Ksh 1.8 million per department. This allocation was not adequate for 10,343 undergraduate engineering students considering that engineering education should have substantial practical projects.

The data therefore suggests that engineering departments that were supposed to be capital intensive and very expensive to run were underfunded. Again, comparatively, MME category of departments had the biggest recurrent budgets at an average of Ksh 1.9 million per department in FY 2014/2015 while the EEE departments had the lowest at an average of Ksh 0.9 million per department. This was surprising because EEE departments had the highest levels of enrollment in FY 2014/2015. At this level of funding, the departments could not maintain their teaching and research infrastructure or support students' practical labs and projects. This shall be a subject for further research.

4.3 ICT facilities for engineering departments

The baseline survey collected data on the availability of specialized computer labs, broadband WiFi, and access to high performance computing facilities by faculty and students in engineering departments. The results show that none of the departments had set up specialized computer labs for design, high performance or grid computing. In addition, we found that the department heads were not aware of the availability of free high performance computing facilities for graduate students and faculty through KENET, the National Research and Education Network (NREN) of Kenya.

The data indicates that 100 students shared an average of about 10 networked computers in the labs as shown in Table 4.5a, while Table 4.5b shows that there was an adequate number of access points for students. Overall, it appears that students had adequate Internet access both from the departmental labs and their own devices through the WiFi networks in the departments. Surprisingly, MME departments had the largest number of WiFi access points available to students. However, only a survey of the students and faculty would confirm that broadband Internet was available and at acceptable speeds.

Table 4.5a: Availability of student computer labs

Engineering Department	Total No. of students in 2014/15 (including graduate students)	Networked student computers in department	No. of departments	PC per 100 students (PC ratio)
CSE	3,176	213	10	7
EEE	4,037	446	13	11
MME	3,446	417	21	12
Overall	**10,659**	**1,076**	**44**	**10**

Table 4.5b: Availability of WiFi access points in engineering departments

Engineering department	Total No. of students in 2014/15 (including graduate students)	Wireless LAN capacity in the departmental buildings (e.g., concurrent users)	Access points per 100 students	No. of departments
CSE	3,176	124	3.9	10
EEE	4,037	178	4.4	13
MME	3,446	590	17.1	21
Overall	**10,659**	**892**	8.4	44

Table 4.6 shows that engineering departments estimated that they required up to Ksh 2.4 billion to upgrade their computer networks and labs. It was not clear why the estimate was not included in the approved infrastructure budgets in Table 4.1

Table 4.6 demonstrates that engineering departments had identified the need for massive investments in ICT infrastructures in order to significantly improve their learning and teaching environment. Although this is not benchmarked with investments in other top engineering departments, anecdotal data suggests that advanced e-infrastructures in engineering departments (including specialized design labs or high-performance computing) were inadequate or not available to support the total engineering students enrollment of 10,659 (undergraduate and graduate students) and to transform engineering education practices at both undergraduate and postgraduate levels.

Table 4.6: Estimated cost of upgrading student labs and departmental networks

Engineering department	Estimated cost of upgrading departmental networks/ computer labs (Ksh)	No. of departments
EEE	904,500,000.00	13
CSE	197,200,000.00	10
MME	1,289,000,000.00	21
Overall	**2,390,700,000.00**	**44**

4.4 Engineering faculty remuneration data

The baseline survey collected data on the remuneration of faculty members and engineering support staff to assess the capacity of engineering departments to attract high quality engineering graduates into academic careers. In addition, remuneration levels could be used as an indicator for the research and innovation output of the engineering departments.

Table 4.8 shows that entry level salary of engineering faculty members at tutorial fellow level was Ksh 89,259 in FY 2014/2015. This compares with an assistant engineer in the telecommunications industry where the 50th percentile salary was Ksh 120,000 according to the Pricewaterhouse Coopers (PWC) salary survey REM channel salaries database. For example, entry-level salary for a graduate trainee engineer at the Kenyan power utility company, Kenya Power, was Ksh 140,000 as of August 2015. This is higher than the entry level salary for an engineering lecturer with PhD degree at the university, which was Ksh 114,566 per month before tax.

Table 4.7: Gross salary ranges of engineering faculty compared to graduate engineers salary ranges

Faculty rank	Average gross salary (including all monthly allowances) (KSh)	Maximum gross salary (including all monthly allowances) (KSh)	Comparable network engineers ranks	50th percentile PWC salary (Ksh)
a)Tutorial fellow	89,259.76	152,411.00	Assistant network engineer	120,076
b)Assistant lecturer	94,032.26	152,411.00	Network engineer	254,713
c)Lecturer	114,566.43	210,000.00	Senior engineer	354,095
d)Senior lecturer	131,358.92	288,200.00	Senior engineer	354,095
e)Associate professor	161,336.95	310,000.00	Chief technical officer	646,105
F)Full professor	186,115.31	360,200.00	Chief technical officer	646,105

Thus, the private sector and the public sector salaries for engineers were much higher than the salaries of engineering faculty in public universities. This means that departments find it difficult to attract young engineers or to retain them after the initial years.

In developed countries, the solution is normally in terms of research grants that supplement the public sector salaries. The data collected in this baseline survey however suggest limited research grants. Anecdotal evidence suggests that engineering faculty members are not interested in bidding for research grants that focus only on research without supplementing their salaries. Instead, they pursue engineering consultancy assignments or teach in several universities to supplement their salaries.

The heads of departments and the senior leadership should therefore address this salary gap in order to motivate faculty to be engaged in research and innovation activities, as well as attract young engineering graduates into academia.

Chapter 5: Engineering Departments Research and Innovations Output

5.1 Indicators for measuring research and innovations output

The e-readiness framework developed by the authors contains 17 indicators of e-readiness and over 90 sub-indicators. In order to assess the level of e-readiness of an institution, the indicators and sub-indicators are staged on a scale of 1 to 4, where 1 is unprepared and 4 is prepared to use ICT to achieve institutional research and educational outcomes (see the 2006, 2008, and 2013 e-readiness reports at http://ereadiness.kenet.or.ke).

One of the 17 e-readiness indicators is ICT Research and Innovations, that is used to measure not only research and innovation output, but also the potential to increase research and innovation output using ICT. The data collected from 17 public and private universities in 2006, 2008 and 2013 suggested that most ICT academic departments were not measuring their research and innovations output or that data was not available to senior university administrators.

This baseline survey therefore collected detailed data for measuring research and innovation output from heads of department of engineering. Although the approach and questions were similar to those used in past institutional e-readiness surveys, the expectation was that heads of departments could provide the data required to measure research and innovation output.

Data was collected on the following sub-indicators that could then be used to measure engineering research and innovations output of a department:

a. Participation of undergraduate engineering students in national or international student projects exhibitions or competitions. *This was a **Yes/No** question and there was no attempt to measure the number of students participating but heads of department were required to indicate the exhibitions and/or competitions the students participated in.*
b. The number of master's level research projects completed in the academic year 2012/2014 (this was considered equivalent to master's level graduates in engineering).
c. The number of engineering PhD degrees awarded by different engineering departments over the period 2011 to 2014 (three academic years).
d. The number of journal or refereed conference papers or textbooks published by faculty in the different engineering departments over a period of five academic years (2009/2010 to 2013/2014), with an indication of the top three journals or conferences that had published the papers for each department.
e. The number of externally funded research projects undertaken by the departments over a period of five academic years.
f. The engineering departments research budgets over the period of FY 2012/2013 to FY 2014/2015. This was a proxy for actual expenditures.
g. The incubation centers established by engineering departments or affiliated to the engineering departments for the purpose of nurturing innovation.

h. The budgets and expenditures of the incubation centers established by or affiliated to engineering departments in the different universities.

The questions used to collect the data for the above indicators were similar to the questions in the institutional e-readiness assessment in 2006, 2008 and 2013.

Table 5.1 also shows that 39 of the 45 departments provided data on participation in undergraduate engineering exhibitions or competitions. The following were examples of the exhibitions that were offering opportunities for engineering students to exhibit their projects:

1. Annual University Exhibition organized by the Commission of University Education (CUE)
2. IEEE Kenya Chapter engineering exhibitions
3. JKUAT Tech Expo
4. Robotic Exhibition organized by JKUAT
5. Agricultural Show of Kenya (ASK) in different parts of the country

We note that none of the exhibitions were regional or international. Students also did not seem to have participated in any national or international engineering design competitions.

In the following sub-sections, we present data in aggregate form for the departments that responded. We note that several data collection iterations shall be required before the data presented could be considered representative of all engineering departments.

Table 5.1: Availability of data for measuring research and innovation output

Sub-indicator	Departments with available data
1. Participation of undergraduate engineering students in national, international student projects exhibitions or competitions	39 departments participated
2. The number of master's level research projects completed in the academic years from 2012–2014	22 departments provided data
3. The number of engineering PhD degrees awarded by different engineering departments over the period 2012–2015	27 departments provided data. Only 6 departments in 4 universities had recorded PhD graduates
4. The number of journal or refereed conference papers or textbooks published by faculty or students in the different engineering departments over a period of five years (2009–2014)	29 departments provided data
5. The number of externally funded research projects undertaken by the departments over five years	37 departments provided data
6. Value of engineering departments research budgets provided by universities over period the 2012–2014	23 departments provided data
7. The number of externally funded research projects undertaken by the departments over a period of five years	28 departments number departments with data
8. Value of external research grants awarded to department over the period 2019–2014	17 departments provided the data

5.2 Undergraduate and postgraduate engineering projects and thesis 2012–2014

5.2.1 Undergraduate engineering projects exhibitions and competitions

All of the engineering departments require their students to undertake a final year project. This is normally in the fifth year of study. However, anecdotal evidence suggests that there were an increasing number of student projects undertaken in the second, third, and fourth year of study. This matched the trend in engineering degree programs at top engineering departments in other parts of the world. It is these projects that allow students to participate in either design competitions or engineering exhibitions.

Up to 39 engineering departments indicated that their students participated in national exhibitions and /or competitions (see Table 5.1). These exhibitions were organized by the Commission for University Education or by the different universities (e.g., JKUAT tech expo). There were also a number of robotics contests that mechatronics engineering students participated in. Although this was an indicator of potential for innovation and research in the departments, we note that none of the departments had participated in international competitions or any exhibitions outside Kenya.

It was also not possible to establish if the undergraduate engineering projects were related to research or innovation programs of the respective departments. This shall be a subject for future research on engineering research and innovation output of engineering departments.

5.2.2 Postgraduate engineering projects and thesis

Table 5.2 shows that there were 195 master's degree graduates from AY 2011/2012 to 2013/2014. The majority of master's degree graduates were from MME category of departments at 164 over the three years and while the CSE departments had 13 graduates. It was not clear why most of the master's degrees awarded were in MME degree programs and this will be a subject for future research.

Table 5.2: Master's enrollment 2014/2015 showing graduates per department 2012–2014

Degree Program	Graduates AY 2011/12	Graduates AY 2012/13	Graduates AY 2013/14	Total graduates over 3 years	No. of Departments providing data
CSE	6	1	6	13	4
EEE	2	5	11	18	3
MME	27	32	105	164	12
Overall	**35**	**38**	**122**	**195**	**19**

Table 5.3a shows the master's graduates were from 8 of the 12 universities. In AY 2013/2014, about 68% of the master's graduates were from JKUAT (84 out of 122) with 78 from the MME departments. University of Nairobi had only 11 master's graduates in engineering in the AY 2013/2014, while Moi University had 12. This is was surprising and it is not clear why JKUAT had more master's graduates in engineering compared to other universities.

Table 5.3a: Master's degrees awarded per university from 2011 to 2014

Universities	Department	Master's Enrollment AY 2014-2015	Graduates AY 2011/12	Graduates AY 2012/2013	Graduates AY 2013/2014
JKUAT	CSE	53	1	1	2
	EEE	46	1	2	4
	MME	74	10	19	78
	Sub total	**173**	**12**	**22**	**84**
UoN	CSE	8	0	0	0
	EEE	11	0	2	5
	MME	34	7	7	6
	Sub total	**53**	**7**	**9**	**11**
MU	CSE	6	5	0	4
	EEE				
	MME	13	1	2	8
	Sub total	**19**	**6**	**2**	**12**
MMUST	CSE	16	0	0	0
	MME	5	1	1	1
	Sub total	**21**	**1**	**1**	**1**
Egerton	MME	1	8	3	3
KU	EEE	14	1	1	2
UoE	MME	7	0	0	2
DKUT	MME	0	0	0	7
	Total	**288**	**35**	**38**	**122**

Table 5.3b also shows that 36 PhDs were awarded by the four universities in the three year period. The four universities were Egerton University, JKUAT, Moi University and University of Nairobi. These were also the universities that had undergraduate degree program accredited by EBK as of November 2014. We note that all the PhD degrees awarded in the AY 2013/2014 were by MME departments. Again the majority of the PhDs awarded were in the MME degree programs particularly by agricultural engineering departments. The lowest number of PhD degrees awarded was in the area of CSE, with only two PhDs awarded in that period. For example, neither University of Nairobi nor Moi University had any PhD graduates in CSE or EEE in AY 2013/2014.

The data therefore confirms that the PhD throughput of engineering departments was very low, particularly in the EEE and CSE academic areas. This might require policy intervention by the Ministry responsible for engineering education and research.

Table 5.3b: PhD degrees awarded per university from 2011 to 2014

Universities	Department	PhD enrollment 2014–2015	Graduates AY 2011/12	Graduates AY 2012/2013	Graduates AY 2013/2014
JKUAT	CSE	4	0	0	0
	EEE	1			
	MME	9	5	3	3
	Sub total	**14**	**5**	**3**	**3**
UoN	CSE				
	EEE	2	1	0	0
	MME	11	4	5	7
	Sub total	**13**	**5**	**5**	**7**
MU	CSE				
	EEE	0	0	0	0
	MME	0	0	0	0
	Sub total	**0**	**0**	**0**	**0**
MMUST	CSE	0	0	0	0
	MME	0	0	0	0
	Sub total	**0**	**0**	**0**	**0**
Egerton	MME	6	2	1	5
KU	EEE	2	0	0	0
UoE	MME	0	0	0	0
DKUT	MME				
	Total	**35**	**12**	**9**	**15**

5.3 Research projects, publications and faculty development

From 2009 to 2013, the engineering departments reported 90 externally funded research projects undertaken by faculty members (see Table 5.4). A total of 341 faculty members published a journal or conference paper. This represents 68% of the total full-time faculty in engineering departments. The majority of the faculty publishing papers were from the mechanical and mechatronic engineering category of degree programs at 184 while only 105 faculty in electrical and electronic engineering departments published papers in that period.

A total of 1,205 journal papers were published by faculty or students in the engineering departments, over 50% of them from MME category of departments (687 out of 1205) with the smallest number of papers being from EEE departments at only 169. The average journal paper per full-time faculty member per year was 0.8, 1.1 and 0.4 for CSE, MME and EEE respectively. 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.

A total of 105 full-time faculty members were pursing doctoral studies from different departments with 58 of them away from their respective departments on study leave. This suggests that doctoral level training was still happening in universities outside Kenya although the survey did not collect data on the universities where the faculty members were registered for PhD.

Table 5.4 summarizes the results of the analysis of the departmental publications and faculty pursuing doctoral degrees.

Table 5.4: Faculty publications and faculty pursuing PhD studies from 2009–2013

Department	Full-time faculty AY2014/2015	Number of faculty who have published	Number of externally funded projects	Number of journal papers published (2009–2013)	Journal papers per full-time faculty per year	Number of faculty pursuing PhD studies	Number of Faculty on PhD study leave
EEE	150	105	21	169	0.4	29	14
CSE	142	52	22	349	0.8	19	12
MME	211	184	47	687	1.1	57	32
Overall Total	**503**	**341**	**90**	**1205**		**105**	**58**

5.4 Engineering departments and institutional incubation centers

Innovation is often defined as invention/research output plus commercialization or implementation. The baseline survey therefore collected data on availability of incubation centers that incubate or commercialize engineering projects. These incubation centers could either have been set up by universities or affiliated to engineering departments.

Table 5.5 shows the number of universities that indicated they had established or were affiliated to incubation centers that were nurturing innovative engineering projects. The table shows that most engineering departments were not yet incubating engineering projects and that was likely to have a negative impact on innovation output. Only four of the universities had established innovation hubs. This is an area requiring additional research. Thus, engineering departments were at very early stages of incubating engineering projects or promoting entrepreneurship among engineering graduates.

Table 5.5: Incubation centers established by universities offering engineering degree programs

University	Incubation center established	Incubator budget FY 2012 to 2015 (Ksh)
KU	Chandaria Business, Innovation and Incubation Center	4,000,000.00
UoN	C4D LAB	No data available
TUM	Creative Lab	9,000,000.00
DKUT	DHub	1,000,000.00
UoN	FABLAB	No Data available

5.5 Perceptions on the impact of ICT on engineering education and research

In order to measure the perceived impact of ICT and broadband Internet on engineering education and research, the heads of department were asked to answer the following questions on a scale of 1 to 5, where 1 was strongly disagree and 5 strongly agree.

a. Had ICT enhanced the quality of teaching
b. Had ICT enhanced the quality of learning
c. Had ICT improved the research productivity of the department
d. Had ICT expanded research opportunities
e. Had ICT increased the efficiency of operations and processes
f. Had ICT improved quality of service delivery to students and faculty
g. Had ICT increased transparency and accountability

Table 5.6 summarizing the results shows that 84% of the heads of engineering departments agreed or strongly agreed that ICT had a positive impact in each of the above areas. However, perceptions data collected was limited and it was not possible to determine why the heads of departments had such a positive perception of the impact of ICT. Additional data needs to be collected to quantitatively establish the impact of ICT on engineering education and research as well as how the impact was measured by the different departments.

In all developed countries, research is now data intensive and ICT is therefore essential for research. KENET as the Kenyan National Research and Education Network (NREN) has also built the infrastructure required by faculty and graduate student researchers to access advanced research infrastructure and high-performance computing owned by other academic networks or universities outside Kenya at no cost to the researchers (see https://www.kenet.or.ke/node/105). Additional research data was required to establish how engineering departments were taking advantage of advanced research infrastructures available through broadband research networks for their research.

Table 5.6: Perceptions of impact of ICT on engineering education and research

	Departmental Outcome	Electrical and electronic engineering	Civil and structural engineering	Mechanical and mechatronic engineering	Overall average score
a.	Enhanced the quality of teaching	4.2	4.3	4.2	4.2
b.	Enhanced quality of learning	4.3	4.3	3.9	4.2
c.	Improved research productivity e.g. number of research papers published	4.3	4.2	4.2	4.2
d.	Expanded research opportunities, e.g. collaboration opportunities	4.3	4.1	3.7	4.0
e.	Increased the efficiency of operations/processes	4.4	4.1	3.9	4.1
f.	Improved quality of service delivery to students and faculty	4.1	4.1	4.1	4.2
g.	Increased transparency and accountability	4.1	3.8	3.4	3.8

5.6 Conclusions on Engineering Departments Research output

This chapter has presented data on some of the indicators of research and innovation output of the different departments offering engineering degree programs at undergraduate, master's and PhD levels. The response of the different departments suggests that most of the departments were not collecting data on research output, for example, the number of journals or the level of research funding for ongoing research projects.

The results also show that four universities, namely, EU, JKUAT, MU and UoN had awarded 36 PhD degrees from 2011 to 2014 (three academic years), most of them in the area of agricultural engineering. In fact, the EEE category departments awarded just two PhD degrees (one by JKUAT and another by UoN), while CSE departments awarded only one PhD degree in this period. This represents a very low productivity, in terms of PhD student supervision and graduation. In addition, we found that almost 50% of the PhD training takes place outside the country. The survey did not collect data on where the faculty members were registered for their PhD degree programs.

The data on publications per faculty per year was only 0.8, 1.1 and 0.4 for CSE, MME and EEE departments respectively. This was a relatively low level of research productivity considering that about 30% of the full-time engineering faculty members were PhD degree holders. There was

therefore a need to establish the reasons for the low research throughput for engineering departments.

Another key observation was that engineering heads of departments either agreed or strongly agreed that ICT had a positive impact on different aspects of engineering education and research (e.g., teaching, learning, research productivity, student services etc.). However, from the data collected, it was not possible to establish how the heads of department were measuring the positive impact.

Chapter 6: Engineering Departments Survey Conclusions and Recommendations

6.1 Summary results

The baseline survey results revealed that only **12** Kenyan public universities were offering engineering degree programs as of November 2014. There were **44** engineering departments with a total undergraduate student enrollment of **10,343** students, representing about **3.6%** of the total students enrolled in the 12 universities.

The universities offered **54** engineering degree programs that were classified into three main categories: civil and structural engineering (CSE); electrical and electronics engineering (EEE); and mechanical and mechatronic engineering (MME) for ease of analysis. Figure 6.1 shows that there was close to 100% increase in enrollment from AY 2013/2014 (5,325) to AY 2014//2015 (10,343).

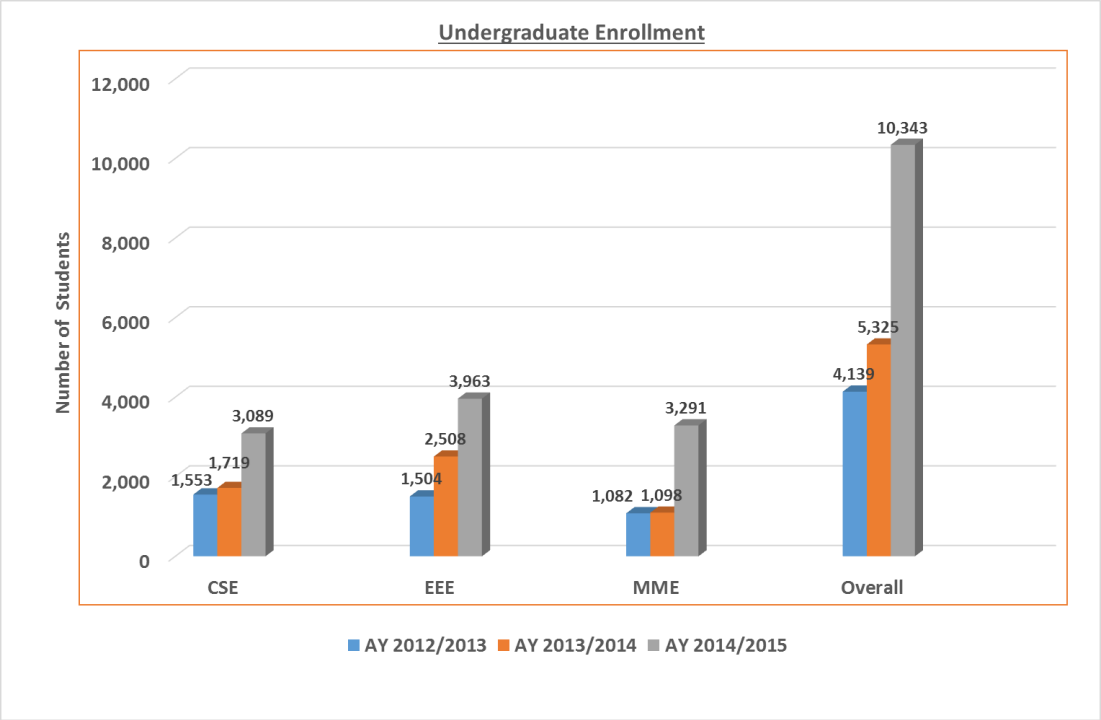

Figure 6.1: Enrollment growth in AY 2012/2013 to AY 2014/2015

Figure 6.2 shows the undergraduate graduates over AY 2011/2012 to AY 2013/2014 and that there were total of 1,625 in the AY 2013/2014. There was no data available to the researchers on the capacity of the local industry to absorb the 1,625 graduates and this is a matter for further research.

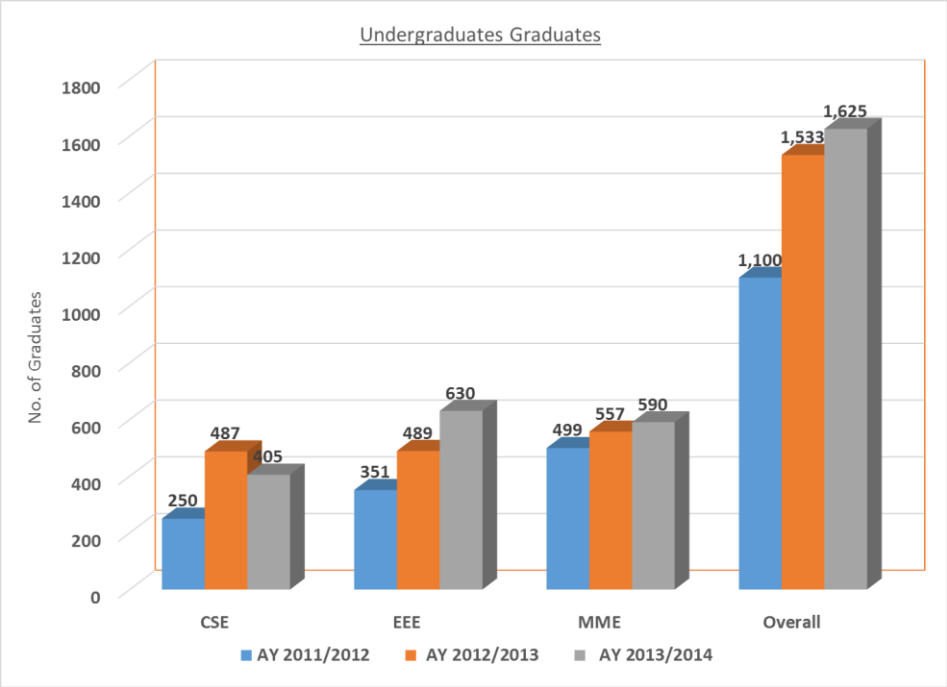

Figure 6.2: Engineering graduates at undergraduate level AY 2011/2012 to AY 2013/2014

Surprisingly, the baseline survey results revealed that there were only **288** master's degree students and **35** students enrolled in PhD programs in AY 2014/2015. Moreover, only **36** PhD degrees were awarded in the period 2011–2014 by three universities, namely, Egerton, JKUAT and UoN. Moreover, most of the PhDs were in the MME degree areas that include area of agricultural engineering.

There were **503** full-time engineering faculty members, **193** with doctoral degrees in engineering. Only 337 indicated they were registered with the Engineers Board of Kenya. About 63% of the engineering faculty members with PhD degrees were employees of University of Nairobi (UoN), Moi University or JKUAT.

The data collected to assess institutional support of engineering departments by universities was incomplete, with only about 50% of heads of department able to provide complete data on budgetary support in different areas. Moreover, the data also indicated very low levels of budgetary support, especially for infrastructure and engineering projects. Figure 6.3 shows the budget allocations for the departments that were able to provide data. The data shows that only about Ksh 2 million was allocated in FY 2014/2015 per department. Research grants support was even lower for the departments that responded. Consequently, the research and innovation output was very low as presented in Chapter 5 of this report.

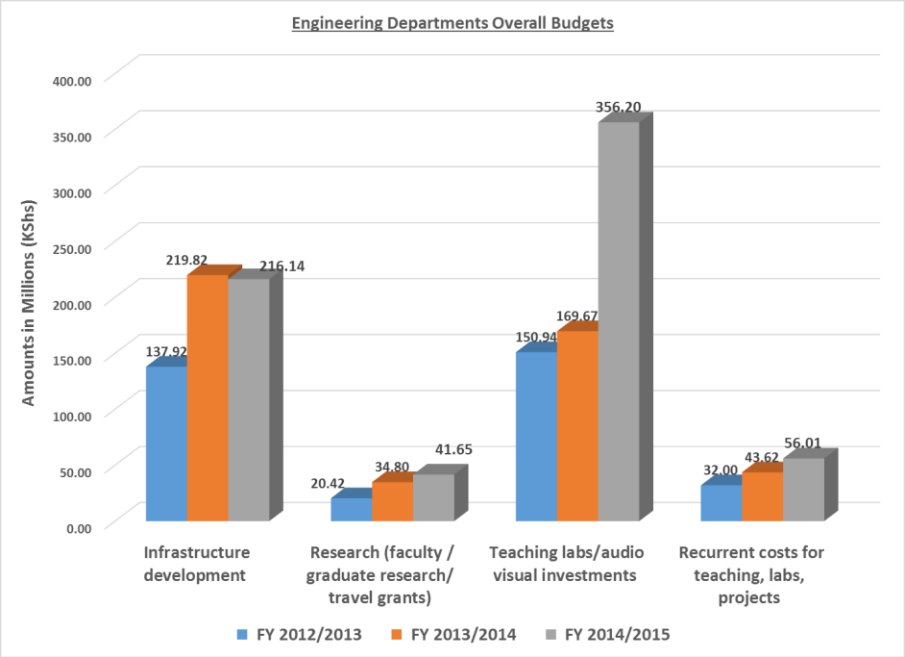

Figure 6.3: Engineering departments overall budgets AY 2011/2012 to AY 2013/2014

6.2 Conclusions and recommendations

In aggregate terms, the **503** engineering faculty members were adequate for teaching the **10,343** undergraduate engineering students, with an overall faculty ratio of one lecturer per 21 students. However, since the faculty members were spread over the 44 different departments in 12 universities, it may imply that the workload of the engineering faculty was high which could affect research or innovation outputs. In fact, most of the faculty members were concentrated in three universities: JKUAT, MU and UoN. This means that it is likely that most of the other nine universities offering engineering degree programs neither have adequate teaching nor research capacity.

The 193 doctoral level engineering faculty members have the potential to support a large number of undergraduate and postgraduate students at both master's and PhD levels if they were concentrated in a few universities and fewer critical departments. The faculty to student ratio is acceptable at an aggregate level which implies that there is adequate faculty in the country for all the enrolled engineering students.

This has two key policy implications: one, if the engineering programs were concentrated in a few universities and departments, we could offer better quality engineering education and two, 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 postgraduate studies in order to increase the number of PhD level faculty in Kenyan universities.

In addition, we found that the number of master's graduates were 4.6% of the graduates at undergraduate levels over a period of three years (195 master's graduates compared to 4,258

graduates at undergraduate). This means that the transition rates to master's degree programs was very low.

Table 3.8 shows that there were 35 PhD students enrolled in all engineering degree programs in AY 2014/2015 and only 15 PhD graduates in AY 2013/2014. This data therefore confirms that PhD throughput of engineering departments in Kenya was very low; especially if one compares 15 PhD graduates against the total graduates at undergraduate level of 1,625 in AY 2013/14.

A comparison of the salaries of engineering faculty and those of engineers in industry shows the salaries are very low. This means that departments struggle to attract young engineers or to retain them after the initial years. An engineering department's forum in October 2015 recommended payment of **non-practicing allowance to engineering faculty to attract and retain lecturers**.

However, in emerging and developed countries, this problem is addressed by increasing research grants awarded to faculty to supplement their salaries. The data collected in this baseline survey suggests that departments and faculty were attracting limited research grants. Anecdotal evidence suggests that engineering faculty members were not motivated to bid for research grants that focus only on research without supplementing their salaries. Instead, they pursued engineering consultancy assignments or taught in several to supplement their salaries.

The heads of departments and the senior leadership must therefore address this salary gap in order to motivate faculty to engage in research and innovation activities as well as attract young engineering graduates into academia.

The data on publications per faculty per year shows that faculty in the three categories of departments were publishing between 0.4 (EEE) and 1.1 (MME) and per year per faculty over a three year period (from 2011 to 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 the faculty in Medicine as shown in Figure 6.4.

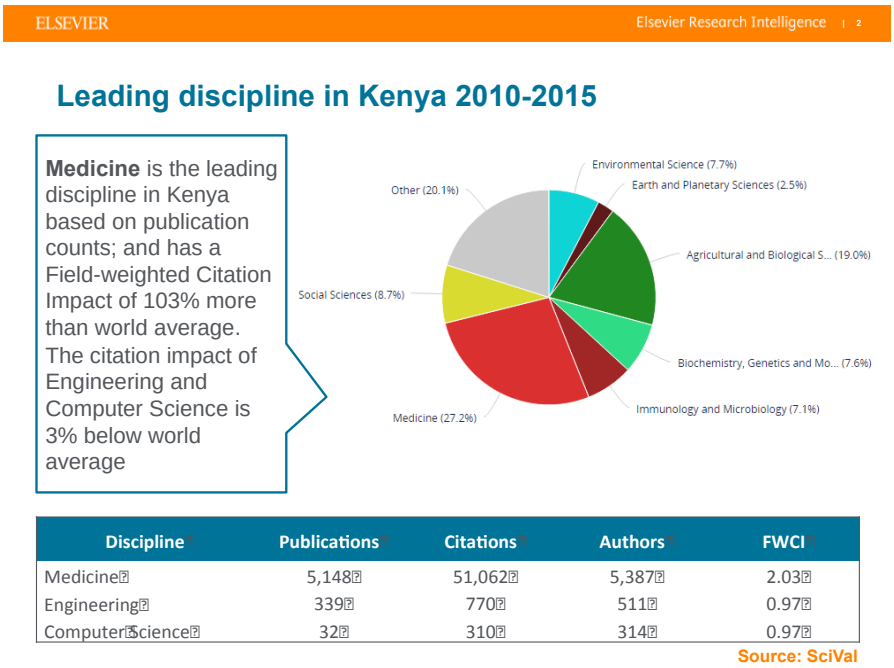

Figure 6.4: Comparison of the publications of medicine and engineering disciplines in Kenya

Thus, there is a need to engage the faculty in engineering departments to establish the reasons for the low research output. The Special Interest Group on Engineering Education and Research is an attempt to engage engineering faculty and identify the challenges of engineering faculty and catalyze research using mini-research grants (see http://raspberry.kenet.or.ke).

This first baseline survey of engineering departments has provided data that could be used by senior leadership of universities and funding agencies to support engineering departments. This data is especially useful for monitoring the implementation of Kenya's Vision 2030.

APPENDICES

Appendix 1: Mapping of engineering degree programs to CSE, EEE and MME categories

No	University	Name of Department	Category of Degree program (EEE, ME, CE)	Enrollment 2014/15	Accredited
1	JKUAT	Biomechanical and Environmental Engineering	MME	404	Yes
2	JKUAT	Civil Engineering	CE	876	Yes
3	JKUAT	Electrical and Electronic Engineering	EEE	735	Yes
4	JKUAT	Mechanical Engineering	MME	275	Yes
5	JKUAT	TIE	EEE	280	No
6	JKUAT	Mechatronics Engineering	MME	274	Yes
7	TUM	Mechanical and Automotive Engineering	MME	52	No
8	TUM	Building and Civil Engineering	CE	87	No
9	TUM	Electrical Engineering	EEE	80	No
10	TUM	Medical Engineering	MME	7	No
11	UoE	Mechanical and Production Engineering	MME	21	No
12	UoE	Civil and Structural Engineering	CE	30	No
13	UoE	Agricultural and Biosystems Engineering	MME	19	No
14	KU	Civil Engineering	CE	321	Yes
15	KU	Electrical Engineering	EEE	391	Yes
16	KU	Mechanical Engineering	MME	341	Yes
17	KU	Energy and Technology Engineering	EEE	58	Yes
18	KU	Gas and Petroleum Engineering	MME	52	No
19	MMUST	Electrical and Communication Engineering	EEE	53	No
20	MMUST	Civil and Structural Engineering	CE	55	No
21	MMUST	Chemical and Petroleum Engineering	MME	41	No
22	MOI	Electrical and Electronic Engineering	EEE	510	Yes
23	MOI	Civil and Structural Engineering	CE	297	Yes
24	MOI	Manufacturing Industrial and Textile Engineering	MME	153	Yes
25	MOI	Mechanical and Production Engineering	MME	52	Yes
26	MOI	Chemical and Process Engineering	MME	199	Yes
27	UoN	Civil Engineering	CE	512	Yes
28	UoN	Electrical and Information Engineering	EEE	849	Yes
29	UoN	Environmental and Biosystems Engineering	MME	310	Yes

No	University	Name of Department	Category of Degree program (EEE, ME, CE)	Enrollment 2014/15	Accredited
30	UoN	Mechanical and Manufacturing Engineering	MME	127	Yes
31	TUK	Electrical Engineering	EEE	187	No
32	TUK	Chemical and Process Engineering	MME	56	No
33	TUK	Civil and Construction Engineering		812	No
34	TUK	Mechanical and Mechatronics	MME	710	No
35	Egerton	Electrical and Control Engineering	EEE	295	No
36	Egerton	Water and Environmental Engineering	MME	25	No
37	Egerton	Agricultural Engineering	MME	80	Yes
38	Egerton	Industrial and Energy Engineering	MME	28	No
39	DKUT	Civil Engineering	CE	74	No
40	DKUT	Electrical and Electronic Engineering	EEE	370	Yes
41	DKUT	Mechanical Engineering	MME	45	No
42	DKUT	Mechatronics Engineering	MME	45	No
43	MMU	Engineering and Technology	EEE	65	No
44	MUST	Engineering and Technology	EEE	90	No
		Total		**10,343**	

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