MAKERERE UNIVERSITY
College of Engineering,
Design, Art and Technology

United Nations
Educational, Scientific and
Cultural Organization

UNESCO-China
Funds-in trust

LABOUR MARKET ANALYSIS

Engineering @Makerere University

SEPTEMBER
2022

Acknowledgement

This work was funded by UNESCO China Funds-in-Trust with a focus on Higher Technical Education in Africa for a Technical and Innovative Workforce (CFIT III). CFIT III aligns with Sustainable Development Goal 4 to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. In particular, this work targets ER 4 - Relevant skills for decent work.

The overall objective of the CFIT III project at Makerere University with a focus on the School of Engineering is to strengthen industry-academia partnerships in support of graduates with training that is better aligned to the labour market and industry needs thereby increasing the employability and engagement of engineering graduates from the College of Engineering, Design, Art and Technology (CEDAT). This will also contribute to Makerere University's focus on research and innovation through the application of engineering in addressing sustainable national and regional development.

MAKERERE UNIVERSITY
College of Engineering,
Design, Art and Technology

United Nations
Educational, Scientific and
Cultural Organization

UNESCO-China
Funds-in trust

LABOUR MARKET ANALYSIS
Engineering @Makerere University

SEPTEMBER 2022

LEAD AUTHORS:

Prof. Bruno Lule Yawe
Eng. Anthony Rucukye
Mr. Geofrey Olanya

Table of Contents

Table of Contents

List of Tables

List of Figures

Acronyms and Abbreviations

ABET	Accreditation Board for Engineering and Technology
CEDAT	College of Engineering, Design, Art and Technology
CFIT	China Funds-in-Trust
COVID	Corona Virus Disease
Eng.	Engineer
ERB	Engineers Registration Board
FGDs	Focus Group Discussions
GIZ	Gesellschaft für Internationale Zusammenarbeit
HEIs	Higher Education Institutions
ICT	Information Communication Technology
ILO	International Labour Organisation
ISO	International Organisation for Standardisation
KIIs	Key Informant Interviews
NITA-U	National Information Technology Authority-Uganda
PDF	Portable Document Format
PIT	Project Implementation Team
RAs	Research Assistants
SDG	Sustainable Development Goal
SOE	School of Engineering
SPSS	Statistical Package for The Social Sciences
STATA	Statistical Software for Data Science
UACE	Uganda Association of Consulting Engineers
UBOS	Uganda Bureau of Statistics
UEDCL	Uganda Electricity Distribution Company Limited
UEGCL	Uganda Electricity Generation Company Limited
UETCL	Uganda Electricity Transmission Company Limited
UGX	Uganda Shillings
UIPE	Uganda Institution of Professional Engineers
UNABCEC	Uganda National Association of Building and Civil Engineering Contractors
UNBS	Uganda National Bureau of Standards
UNCST	Uganda National Council for Science and Technology
UNESCO	United Nations Educational, Scientific and Cultural Organization
UPDF	Uganda Peoples' Defense Forces
USA	United States of America


HYDRAULIC OIL
LIQUIDE HYDRAULIQUE
HYDRAULIK-ÖL
LÍQUIDO HIDRÁULICO

1.0 Background

1.1 CFIT Phase III Project

The UNESCO China Funds-in-Trust (CFIT) Phase III: Higher Technical Education in Africa for a Technical and Innovative Workforce was initiated with the signing of an agreement between the People's Republic of China and UNESCO in October 2019. The overall objective of the project is to enhance the capacity of higher education institutions (HEIs) to respond to the skills needs for national development by facilitating collaboration between higher education and the industry, enhancing labor market-oriented teaching, and strengthening competence-based learning.

The project intends to contribute to the promotion of inclusive and equitable quality education in higher technical fields at the tertiary level, to serve both economic development and lifelong learning needs. The project will specifically promote Goal 4.4 of the SDG which emphasizes the need for higher level technology skills training to substantially increase the number of youths and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship.

A CFIT III Formulation Study (July 2021) identified key problems resulting from the mis-match between skills needs for national development and education by HEIs. The problems included high graduate unemployment; shortage of high technical skills to drive economic growth and how to manage the increasing youth population in this regard; and how university innovations might begin to address these problems.

Two public universities, Makerere University and Mbarara University of Science and Technology were identified, profiled and selected to participate in the CFIT III project. At Makerere University, the focus is on the engineering programmes offered at the College of Engineering, Design, Art and Technology (CEDAT).

The Formulation Study (July 2021) concluded that, from the CFIT perspective, Uganda faced the following issues:

a. A rapidly growing population with a significant 'youth bulge' placing pressure on all state systems and which will become more acute in the coming years;
b. Teaching equipment were seriously obsolete with little expectation of additional budget lines for upgrading in the near future;
c. Curricula and teaching methods that were generally lagging behind the needs of the economic growth areas prioritised in the National Development Plan III, and that this situation would deteriorate as a result of COVID lockdowns;
d. Career guidance for graduates, as well as essential training in transferrable skills such as ICTs, oral communications for work, written communications skills, and basic training skills needed to be prioritized;
e. A good percentage of graduates would be obliged to become self-employed, in which case all graduates should have the basic skills to construct a business plan and to manage a project. This might involve a re-set of expectations on graduating, and a shift in mind-set to become more entrepreneurial;
f. A tendency for female graduates to be under-employed and/or to become involved in family businesses in the informal sector, despite reasonably equitable participation rates and equitable performance in education;
g. A relatively large number of private universities whose graduates may not be immediately employable in 'applied, higher technical' fields of work and who would need to reskill or up-skill into growth sector employment through post-graduate programmes in public universities;
h. That large infrastructure projects now in planning and/or in progress in Uganda, will increasingly oblige universities to interface with contractors and to take every advantage of graduate training for sustainable employment into the future. It would be an opportunity to interface with international contractors regarding upgrading of teaching equipment and in-company internships;

i. An increasing need for more advanced

scientific methods of production, processing and marketing which universities would be obliged to supply.

Actionable and practical recommendations were framed to investigate and provide solutions to the issues agreed upon in the Formulation Study. A key recommendation from the study was the need for a labour market analysis whose results would be utilized by HEIs to provide rigorous evidence in refining higher technical education. An extract of the recommendation with regards to Labour Market Analysis is shown in table 1.

Table 1- CFIT III Formulation Study Recommendation

Outcomes	Outputs	Activities
Outcome 1: Effective utilization of information from labour market analysis, curriculum review, graduate tracer studies by HEIs to improve the delivery of technical education	Output 1.1: Labour market analysis conducted and results utilized to provide rigorous evidence in refining higher technical education	Activity 1.1.1: Both universities could separately and jointly revisit their processes for gathering current labour-market data in fine detail and benchmark their processes against good international exemplars with a view to identifying what types of labour market data could best be used to inform: • review of curricula • teaching equipment upgrading • career guidance services for students • preparation of students for transition to work. A jointly agreed process could be piloted by both universities in year one of the CFIT project, evaluated for effectiveness and the results used to recommend similar processes across the HE sector at a national level by the end of the project.

1.2 Country Context

1.21 Economic and Social Context

According to the Annual Macroeconomic and Fiscal Performance Report 2020/21 published by Ministry of Finance, the size of the Ugandan economy expanded to USD 42 billion in Financial Year 2020/21, registering a real GDP growth rate of 3.4%. The International Monetary Fund (IMF) predicts that this Financial Year 2021/22, growth will be about 4.0%. This recent performance represented a form of recovery as the country continues managing the COVID 19 pandemic. The performance of the economy dropped from remarkable 6.3% in 2017/18 and 6.4% in 2018/19 to 3.0% in 2019/20, mostly attributed to the COVID-19 pandemic.

Uganda's total population is 41.6 million according to Uganda Bureau of Statistics (UBOS) with an annual growth rate of 3.0%.

According to the UBOS Statistical Abstract 2021, the working population in the country grew from 15.1 million in 2017 to 15.9 million in 2020. The Working age population, defined as persons between 14 and 60 years of age, grew from 19.1 million to 21.4 million. Majority of working population, i.e., 47.6% are in subsistence agriculture. In 2020, there was an even split between male and female that made up the working population. 74% of the working population lived in rural areas while 26% live in Urban centres. 41% of working population lived in Kampala and Central Uganda, Kampala alone accounting for 16.5% of the working population in the country.

Agriculture, forestry and fishing sector accounted for 68.1% of the working population. Trade, Manufacturing and Construction accounted for 10.4%, 4.3% and 2.4% respectively. Of the 8.3 million persons in employment in 2020, only 6.3%

were professional. This implies that only a small number of jobs are well paying. The median monthly cash earnings (nominal) for an employee in Uganda was UGX 200,000 in 2019/20. Gender differentials showed that male employees earned more than twice (UGX 250,000) as much as their female counterparts (UGX 120,000). On the other hand, employees in the urban area earned more than double (UGX 300,000) what employees in the rural areas earned (UGX 130,000). Additionally, employees in the public sector earned more (UGX 510,000) than those in the private sector (UGX 150,000).

1.2.2 The Academic Pathway for Engineers in Uganda

Students complete seven (7) years of primary school to become eligible to join secondary school. In primary school, four (4) subjects are compulsory, i.e., Mathematics, English, Science and Social Studies. In Uganda, secondary school education is divided into Ordinary level, commonly known as O' level, which can be completed in four (4) years resulting into an award of Uganda Certificate of Education (UCE). A student is expected to take and sit exams for at least six (6) subjects. At O' level, the subjects taken significantly begin to shape the career choices of a student. A student aiming for an engineering career must take Mathematics and Physics among the minimum six (6) subjects. Most students take more subjects, up to ten (10) subjects, so as to keep their career choices wider. A further two (2) years of secondary school education is called Advanced level, commonly known as A' level. After A' level, a student is awarded a Uganda Advanced Certificate of Education (UACE). With UACE, the student is eligible for programmes offered by HEIs such as SOE CEDAT Makerere University. At A'level, the student is expected to take three (3) principal subjects and a maximum of two (2) subsidiary subjects. Students aiming to do engineering courses at SOE-CEDAT are expected to take Physics and Mathematics as two of the three principal subjects at A' level.

A student may still join SOE-CEDAT by first joining a Technical College after A 'Level and obtaining a relevant National Diploma in Engineering.

1.2.3 The Professional Engineer in Uganda

After completing a four-year engineering undergraduate programme at SOE-CEDAT, the student is awarded a Bachelor of Science degree in Engineering. To become a professional engineer, one has to be registered with the Engineers Registration Board (ERB). ERB is a statutory authority established in 1969, under the Engineers Registration Act (ERA) Cap 271 whose mission is to regulate and supervise the profession of engineering in Uganda. Under its mandate, the ERB is authorized to (a) register (b) de-register (c) restore registration (d) suspend registration (e) hold inquiries (f) hear appeals and (f) appear as respondents against a case brought against it in the High Court. A registered engineer must be a Corporate member of the Uganda Institution of Professional Engineers (UIPE) and must have a Bachelor of Science (or higher) in engineering together with relevant engineering experience that must be documented, supported by two registered engineers, and defended by the applicant in an interview. ERB is also mandated to advise the government regarding the engineering sector. The board is appointed by the Ugandan Minister of Works and Transport in consultation with the Uganda Institution of Professional Engineers (UIPE), the professional body of engineers in the country, who are guaranteed for positions on the board. Registered engineers in Uganda, enjoy cross-border reciprocity of recognition of credentials in the countries of the countries of the East African Community (Burundi, Kenya, Rwanda, Tanzania and South Sudan).

1.3 Engineering Studies at Makerere University

1.3.1 Historical background

Makerere university celebrates 100 years of existence in 2022, in which years it has grown to be one of Africa's leading universities. The University's vision is to be a thought leader of knowledge generation for societal transformation and development. Its Mission is to provide transformative and innovative teaching, learning, research and services responsive to dynamic national and global needs. The Academic units are organized into constituent colleges, one of which is the College

of Engineering, Design, Art and Technology (CEDAT). CEDAT comprises 3 Schools, i.e., the School of Engineering, School of the Built Environment and the Margaret Trowell School of Industrial and Fine Arts.

The School of Engineering comprises three departments-the Department of Civil & Environmental Engineering, Department of Electrical and Computer Engineering, and the Department of Mechanical Engineering. The School of Engineering boasts of 52 years of existence, having opened its doors to 26 pioneer engineering students in 1970. Until December 1995, the engineering program, which lasted four years, was divided into two parts:

Table 2- Engineering Programmes 1990-1995

Part	Duration	Notes
Preliminary/ Part I	2 years	Common to all students of engineering
Part II	2 years	Students were split into the three disciplines of Civil, Mechanical and Electrical Engineering

From 1996, the engineering programme underwent a major change when it was decided that admissions would be direct into the three disciplines of Civil, Electrical and Mechanical Engineering.

1.3.2 Programs offered at the School of Engineering, Makerere University

Each department offers degree programs at undergraduate and graduate level.

Table 3- Programmes offered at the School of Engineering Makerere University

Department	Programs offered	Duration (years)	Comments
Civil and Environmental Engineering	Bachelor of Science in Civil Engineering (1970- to date)	04	
	Master of Science in Civil Engineering	02	Admissions are made per area of specialization *(Structural Engineering, Highways Engineering, Water Resources Engineering, Environmental Engineering)*
	PhD	04	Provisional admission for 01 year during which time the applicant develops a comprehensive research proposal necessary for a full admission as soon as the proposal is approved.

Department	Programs offered	Duration (years)	Comments
Electrical and Computer Engineering	Bachelor of Science in Electrical Engineering (1970 – to date)		
	Bachelor of Science in Computer Engineering (2010-2020)	04	No admissions done 2021/2022 academic year. There is a proposal to merge Computer Engineering and telecommunications Engineering into one undergraduate course.
	Bachelor of Science in Telecommunication Engineering (2004-2020)	04	
	Master of Science in Telecommunication Engineering	02	
	Master of Science in Power Systems Engineering	02	
	PhD	04	Provisional admission for 01 year during which time the applicant develops a comprehensive research proposal necessary for a full admission as soon as the proposal is approved.
Mechanical Engineering	Bachelor of Science in Mechanical Engineering (1970-to date)	04	
	Master of Science in Mechanical Engineering	02	
	Master of Science in Renewable Energy	02	
	Master of Science in Technology Innovation and Industrial Development	02	
	PhD	04	Provisional admission for 01 year during which time the applicant develops a comprehensive research proposal necessary for a full admission as soon as the proposal is approved.

1.4 Engineering Graduate Employability

Graduates of the School of Engineering are gainfully employed in several sectors. According to the Uganda National Council for Science and Technology (UNCST) Tracer Study Report (2016), 79% of engineering graduates were employed by large multi- national companies, large local companies, medium-Sized enterprises, local and central government and other subcontracting firms, 10% employed & self-employed, 7% self-employed and 4% unemployed in the period between 2008 and 2014 (Sebbale & Barugahara, 2016)[1].

In order to align the skills of the graduates from the School of Engineering with the labour market needs, the School of Engineering:

a. Reviews its curricula every 3-5 years. The process includes consultation with different stakeholders e.g., regulatory bodies and industrial partners;
b. Each department has an Industrial Training Coordinator who helps with placement of students in different firms for industrial training;
c. Through the Makerere Engineering Society, the School of Engineering works with engineering bodies such as the Uganda Institution of Professional Engineers (UIPE), the Engineers Registration Board (ERB), Uganda National Association of Building and Civil Engineering Contractors (UNABCEC), Uganda Association of Consulting Engineers (UACE) to offer career guidance to the students.

Despite those interventions, there is need for ongoing engagement with industry, without waiting for the curriculum review cycle. It is hoped that this engagement would help monitor industry satisfaction with School of Engineering graduates and influence the road map for improving the curricula.

The CFIT III study in 2021 identified the lack of a strong industry-academia engagement and a possible mismatch between the graduates with market needs as key challenges. To address these challenges, a regular scan of the labour market is needed so that the results can feed into the curricula review cycles to have better fit of engineering graduates.

1 Sebbale, S., and Barugahara, I., 2016. 'Tracer Study of Engineering Graduates in Uganda: An Expedition from University to Work'. Uganda National Council for Science and Technology (UNCST), Kampala.

1.5 Sustainable Development Goals, Agenda 2063 and National Development Plan III Outlook

Employability concerns are at the center of the 2030 agenda (sustainable development goals), Agenda 2063 (Africa we want); as well as Uganda's the third national development plan and Vision 2040. Sustainable Development Goal 8 advances the promotion of inclusive and sustainable economic growth, employment and decent work. The goal covers a variety of topics, including those for which there are tier I and tier II indicators, such as labour productivity, informal employment, earnings (including the gender pay gap), unemployment, youth not in education, employment or training, child labour and occupational injuries (International Labour Organization, 2018).[2]

International Labour Organization (2021) provides a shared vision of its human-centred approach to shaping a secure future of work, with full, productive and freely chosen employment and decent work for all. To develop this human-centred approach to the future of work, the framework proposes a range of core skills to strengthen the capacities of all people to pursue lifelong learning and to address the needs of vulnerable groups, who would not otherwise be able to benefit from the opportunities offered by a changing world of work.

Article 57 of Agenda 2063 notes that "youth unemployment will be eliminated, and Africa's youth guaranteed full access to education, training, skills and technology, health services, jobs and economic opportunities, recreational and cultural activities as well as financial means and all necessary resources to allow them to realize their full potential" (African Union Commission, 2015).[3]

The human capital development aspirations of the third national development plan seek to produce appropriate knowledgeable, skilled and ethical labour force. A functional labour market will be established through: (i) setting up a functional labour market information

2 International Labour Organization (2018) Decent Work and the Sustainable Development Goals:
A Guidebook on SDG Labour Market Indicators, https://www.ilo.org/global/statistics-and-databases/publications/WCMS_647109/lang--en/index.htm
3 African Union Commission (2015) Agenda 2063: Africa we Want, https://www.afdb.org/fileadmin/uploads/afdb/Documents/Policy-Documents/Agenda2063_Popular_Version_English.pdf

system; (ii) development and implementation of an apprenticeship and job placement policy and programme; (iii) extending internship programme to out-of-school youths; and (iv) conducting regular tracer studies (Republic of Uganda, 2020).[4]

1.6 Objectives of the Labour Market Study

The labour market study had the following key objectives:

a. To assess the short, mid and long-term labour market needs across all sectors of the national economy that can be filled by engineering graduates, and identify needed skills – with a particular focus on highly demanded skills
b. To provide an overview of current labour market trends and snapshots from industry on training and strategic skill needs as well as an overall assessment of economic, social and technical drivers of market growth
c. Given results of the needs and labour market analysis and with benchmarking against international exemplars, identify what types of labour-market data could best be used to inform:
    i. review of curricula for the engineering programmes offered by HEIs;
    ii. required upgrading of teaching equipment and/or tools;
    iii. career guidance services for students;
    iv. preparation of students (orientation) for transition from HEIs to the work environment.

1.7 Scope of the study

The scope of study included the following:

a. Conducting labour market analysis, reviewing existing labour market information and intelligence for the curriculum review, assessment reforms and programme development;
b. Organizing consultations with the private sector and relevant stakeholders to map out any existing skills gaps, and emerging demands for new skills based on new / evolving technologies;
c. Identifying skills gaps and anticipating skills needs based on the labour market analysis, consultations, national development plans, etc., and exploring the necessity of introducing new curriculum and programmes required from HEIs;
d. Developing recommendations in curriculum and programme development depending on skills needs identified in the labour market analysis results, upholding the principles of inclusiveness, relevance and gender-equality.

1.8 Labour Market Surveys

The term "labour market" can be defined as the 'interplay of those willing and able to work (supply of labour) and those looking for workers (demand for labour) (GIZ and Prospera Consulting, 2020)[5].

A labour market Survey is aimed at a better understanding of the functioning of a labour market. For this study, the main purposes were:

a. To understand the factors related to the supply, demand and matching side of the engineering labour market; with emphasis on the skilling side (supply) and the employment side (demand).
b. To understand the specific labour market for engineering-local market trends, skills needs, medium and long term plans, in order to identify opportunities that can influence interventions in the delivery of engineering courses.

Labour market survey results can help HEIs to adopt demand-driven approaches in their training, for example in focusing on courses with high employment potential and skills that are most needed by the market.

It is hoped that the results of the Labour market survey will answer some of these questions:

a. Is there an over-supply of engineering graduates?
b. Is there evidence of skill mismatch or over-qualification?
c. Are students studying the right type of course units at the school of engineering?

1.9 Skills Mismatch

Skills mismatch refers to the 'gap between the skills required on the job and those possessed by individuals' (European Commission (2018)[6].

4 Republic of Uganda (2020) Third National Development Plan: 2020/21-2024/25 (Kampala: National Planning Authority).

5 GIZ and Prospera Consulting, 2020. 'Compendium of Tools for Labour Market Assessment, VET Toolbox Coordination Hub' Brussels-Belgium

6 European Commission , 2018. 'Promoting employment and decent work in development cooperation' Luxembourg

According to McGuinness, Pouliakas and Redmond (2017)[7], skills mismatch can take several forms: -

a. **Over and under-qualification:** The Qualification being higher or lower than required
b. **Qualification mismatch:** Qualification level is different from that required
c. **Over- and underskilling:** Overskilled workers believe that they possess more skills than their current role requires. Underskilled workers believe that their skills do not meet the demands of the job.
d. **Skill gap:** The extent to which workers lack the skills necessary to perform a role
e. **Skill shortage:** The demand for a particular skill exceeds the supply of people with the needed skills at market rates.
f. **Occupational (horizontal) mismatch:** Workers employed in roles unrelated to their field of study.
g. **Skills obsolescence:** Ageing, occupations disappearing, changing skill needs may render worker's skills obsolete.

The Labour market survey fed into an analysis stage in which review of existing labour market information was done and used to map skill gaps and emerging demands for new skills. Another source of information for the mapping of skills gaps was the national development plans.

1.10 Employers of Engineering Graduates

The School of Engineering provides several undergraduate and graduate programmes as shown in Table 3. After graduation, engineering graduates are absorbed in several sectors of the economy. According the Uganda Bureau of Statistics (UBOS, 2021)[8] the economy is characterized by thee (3) broad sectors that are further divided in subsectors as shown in Table 4 below.

Table 4- Institutions Employing Engineering Graduates

SECTOR	SUB-SECTORS	EXAMPLES OF INSTITUTIONS
Agriculture, Forestry and Fishing	Agriculture (Cash crops, food crops)	Ministry of Agriculture
	Fishing	Ministry of Agriculture
	Forestry	Ministry of Water and Environment National Environmental Management Agency
Industry	Mining and Quarrying	Ministry of Energy & Minerals Development Uganda National Oil Company
	Manufacturing	Roofings Limited Century Bottling Limited Kiira Motors Limited
	Electricity	Uganda Electricity Generation Company Limited Rural Electrification Agency
	Construction	Uganda National Roads Authority Roko Construction Ltd Abubaker Technical Services
	Water Supply	National Water and Sewerage Corporation Ministry of Water and Environment

7 McGuinness S., Pouliakas K., Redmond P., 2017. 'How Useful Is the Concept of Skills Mismatch?' International Labour Organization, Geneva

8 Uganda Bureau of Statistics (UBOS) 2021, 'Annual Statistical Extract 2021' Uganda Bureau of Statistics, Kampala

SECTOR	SUB-SECTORS	EXAMPLES OF INSTITUTIONS
Services	Trade and Repairs	Car and General Uganda Limited Mantrac Uganda Limited
	Transportation and Storage	Civil Aviation Authority Uganda Railways Corporation
	Accommodation and Food Service	
	Information and Communication	MTN Uganda Airtel Uganda Uganda Communication Commission
	Financial and Insurance Activities	Bank of Uganda Absa Bank
	Real Estate Activities	
	Administration Services	
	Professional, scientific and technical activities	Armstrong Consulting Kagga and Partners UB Consulting Engineers
	Public Administration	UPDF Uganda Police
	Education	Makerere University Kyambogo University Ndejje University
	Human Health and Social Work	Infectious Diseases Institute GOAL Uganda
	Arts, Entertainment, Recreation	

Table 4 shows examples of employers of engineering graduates extracted from the Uganda Institution of Professional Engineers (UIPE) database. It can be seen that engineering graduates are absorbed in almost all sub-sectors of the economy. These employers collectively represent the labour market for engineering graduates. Each sub-sector, each employer however, has specific needs. The study sought to understand short-term, medium-term and long-term needs of these employers. For the purposes of the study, short-term represents needs within one year, medium term refers to needs between 2 and 5 years while needs beyond 5 years were regarded as long-term. Organisational, Operational and Strategic plans wewere targeted as the likely determinant and source of information regarding employer needs. For the purpose of this study, needs were characterized as; (a) engineering disciplines and specializations required, (b) number of personnel required with those qualifications; (c) Specific skills required of the personnel (d) level of qualification.

For the purpose of this study, the main engineering disciplines required by employers were adopted from the undergraduate programmes provided by the School of Engineering and include:

- Civil engineering
- Electrical engineering
- Computer engineering
- Telecommunication engineering
- Mechanical engineering

1.12 The Professional Engineer's Skills

Engineers require numerous skills to proper at the work place. International Labour Organisation (ILO, 2021)[9] defined non-technical skills required by any professional and can be applied to engineering as well. These skills are categorized as shown in Table 5.

9 International Labour Organisation, 2021 'Global Framework for core skills for life and work in the 21st Century' International Labour Organisation, Geneva

Table 5- ILO Non-technical skills

#	Broad Skill Set	Skills
1	Basic Skills for Green Jobs	Environmental awareness
		Waste reduction and waste management
		Energy and water efficiency
2	Basic Digital Skills	Use of basic hardware
		Use of basic software
		Operate safely in an online environment
3	Cognitive and Metacognitive Skills	Foundational literacies
		Analytical and critical thinking
		Creative and innovative thinking
		Strategic thinking
		Problem solving and decision making
		Self-reflection and learning to learn
		Collect, organize and analyse information
		Planning and organizing
		Career management
4	Social and Emotional Skills	Communication
		Collaboration and teamwork
		Conflict resolution and negotiation
		Emotional intelligence

The Accreditation Board for Engineering and Technology (ABET 2021)[10], an ISO 9001 certified organization that accredits college and university programs in applied and natural science, computing, engineering and engineering technology in the USA, lists seven (7) student outcomes against which all engineering programmes must be designed to meet. These outcomes relate to technical and non-technical skills that engineering graduates must have. The skills include:

- Ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics ;
- Ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors;
- Ability to communicate effectively with a range of audiences;
- Ability to recognize ethical and professional responsibilities in engineering situations, and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts;
- Ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives;
- Ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions;
- Ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

This study sought to identify skills required by the market and identify the most important skills that can be incorporated or enhanced in the School Curriculum.

10 ABET 2021, 'Criteria for Accrediting Engineering Programs' ABET, Baltimore

2.0 Methodology

2.1 Methodological Approach by each Objective

Below were the procedures that were undertaken in order to achieve each objective.

Objective 1: To assess the short, mid and long-term labour market needs across all sectors of the national economy that can be filled by engineering graduates, and identify needed skills – with a particular focus on highly demanded skills.

Objective 2: To provide an overview of current labour market trends and snapshots from industry on training and strategic skill needs as well as an overall assessment of economic, social and technical drivers of market growth.

Approach:

Step 1 Desk Review.

The following documents were reviewed:

- Vision 2040 (Uganda): National Development Plan III
- The African Agenda 2063
- East African Community VISION 2050
- Annual reports from the College of Engineering, Design, Art and Technology
- Sector Development Plans
- Strategic plans for both the University and the College of Engineering, Design, Art & Technology
- Curricula of undergraduate programmes at School of Engineering;
- School of Engineering graduation lists over the 2013-2022 period;

Step 2 Data Collection

Respondents

a. Survey Questionnaire

A survey was conducted targeting alumni of School of Engineering who completed their undergraduate studies between 2012 and 2021. The survey sought to identify the skill gaps. The respondents were reached through social alumni groups as well as through the UIPE secretariat.

b. Sample Selection Procedures for Key Informant Interviews

Purposive sampling method was used. Top 5 employers in public and private sector for each engineering discipline were identified. The top 5 employers were identified from UIPE database except for Computer Engineering discipline, whose list was developed from recommendations from the Department of Electrical and Computer Engineering. Additional Organisations were also included in the sample to represent sectors such as Manufacturing and Local Governments that had not been represented from the above sampling method.

Interviews were held with the selected key informants in the public and private sectors for the various engineering disciplines as per the Table 6.

Table 6- Sample of Employers by Engineering Discipline

Engineering discipline	Public Sector	Private Sector
Civil Engineering	• Uganda National Roads Authority • National Water & Sewerage Corporation • Ministry of Works and Transport • Kampala Capital City Authority • Kanungu District Local Government • Kira Municipal Council	• Professional Engineering Consultants (PEC) Ltd • ICS Engineering and Environment • Getlab • Excel Construction Limited • Segamu 14 Consults Ltd • MBW Consulting Ltd
Electrical Engineering	• Transmission Company Limited (UETCL) • Rural Electrification Agency • Uganda Electricity Distribution Company Limited • Uganda Electricity Generation Company Limited • Ministry of Energy and Mineral Development	• Umeme Ltd • Multi-Konsults Ltd • Megger Technical Services Ltd • Electrical Controls and Switchgears Limited • M&E Associates Ltd • TESLA Technical services • Ericsson AB Uganda
Computer Engineering	• National Information Technology Authority – Uganda (NITA-U) • Ministry of ICT • Uganda Electricity Transmission Company Limited (UETCL) • Civil Aviation Authority	• Roke Telecom • Safe boda • ORIT Engineering • Technology Associates Uganda • Currently Freelance engineer • Bizit Solutions Ltd • Never Ending Solutions
Telecommunication Engineering	• Uganda Civil Aviation Authority • Uganda Electricity Transmission Company Limited (UETCL) • Uganda Telecom	• MTN Uganda • American Tower Corporation (ATC) Uganda • Airtel Uganda • UTL • Csquared Uganda • Soliton Telmec (U) Limited • Ericson Uganda Limited
Mechanical Engineering	• Ministry of Works and Transport • Uganda National Roads Authority • National Water & Sewerage Corporation • Uganda National Bureau of Standards (UNBS) • Uganda Electricity Generation Company Ltd (UEGCL)	• Car & General (U) Ltd • Vivo Energy Uganda Ltd •

C. Other Stakeholders

The following stakeholders were interviewed;

- Engineer's Registration Board (ERB)
- Uganda Institution of Professional Engineers (UIPE)
- Uganda Association of Consulting Engineers (UACE)
- Uganda Manufacturers' Association (UMA)
- Uganda National Association of Building and Civil Engineering Contractors (UNABCEC)
- Uganda National Council of Science and Technology (UNCST)
- Departments in the School of Engineering
- Dean of the School of Engineering

Objective 3: Given results of the needs and labour market analysis and with benchmarking against international exemplars, identify what types of labour-market data could best be used to inform: (i) review of curricula for the engineering programmes offered by HEIs; (ii) required upgrading of teaching equipment and/or tools; (iii) career guidance services for students; (iv) preparation of students (orientation) for transition from HEIs to the work environment.

Approach:

Step 1 Desk Review:

A desk-based research was conducted to collect curriculum and curriculum review procedures from three international Higher Education Institutions.

Step 2 Data Collection

Respondents

a. Survey Questionnaire

A survey was conducted targeting alumni of School of Engineering who completed their undergraduate studies between 2012 and 2021. The respondents were reached through social alumni groups as well as through the UIPE secretariat.

b. Sample Selection Procedures for Key Informant Interviews

Purposive sampling method was used. Top 5 employers in public and private sector for each engineering discipline were identified. The top 5 employers were identified from UIPE database except for Computer Engineering discipline, whose list was developed from recommendations from the Department of Electrical and Computer Engineering. Additional Organisations were also included in the sample to represent sectors such as Manufacturing and Local Governments that had not been represented from the above sampling method.

Interviews were held with the selected key informants in the public and private sectors for the various engineering disciplines as per the Table 6.

c. Other Stakeholders

The following stakeholders shall also be interviewed;

- Engineer's Registration Board (ERB)
- Uganda Institution of Professional Engineers (UIPE)
- Uganda Association of Consulting Engineers (UACE)
- Uganda Manufacturers' Association (UMA)
- Uganda National Association of Building and Civil Engineering Contractors (UNABCEC)
- Uganda National Council of Science and Technology (UNCST)
- Departments in the School of Engineering
- Dean of the School of Engineering

2.2 Data Analysis Methods

The following methods were used to analyse data collected:

a. Quantitative data analysis: Quantitative data was entered into STATA and/or SPSS where it was analysed using quantitative techniques (i.e., Cross tabulations, correlations, descriptive statistics e.g., mean, absolute number & percentages).

b. Qualitative data analysis: Audio recorded data of stakeholder meetings were transcribed and typed in MS-Word. Data collected using key informant interviews, was analysed using a thematic, content, narrative, and discourse analysis techniques. In certain instances, direct quotes from stakeholders and informants were used.

c. Inferencing: From the data consolidation and analysis of both qualitative and quantitative data, inferences were drawn inform of infographics and other standardized ways of reporting which are included in this study report.

3.0 Results and Findings

3.1 Desk Review

3.1.1 Vision 2040 (Uganda): Third National Development Plan (NDP III) 2020/21-2021/25

The National Development Plan (NDPIII) is the third in a series of six NDPs that will guide Uganda in delivering the aspirations articulated in Uganda Vision 2040. The Uganda Vision 2040 aims to transform the Ugandan society from a peasant to a modern and prosperous society. The Vision of Vision 2040 is 'a transformed Ugandan Society from a peasant to a modern and prosperous country within 30 years'.

For successful implementation of the NDPIII, among the key development strategies to be pursued are Enhance skills and vocational Development; and Promotion of Science, Technology, Engineering and Innovation as well as ICT.

The NDP III identifies 5-year skills gaps which have been adopted in the estimation of the demand for engineers in Uganda.

NDP III lays out 18 programs to achiever the development objectives, which are also aligned to the Sustainable development goals, Africa Agenda 2063 and East African Community Vision 2050.

Table 7- Mapping of development frameworks (SDGs, AA2063, EAC 2050 and NDPIII)

Program (NDP III)	SDG	AA2063 (PA-Priority areas)	EAC 2050
Mineral Development Programme	SDG: 9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation SDG: 12 Ensure sustainable consumption and production patterns	Goal 4 in Aspiration 1 - PA 4.2: STI driven manufacturing/ industrialization Goal 7 Aspiration 1 - PA 7.3 Sustainable consumption patterns	GOAL: Leveraging industrialization (Extractive Industries) -Chapter 6: Industrialization
Sustainable Development of Petroleum Resources	SDG: 9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation SDG: 12 Ensure sustainable consumption and production patterns	Goal 4 in Aspiration 1 - PA 4.2: STI driven manufacturing/ industrialization Goal 7 Aspiration 1 - PA 7.3 Sustainable consumption patterns	GOAL: Leveraging Industrialization (Chapter 6: Industrialization)

Program (NDP III)	SDG	AA2063 (PA-Priority areas)	EAC 2050
Climate Change, Natural Resources, Environment and Water management programme	SDG: 12 Ensure sustainable consumption and production patterns SDG 13 Take urgent action to combat climate change and its impacts , SDG 14 Conserve and sustainably use the oceans, seas and marine resources for sustainable development , SDG 15 Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	Aspiration 1 Goal 1: Modern and Livable Habitats and Basic Quality Services (Water and Sanitation) Aspiration 1 Goal 7: Environmentally sustainable climate resilient economies	GOAL: Sustainable utilization of natural resources, environment management and conservation with enhanced value addition. (Chapter 7: Natural resource and environment management)
Manufacturing Programme	Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation SDG: 12 Ensure sustainable consumption and production patterns SDG 13 Take urgent action to combat climate change and its impacts	Aspiration 1 Goal 4 – PA 4.2: STI driven manufacturing/ industrialisation Growth of SMEs	GOAL: Leveraging industrialization (Industrial Development and SMEs) (Chapter 6: Industrialization)

Program (NDP III)	SDG	AA2063 (PA-Priority areas)	EAC 2050
Integrated Transport Infrastructure and Services Programme	SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation SDG: 12 Ensure sustainable consumption and production patterns	Goal: 10: World class infrastructure criss - crosses Africa Goal: 4 Transformed economies. Aspiration 1 Goal 6 – PA 6.2 Port Operations	GOAL: Improved access to affordable and efficient Regional transport, energy and communication network (Chapter 4: Infrastructure Development)
Energy Development Programme	SDG 7 Ensure access to affordable, reliable, sustainable and modern energy for all SDG: 12 Ensure sustainable consumption and production patterns	Aspiration 1 Goal 7-Renewable energy Aspiration 1 Goal 1: PA 1 .4 Modern and liveable habitats (electricity) Aspiration 1 Goal 7 – PA 7.1 Sustainable consumption patterns	GOAL: Improved access to affordable and efficient Regional transport, energy and communication network (Chapter 4: Infrastructure development)
ICT and Digital technology programme	SDG:9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation SDG 17 Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development	Goal 10 World class infrastructure criss - crosses Africa (Communications and Infrastructure Connectivity)	GOAL: Improved access to affordable and efficient Regional transport, energy and communication network (Chapter 4: Infrastructure Development)
Sustainable Housing and Urban Development Programme	SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation SDG: 12 Ensure sustainable consumption and production patterns	Goal: 10 World class infrastructure criss Goal: 4 Transformed economies. Aspiration 1 Goal 6 – PA 6.2 Port Operations	GOAL: Improved access to affordable and efficient Regional transport, energy and communication network (Chapter 4: Infrastructure Development)

Program (NDP III)	SDG	AA2063 (PA-Priority areas)	EAC 2050
Innovation, Technology Development and Transfer Programme	SDG 17: Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development	Aspiration 1 Goal 4 – PA 4.2: STI driven manufacturing	GOAL: Improved access to affordable and efficient Regional transport, energy and communication network (Chapter 4: Infrastructure Development)

Source: Annex 1 Nation Development Plan III (NPA, 2020)[11]

3.1.2 Makerere Strategic plan (2020-2030)

The aim of Makerere's Strategic plan is to "consolidate Makerere's position as the global knowledge hub at the heart of Africa" building on the previous strategic plan (2007-2019) which sought to 'make Makerere a Center of excellence in teaching and learning, research and innovation in Africa'.

The University's Vision 2030 is "Makerere a thought leader of knowledge generation for societal transformation and development"

Makerere University's Mission is "Providing transformative and innovative teaching, learning, research and services responsive to the dynamic national and global needs". It is envisaged that the mission shall be achieved through the following interventions:

a. Learner-centred academic programs., with flexible study options
b. Curriculum should be learner centered, promote participation, experimentation and collaborative learning.
c. Problem/community oriented and competence-based learning
d. Lecturer to be a coach designing learning experiences and not a lecturer to promote independent thinking and analysis of complex situations.
e. Open, Distance and e-learning as demanded by the workplace
f. Enrich curriculum with practical knowledge
g. Collaboration with industry in order to enrich the university's curricula

The strategic plan is built on the need to transform the university into a research-led university, and enhanced engagement with industry and business sector. The Plan hinges on Vision 2040 (Uganda) and Africa's development agenda 2063

Goal 4 of the strategy is "an engaged university with enhanced partnerships with industry, the community and international institution". The goal is hinged on prioritizing the needs of the community in which she is located, enhancing community outreach programs and revitalizing university open days.

3.1.3 CEDAT Draft Strategic Plan (2019/20-2029/2030)

The Strategic plan for the College of Engineering, Design, Art and Technology (CEDAT) is built on the university wide strategy. The CEDAT strategic plan notes that 'We are living in a changing world. Engineering and other aspects of technology are very much influenced by the new advances in ICT', and therefore the graduates should be equipped with the latest knowledge and skills in ICT.

CEDAT Mission: To provide transformative innovative teaching, learning, research and services responsive to dynamic national, regional and global needs, in Engineering, Design, Art and Technology.

The CEDAT Strategic direction is to encourage private sector participation in the programs in CEDAT.

The plan notes that Internships are 'the best practical learning exposure needed for students in the college'. In CoVID (two years, training was reduced by 50% and students allowed flexi schedule, with some swapped for online courses available on Coursera.

The strategic plan takes note of failures in the previous plan including:

a. Few courses taught through e-learning
b. Students on industrial training not visited by members of staff
c. No technological innovations transferred to

11 National Planning Authority, 2020, Third National Development Plan (NDP III) 2020/21-2024/25., Kampala

the private sector. No patents registered

d. No major revenue generated from the Science and technology consultancies
e. No Consultancy and Knowledge Transfer partnership/knowledge transfer partnerships
f. 60% of lecturers using chalk and talk
g. College lacks technicians and so some critical lab sessions are missed
h. Students were not assigned to mentors

3.2 Survey Response rate

The study targeted 100 key informant interviews from 50 employers of engineering graduates. The study also targeted 100 alumni of the School of Engineering who graduated between 2012 and 2021. 93 key informant interviews were held and 56 SOE alumni responses were received providing a response rate of 93 percent and 56 percent respectively as shown in the table below.

Table 8- Study Response Rate

	Target	Responses	Response Rate
Key Informant Interviews	100	93	93%
SOE Alumni Survey	100	56	56%

3.3 Characteristics of Survey Respondents

3.3.1 Demographic profile of the KII respondents

Figures 1-3 show the demographics of the KII respondents who were interviewed including; gender, organization category, and sector of the economy. A total of 93 key Informants participated in the study, of these 87 percent were males and 13 percent were females. In terms of Employment agency, both private sector and public/government contributed 46 percent each while 5.1 percent and 1.3 percent were from multi-national organisations and Development agencies respectively. The majority of the respondents belong to the Electricity (30.4%), followed by Buildings construction (24.1%), Professional, scientific and technical activities (21.5%), Road construction (18.9%) and Water supply (10.1%).

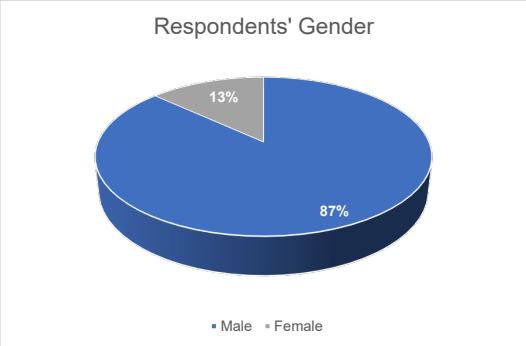

Figure 1- KII Respondents Gender Profile

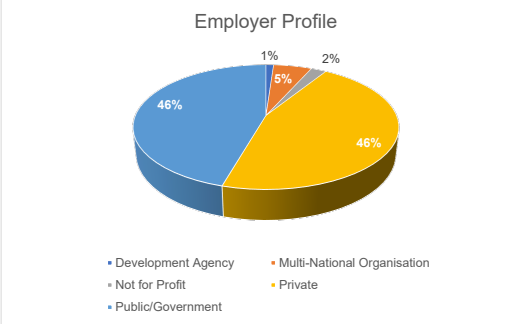

Figure 2- KII Employers' Profile

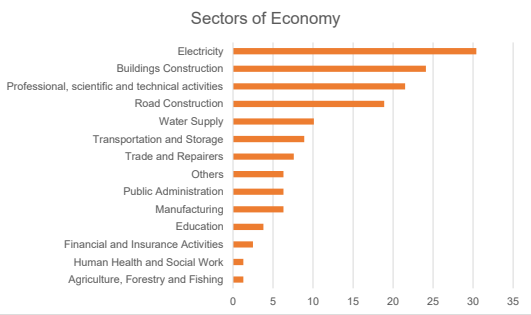

Figure 3- KII Respondent's Sectors of the Economy

3.3.2 Demographic profile of the SOE Alumni Survey Respondents

Figures 4-7 show the demographics of the SOE Alumni who were surveyed including; gender, organization category, and sector of the economy. A total of 56 Alumni participated in the study, of these 78.6 percent were males and 21.4 percent were females. Majority (64.3%) that were interviewed were civil engineers, 14.3 percent electrical engineers, 8.9 percent computer engineers, 8.9 percent mechanical

engineers and 3.6 percent telecommunication engineers. In terms of Employment agency/ organisation, majority (69.1%) are employed in the private sector, followed by public/ government at 21.8 percent, 5.5 percent and 3.6 percent were from multi-national organisations and not for profit agencies respectively. The majority for the Alumni belong to Road construction (37.5%) followed by Buildings constriction (32.1%), Electricity (16.1%), and Water supply (12.5%).

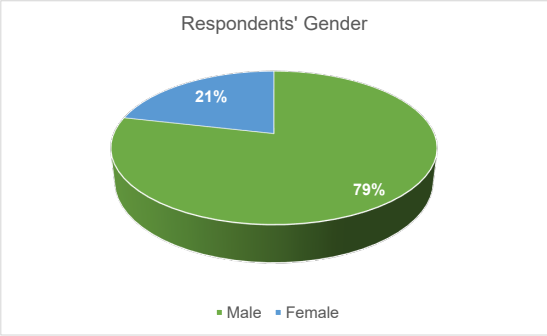

Figure 4- Alumni Survey Respondents' Gender Profile

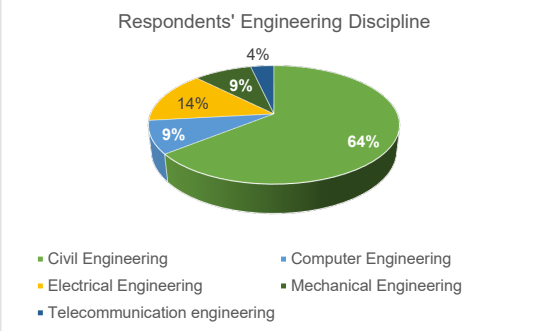

Figure 5- Alumni Survey Respondents' Engineering Discipline

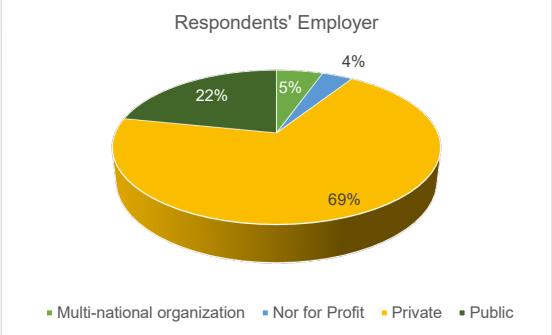

Figure 6- Alumni Survey Respondents' Employers

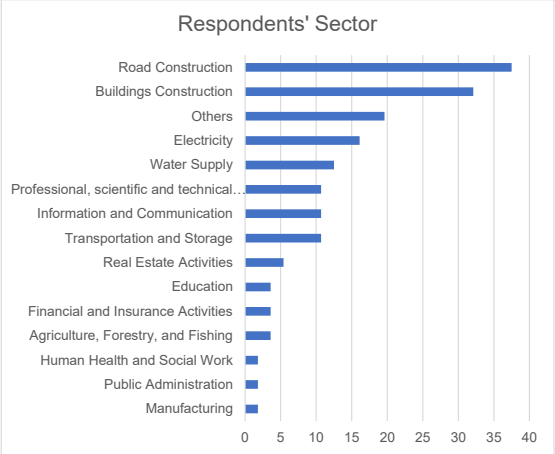

Figure 7- Alumni Survey Respondents' Sector of Economy

3.3.3 Key Stakeholder Profiles

Key Informant Interviews with selected key stakeholders were held as shown in Table 9.

Table 9- Key Stakeholders engaged

Stakeholder	Relevance of Organization to engineering and the study
Uganda Manufacturers Association	• the largest Business membership Organization representing the manufacturing sector in Uganda. UMA has a membership of about1,500 members. • Manufacturing is crucial to Uganda achieving its Vision 2040. Many engineers, especially mechanical engineers are employed by the manufacturing sector • UMA runs an ACCESS to employment Graduate program, in which graduates are attached to member for 3 months after graduation. They are monitored and companies retain those that make the grade.
Engineer's Registration Board	• The Engineers Registration Board (ERB) is established under the Engineers Registration Act (ERA) Cap 271, as a statutory body with a mission to regulate and control engineers and their profession within Uganda. • Role of ERB: To make sure that licensed engineers are competent enough to lead projects of engineering nature. • No one is allowed the title 'Engineer' without being on the ERB register
Uganda Institution of Professional Engineers	• The leading independent organization for the engineering profession in Uganda and embraces Engineers, Technicians and Technologists • Runs a Graduate Training Program
Uganda Association of Consulting Engineers	• The Uganda Association of Consulting Engineers (UACE) brings together all engineers in consultancy across the spectrum. • They run Continuous Professional Development trainings which are approved by the Uganda Institution of Professional Engineers.
Uganda National Association of Building and Civil Engineering Contractors	• Uganda National Association of Building and Civil Engineering Contractors (UNABCEC) is a member-driven, national trade association representing genuine contractors, and other companies and organizations engaged in construction in Uganda. Current membership is 170 companies/organizations • UNABCEC is the umbrella association of contractors (majority Civil). It is the voice of the contractor and its membership is a significant source of employment of engineering graduates. • UNBACEC runs a Construction Industry Advancement Program, offering training opportunities to final year students and fresh graduates of construction and engineering related fields of study in Uganda.
Uganda National Council of Science and Technology	• The Uganda National Council for Science and Technology is a semi-autonomous government agency to advise, develop, implement policies and strategies for integrating Science, Technology and Research development in Uganda. • UNCST is mandated to promote science and technology in Uganda. • In 2016, the UNCST published a 'Tracer study of engineering graduates in Uganda-And expedition from University to work', whose results would be important in judging any progress made since then by Makerere University, School of Engineering.
School of Engineering, Makerere University	• The premier training school of engineers in Uganda. • Sanctioned the study

3.4 Demand for Engineers

3.4.1 Number of Engineers Required

The demand for engineers can be inferred from Uganda's third National Development Plan (NDP III) for the 2021/22-2024/25 period. Engineers with various specializations are needed to implement various socioeconomic programmes. Table 10 indicates that 23,741 engineers (6,412 Civil Engineers; 7,699 Electrical Engineers; 5,414 Mechanical Engineers; 389 Telecom Engineers and 3,827 Computer Engineers) are required to implement various programs within NDP III within 5 years.

Table 10- Number of Engineers by Specialization Required to Implement NDP III

National Development Program	Civil Engineers	Electrical Engineers	Mechanical Engineers	Telecom Engineers	Computer Engineers
Mineral Development		534	1,351		
Sustainable Development of Petroleum Resources	322	249	1,123		
Climate Change, Natural Resources, Environment and Water management	3,250	287			
Manufacturing	323	1,489	950		
Integrated Transport Infrastructure and Services	287	36	142		
Energy Development		3,346	860		
ICT and Digital technology					1,520
Sustainable Housing and Urban Development	1840				
Innovation, Technology Development and Transfer	390	1,758	988	389	2,307
TOTAL	**6,412**	**7,699**	**5,414**	**389**	**3,827**

Source: Republic of Uganda (2020) Third National Development Plan: 2020/21-2024/25 (Kampala: National Planning Authority).

42% of the 23, 741 jobs available are for ordinary positions for which a Bachelor's Degree holder from the School of Engineering, Makerere University can apply for.

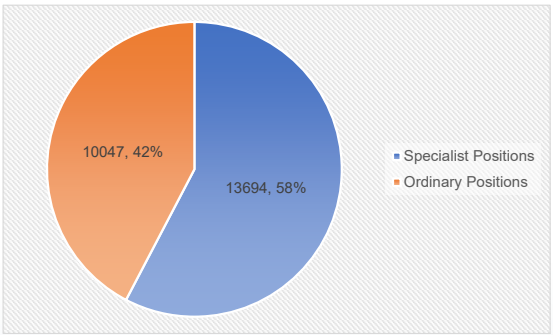

Figure 8- 5-year skill gap in engineering

The majority of the positions (52%) are for specialists. The Uganda Engineers Scale of fees published in 2011, categorized engineering roles in 11 groups, starting from level 1: technical assistant to Level 11: Specialist. It defined a specialist as a 'top practitioner with a bachelor's degree, registered by ERB whose expertise and relevant experience is exceptional and is nationally and internationally recognized as that of an expert on a particular subject with at least a master's degree in engineering, fellow, etc .' For 52% of the positions available, one would need at least a master's degree in engineering to qualify.

The Engineers registration board's Strategic plan for FY 2020/2021-2024/25 notes that by

July 2020, there were 942 licensed engineers for a population of 41.5Million Uganda, translating to an engineer per people ratio of 1:44,055. Even when you factor in that there were about 8,000 engineers, unregistered and practicing illegally, the ratio would only come down to only 1:4,641 which is way higher than the desired global average of 1:770 (UNCST,2016). According to the Uganda National Council of Science and technology, the preferred engineer to population ratio is 1:25. According to the Uganda Gazette of 11th February, 2022, there are only 1,149 licensed engineers in Uganda. (Sebbale & Barugahara, 2016)[12].

3.4.2 Specialisations needed in the short term

Employers were asked to list engineering specialisations that were required by their organisations in the short term. In this study, short term was considered to be "the next 12 months". Specialisations were defined as branches of the five main engineering disciplines that were required to conduct business. Most employers' responses were a reflection of current activities and current demands. Employers listed the following specialisations as those needed in the short term.

Table 11- Specializations needed in the short term

Discipline	Specializations needed in the short term
Civil	• Materials engineering • Highways engineering and pavement design • Hydrologists/ drainage engineers • Structural engineers • Project Management • Occupational health and safety • Road safety, traffic engineering, traffic control and traffic signal design • Transportation engineering • Geotechnical engineers • Cost and measurement engineers • Civil works inspectors • Contract claims specialists • Environmental engineers • Bridge engineers
Electrical	• Power system protection specialists – switchgear engineering • Power transmission systems engineering – load flow analysis, design of HV, MV and LV networks and substations, construction, operation and maintenance. • Building services- power distribution in buildings and design and installation • Solar energy/power generation and distribution- design, specification/ sizing and installation • Instrumentation engineers (programming, installation and maintenance of energy meters) • Hydro power generation operation and maintenance, asset management planning, control and instrumentation, • Energy economics, technical and energy efficiency audits • Power Generation: Diesel Generator installations, ratings, synchronization of generators, calibration of electronic control units, power command controls • Electronics (automation of plants with industrial PLCs), analysis, programming, design and develop electrical circuits/boards, interpret, review and modify circuits; troubleshooting and reconfiguration of systems • Nuclear energy science and engineering • Instrumentation for condition-based maintenance

12 Sebbale, S., and Barugahara, I.,2016. 'Tracer Study of Engineering Graduates in Uganda: An Expedition from University to Work'. Uganda National Council for Science and Technology (UNCST), Kampala.

Discipline	Specializations needed in the short term
Computer	• Traffic signalisation • Human Machine interface for traffic control centres, data collection and analysis • Computer programming • Configurations of networking equipment and Network security • Installation and configuration operation and maintenance of computer systems, network security including network servers, routers, firewalls, Computers, printers and scanners • Installation and configuration operation and maintenance of computer software • Networks and data security • Software development • Database management. • Linux operating system • Digital marketing, digital content management
Telecom	• Telecommunications network planning, operation and maintenance • Optic fibre technology, transmission, maintenance and deployment • Financial technology • Cable networks • IP data communications • Radio communications • Configuration, operation and maintenance of telecommunication software • Virtual Local Area Network (VLAN) spanning • Configurations of networking equipment and Network security • Project management
Mechanical	• Automotive • Plant automation and programming in production and manufacturing • Mechatronics • Hydraulics and pneumatics (design and failure modes) • Plant specification and sizing, operation and maintenance, parts inventory management • Engine overhauls and servicing • Machining, design of machine parts and analysis, welding and joinery , powder coating • Installation and operation of agricultural implements • Health, Safety and Environment • Chemical engineering; materials selection e.g. to suit the chemical composition of water in various areas (development of specifications); • Energy economics, technical and energy efficiency audits • Design of piping systems and implications of selected design in terms of piping losses (water hammer analysis and its mitigation); air valve design and sizing, selection of valve positioning in the system); • Bearing design, selection and installation to withstand loads in various systems; • Lubricant selection and application in various systems; • Drawing interpretation • Public procurement principles and procedures • Marine machine design; marine auxiliary machines; marine electrical power systems; naval architecture; marine control systems engineering; maritime safety • Heating, Ventilation and Air Conditioning (HVAC) engineers

3.4.3 Specialisations needed in the mid term

Employers were asked to list engineering specialisations that were required by their organisations in the medium term. In this study, medium term was considered to be the period 2 to 5 years. It was observed that the short-term needs were applicable in the medium term as well. However, the most significant specialisations required in the medium term were analysed to include the following shown in the table below.

Table 12- Specialisations needed in the mid term

Discipline	Specialisations needed in the mid term
Civil	• Water and sanitation engineering • Hydrologists • Highway and pavement design engineers • Traffic control, traffic signaling and road safety engineers • Transportation engineering
Electrical	• Energy economics, energy audit and efficiency specialists • Power system protection specialists • Power systems engineering specialists • Building services specialists • Solar energy/power design and installation, operation and maintenance • Instrumentation engineers • Hydro power generation operation and maintenance, asset management planning, control and instrumentation • Nuclear energy science and engineering • Marine energy, geothermal, floating solar, wind • Machine learning • Design of electrical boards and analysis
Computer	• Design of traffic signals • Aviation control systems installation and monitoring • Advanced computer programming, • Design, installation, configuration, operation and maintenance of computer systems (software and hardware), networking equipment and network security • Database design and management • Project management of computer system projects • Search engine optimization • Software development and deployment • Data analysis and visualization • Digital content creation.
Telecom	• Telecommunications network planning and systems operations • Configurations of networking equipment and network security • Radio communications, microwave and RF optimisation • Aviation control systems installing and monitoring. • Fiber technologies, fiber network monitoring and maintenance. • IP Data communications • Financial technologies • Project management
Mechanical	Marine engineering (Marine machine design, marine auxiliary machines, marine electrical power systems, naval architecture, marine control systems engineering, maritime safety) Design of machine parts and analysis, welding and joinery, powder coating

3.4.4 Specialisations needed in the long term

Employers were asked to list engineering specialisations that were required by their organisations in the long term. In this study, long term was considered to be the period between 5 to 10 years. Some employers found it difficult to forecast labour needs beyond 5 years. Nonetheless, some respondents made an attempt. It was observed that the short term amd medium term needs were applicable in the long term as well. However, the most significant specialisations required in the long term were analysed to include the following shown in the table below.

Table 13-Specialisations needed in the long term

Discipline	Specialisations needed in the long term
Civil	• Water and sanitation engineering • Transportation engineering • Traffic signalization • Channelization • Bridge engineers
Electrical	• Energy audit & efficiency specialists • Power system protection specialists • Power systems engineering specialists • Building services speciaists • Solar energy design and installation • Instrumentation engineers • Hydro power plant operation and maintenance, asset management planning, control and instrumentation • Nuclear energy science and engineering • Marine energy • Geothermal and wind energy/power generation • Machine learning • PLC and design of electrical boards and analysis
Computer	• Computer programmer • Computer systems installation, configuration, operation, optimization and maintenance including networks and security • Database design and management • Project management • Software/ application development • Quality assurance testing, management and data analytics • Cyber security • Cloud administration, Automation, Backup and recovery • Aviation control systems
Telecom	• Network planning, configurations of networking equipment and network security • Radio communications, microwave, RF deployment and Maintenance • Aviation systems engineering • Optic fiber technologies • IP Data communications. • Data analytics • Financial technologies

Discipline	Specialisations needed in the long term
Mechanical	• Automotive • Plant automation in production and manufacturing • Mechatronics • Marine engineering; machine design, marine electrical power systems, naval architecture, control systems engineering, maritime safety • Design of machine parts and analysis, welding and joinery , powder coating

3.4.5 Specialisations in short supply

Employers were asked to list the specializations that are currently in short supply in the country. The table below shows specialization that were considered not sufficient in the Ugandan labour market.

Table 14- Specialisations in short supply

Discipline	Specialisations in short supply
Civil	• Highway and pavement design, • Traffic engineering, traffic control, traffic signaling, • Public transport management • Municipal engineering (solid waste) and drainage engineering • Geotechnical engineering • Bridge engineers • Materials engineers • Railway engineering, • Transport planning engineers (railway, airport, ports and harbors) • Transport economists • Structural engineers • Hydrologists • Irrigation engineers • Contract claims experts, • Engineering metallurgy • Material scientists • Biomedical engineering (instrumentation, laboratories) quality control (laboratories)
Electrical	• Power systems protection specialists • Automation and programming specialists • Nuclear energy engineers • Machine learning • Floating solar power plants specialists
Computer	• Cyber security engineers • Traffic signal design engineers • Computer components designers and fabrication • Automation and embedded systems designers • Artificial Intelligence specialists • Big data analysts • Programming and system control engineers • Network infrastructure planning and design engineers • Cloud architects, enterprise architects • Software developers

Discipline	Specialisations in short supply
Telecom	• Fintech software engineers • Aviation engineers • Network infrastructure planning and design engineers • Optic fibre engineers
Mechanical	• Mechatronics and instrumentation • Health, Safety and Environment certifications, • Project management certifications • Balancing of rotating masses e.g. for impellers • design for condition-based maintenance • Machine shop and production skills (e.g. milling, turning, threading, heat treatment for case hardening) • Mechatronics and automation of equipment • Drawing interpretation • Engineering design and specifications development • Marine engineering; machine design; marine auxiliary machines; marine electrical power systems; naval architecture; marine control systems engineering; maritime safety • Robotics • CAD engineers • CNC machines specialists

3.4.6 Required Skills over the Short-Term, Medium-Term and Log-Term

Employers were asked about the skills they required over the short-term, medium-term and long-term. Figure 9 presents the ranking of required skills over the short-term by the sampled employers of engineering graduates. In the short-term the employers reported that the most required skills are: (i) use of basic hardware, (ii) use of basic software and (iii) collaboration and teamwork.

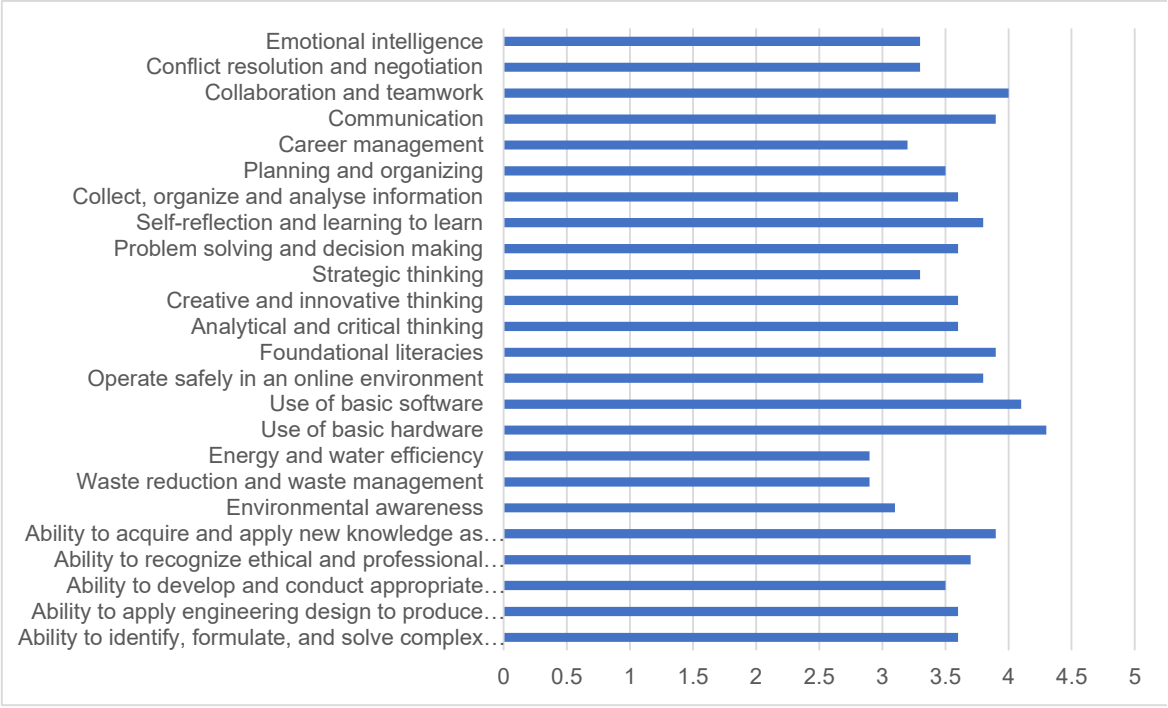

Figure 9- Ranking of the Required Skills over the Short-Term

In the medium term the most required skills are (i) use of basic hardware; (iii) use of basic software, (iv) communication and (v) collaboration and teamwork as presented in Figure 10.

Figure 10- Ranking of the Required Skills over the Medium-Term

In the long-term the most required skills are (i) ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics; (ii) use of basic hardware; (iii) use of basic software and, (iv) collaboration and teamwork (see Figure 11)

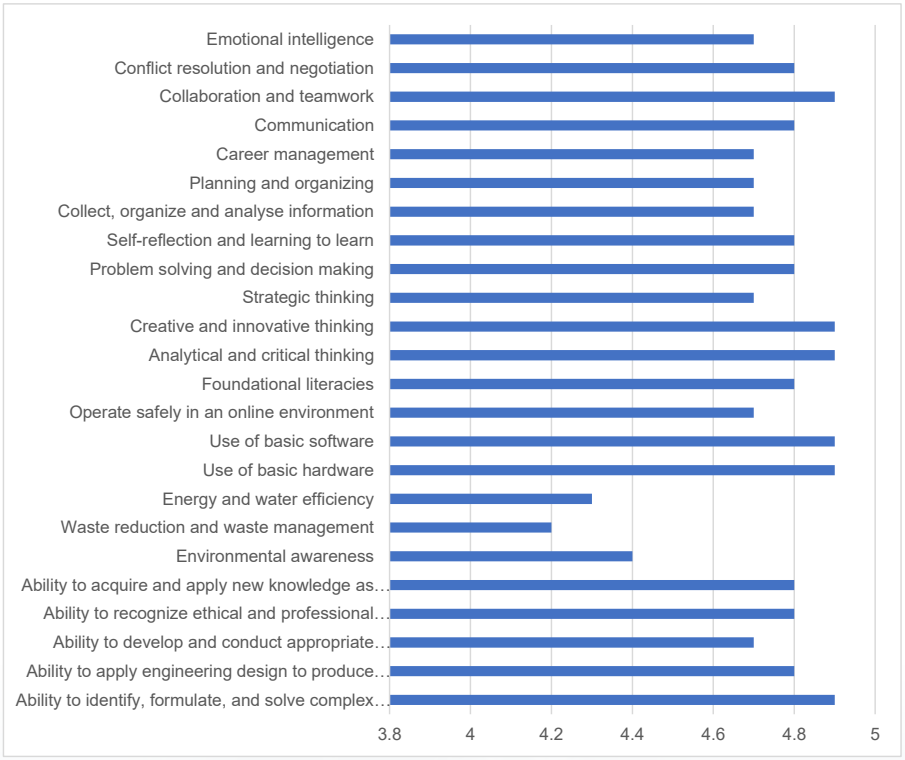

Figure 11- Ranking of the Required Skills over the Long-Term

3.4.7 Skills in short supply

Employers were asked to list skills that were currently in short supply in the country. What can be noted is that due to technological advancement, most employers have cited a shortage of skills in the use of computer aided design applications. Whereas design from first principles is appreciated and should be known, most modern engineering designs are application based. Entrepreneurial skills were also among those cited as lacking amongst engineering graduates in the market. The table below shows skills that were considered not sufficient in the Ugandan labour market.

Table 15- Skills in short supply in industry

Discipline	Skills in short supply
Civil	• Project risk management • Leadership skills • Strategic thinking • Interpersonal skills • Business management skills • Use of modern CAD applications
Electrical	• Engineering drawing using CAD applications (sub-station drawing and powerline drawings) • Leadership and management skills
Computer	• Creative and innovative thinking and the ability to identify, formulate, and solve complex engineering problems by applying principles of engineering • Creative and innovative thinking skills and the ability to transform the innovative idea into a tangible product • Analytical and critical thinking skills • CAD software design and analysis skills • Concept development • Versatility
Telecom	• Skills to handle and work with newer technologies • Concept development • Creativity and Innovation • Big data analytics • Practical and problem solving skills • Business and financial skills
Mechanical	• Design, optimisation and troubleshooting skills especially where proprietary software is involved, • power command calibration skills, • Intrapreneurship • Report writing skills • CAD software design and analysis skills

3.4.8. Perceived Skill Gaps

Alumni were asked about whether they perceive themselves to have skills gaps versus what their jobs required. This was accomplished by inquiring about: (i) whether they possessed more or less skills than those demanded by the job; (ii) whether they consider themselves to be overqualified or underqualified at their current jobs; (iii) their perceptions regarding whether their job was related to their field of study; (iv) the time (in months) it took them to get the first job after undergraduate studies; (v) their rating of the extent to which undergraduate studies prepared them for the first job; and (vi) whether their undergraduate degrees are still relevant (Figure 12 to 17).

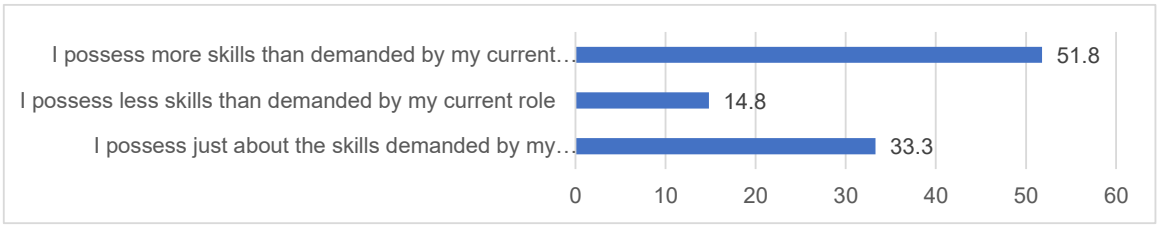

Figure 12- Perceptions of Alumni regarding Skills they Possess versus those demanded by the job

The majority of the respondents (51.8%) considered themselves as having more skills than those demanded by their current employer.

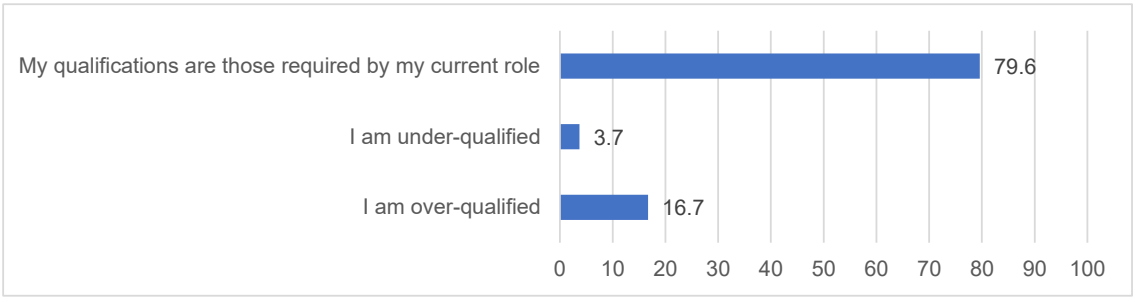

Figure 13- Percentage of respondents who consider themselves to be overqualified or underqualified at their current jobs

79.6% of the respondents considered their qualifications as the right ones for the roles they were performing.

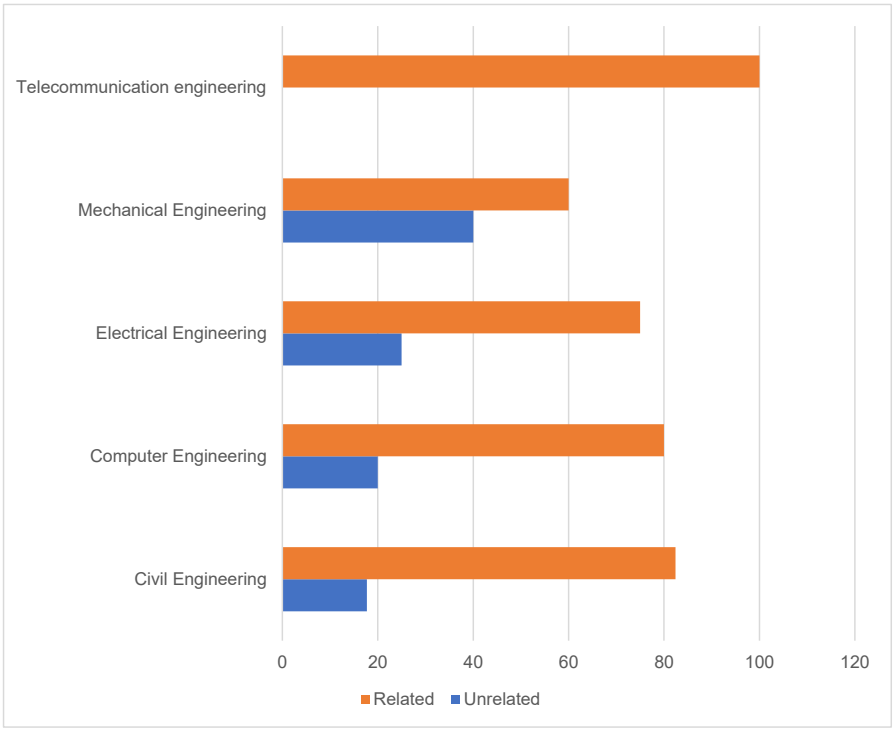

Figure 14- Perceptions of respondents regarding whether Their Job is related to their Field of Study

100% of the Telecommunication engineering alumni considered their current jobs to be related to their area of study, where as only 60% of the mechanical engineers considered their roles to be related to what they studied at Makerere University.

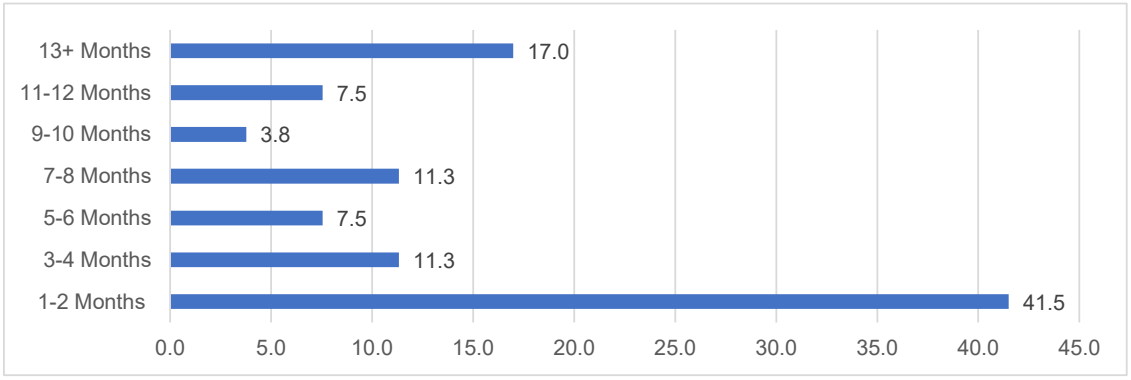

Figure 15- Time (in months) taken to get the first job after undergraduate studies

41.5% of the graduates from school of engineering got their first job within 2 months of finishing. Only 17% of the graduates from school of engineering took more than a year before getting their first job.

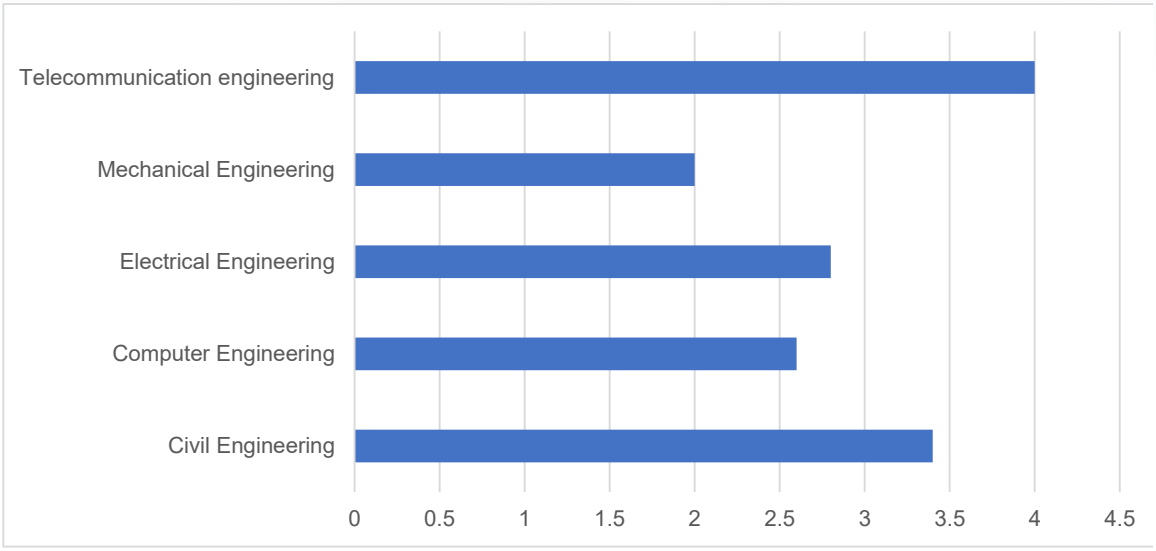

Figure 16- Rating of the Extent to which Undergraduate studies prepared respondents for their first job

When asked on a scale of 0-5, whether the alumni thought that the undergraduate studies prepared them sufficiently for their first job, the highest rating (4) was given by Telecommunication Engineers and the lowest (2) by Mechanical engineers.

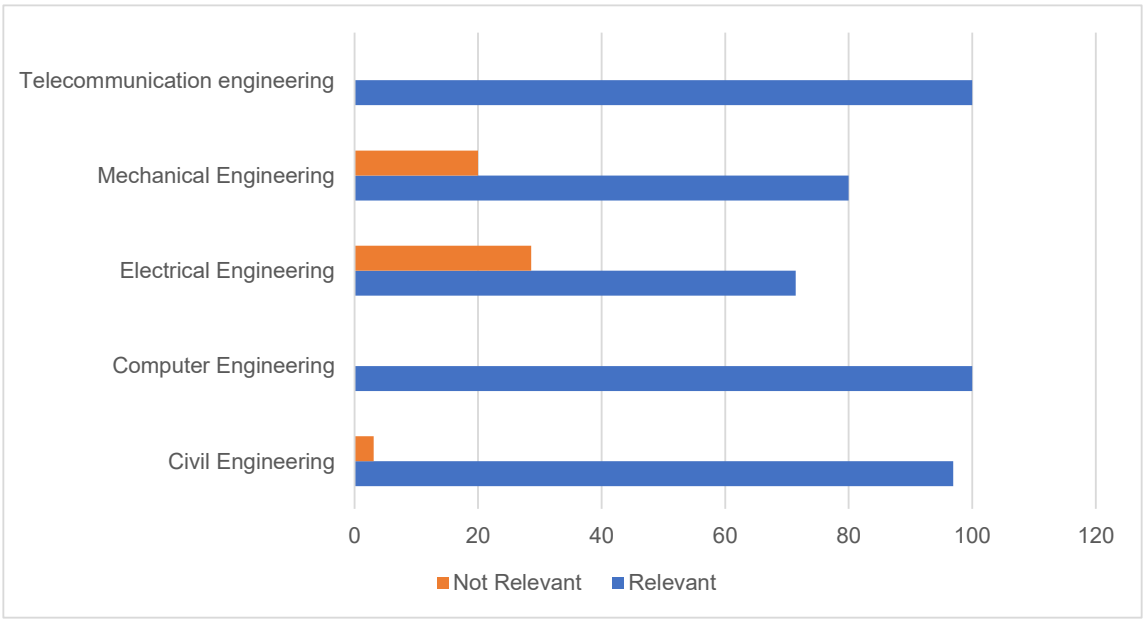

Figure 17- Percentage of respondents reporting that their undergraduate degrees are still relevant

Considering the relevance of the degree courses to the current job requirements, all the respondents from Computer engineering and telecommunication engineering thought so. At least 20% of the respondents from mechanical engineering and electrical engineering thought the courses offered were not relevant any more.

3.5 Engineering Job Characteristics

3.5.1 Salary of Engineering Graduates

There is little discrepancy in the monthly gross pay for the first job across the engineering disciplines. The overall average monthly gross pay at the first job was estimated at UGX 1,778,208. This was highest among the mechanical engineers at UGX 1,800,039 and lowest among civil engineers at UGX 1,765,738 (Figure 18).

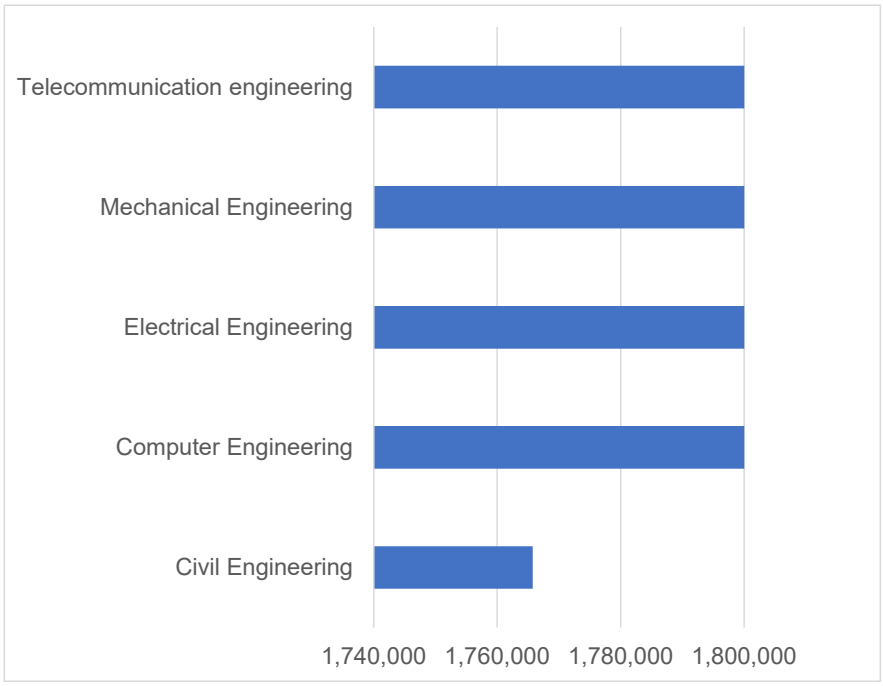

Figure 18- Average Monthly Gross Salary (UGX) by Engineering Specialization

According to the Engineers Scale of Fees published by the Engineers registration board (2015), a graduate engineer (0-4 years post-graduation) should be earning $ 3,960 per month, which is over 8 times the actual starting salary as reported by respondents.

3.5.2 Job Movements

In order to characterize the engineering labour market, respondents were asked to enumerate reasons why engineering personnel leave their jobs. Across all the engineering disciplines, the responses were similar. Better pay offers, career advancement and further studies were the most common responses. Other reasons included;

- To specialize in an area of interest
- To take up more challenging jobs
- To comply with organizational retirement policies
- As a result of organizational restructuring
- As a result of dismissal due to gross misconduct
- Non-conducive work environment and high occupational risk especially in mechanical engineering work environment
- Failure to fit in the organizational culture including poor attitude etc

3.5.3 Entry job requirements

To characterize engineering jobs to which engineering graduates are absorbed, data was collected on job requirements. The largest employers of engineering graduates offer internship positions for fresh graduates for a period of 1 to 2 years. In most organisations, these positions are called Graduate Trainee positions or Graduate Engineer position. This is seen as a means to give an opportunity to the graduate to impress prospective employers according to UIPE President, but is also a means to provide more hands-on training to the graduate before being fully employed. However, some graduates see this as a means of inexpensive employment of engineers.

3.5.4 Professional/technical job requirements

Professional and technical level job requirements hold the following characteristics. Civil engineering graduate employers require a Bachelor's degree in civil engineering field and between 2 and 10 years of experience. Most do not require personnel to be registered or certified engineer. However, senior positions (e.g. Resident Engineer at UNRA, Principal Officer in Government MDAs) require a postholder to be a registered engineer with ERB. Graduate qualifications such as Masters degree or PhD are not mandatory but if possessed give a candidate an added advantage. Among employers of Electrical engineering graduates additional qualifications such as ERA class A or B permit holder are required in addition to a Bachelors degree in electrical engineering and between 2 and 5 years of experience. Unless holding Senior government positions i.e. Principal Officer and higher, there are hardly any requirements to be a registered engineer with ERB or to possess a graduate qualification. Employers of computer engineering graduates place a lot of focus is on industry certifications for professional and technical positions. Most jobs require certain relevant certifications in addition to experience. Certifications are driven by the extent of domination of a certain technology in the market. For instance, Microsoft certifications are mostly required due to the dominance of Microsoft applications and technologies. Graduate qualifications would be an added advantage to the post holder. Telecommunications engineering employers rely on a Bachelors degree and 2 to 5 years of experience for professional and technical positions. Certifications in specific technologies is also desired. Graduate qualifications are an added advantage. Amongst mechanical engineering employers, professional positions require a Bachelors degree and 3 to 5 years of experience. In government MDAs, senior positions (Principal Officer and higher) require one to be registered with ERB and UIPE. Graduate qualifications are optional.

3.5.5 Manager job requirements

Most managerial positions across the board attract Masters degree in science field or engineering or business management or project management with 5 to 15 years of experience. Civil, electrical, mechanical graduate government employers require a candidate to be a registered engineer with ERB and a member of a professional body such as UIPE. This requirement however, is relaxed for private sector employers. Across the board, managerial positions tend to emphasize experience in non-engineering work, but rather in management aspects such as people management, risk management, project management, target setting, performance management, business management.

3.5.6 Induction and On-the-Job Training

Overall 57.7 percent of the respondents underwent additional training during their first year of employment. All the telecommunication engineers interviewed underwent additional training during their first of employment, 56.3 percent of civil engineers, 60 percent of computer engineers, 62.5 percent of electrical engineers underwent additional training during their first year of employment while only 40 percent of mechanical engineers underwent additional training during their first of employment (Figure 19).

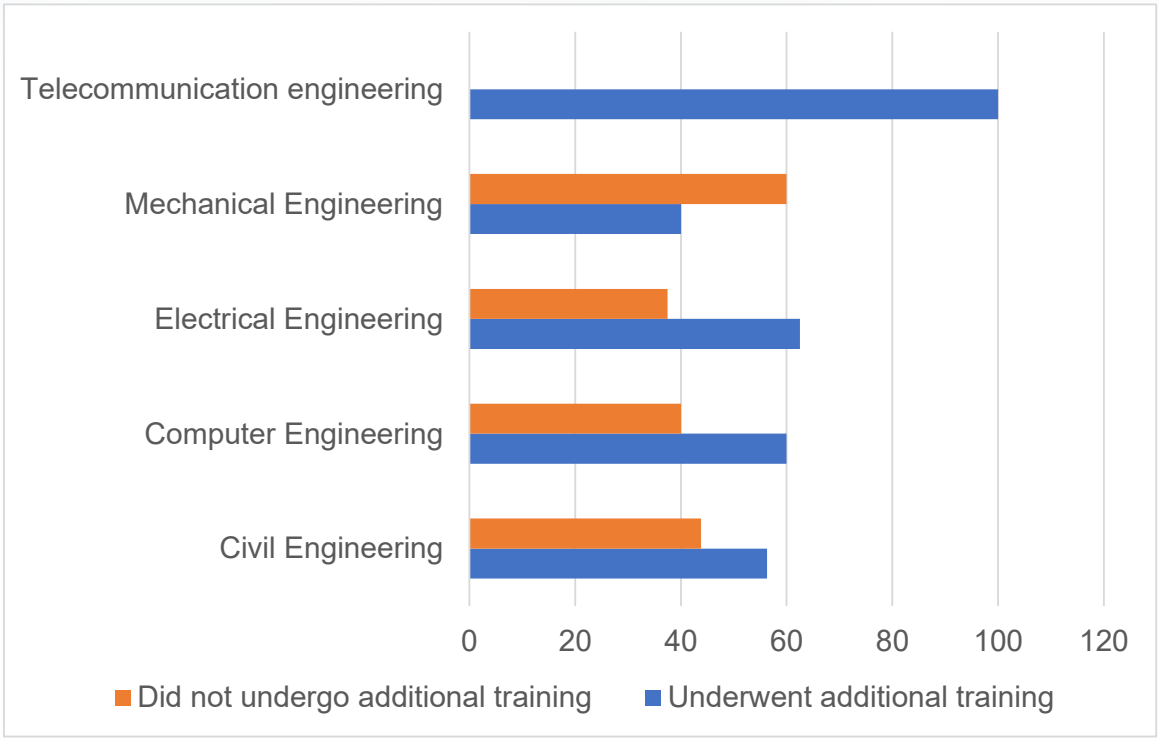

Figure 19- Percentage of Alumni who underwent Additional Training

3.5.7 Induction training programmes

The study sought to find out the nature of training programmes organized by employers to plug deficiencies is knowledge and skills of the labour market. Employers were asked the nature of induction trainings conducted at their organisations. Responses from most employers revealed that induction trainings were aimed at orienting new employees into their work environment. New employees were taken through the operations and functions of different departments and explained how their individual jobs fitted in the overall goal of the organization and what contributions they made to the success of the organization. At organisations such as UEGCL, NWSC, UETCL that undertake a graduate training programme, induction was incorporated in the training programme.

3.5.8 On-the-job/strategic training programmes

The study also sought to find out the nature of on-the-job / strategic training programmes organized by employers to plug deficiencies in knowledge and skills of employees. Responses from employers revealed wide range of trainings conducted. At UCCA, new entrants are subjected to an intensive, extensive and expensive training for 5 years and gradually advance as they go up the ladder. The training is in three phases; indoctrination, specialization and experiential. The indoctrination phase aims at initiating the entrants into the aviation industry and confirm whether the graduate has the right aptitude, attitude and ambition for the industry. The specialization phase orients the graduate into the technical aspects of the training with the goal of aiding specialization and mastery in a given engineering field in the aeronautic engineering. The experiential stage is the continuous encountering of the studied aviation principles and standards both technical and non-technical to help in your aviation work and also acquire the experiences to share with the graduates who will come during your tenure. For all the training modules, a written or oral exam is conducted by the training institute with the pass mark being 70%. At ROKE Telecom, the more senior staff demonstrate different networking problems and practically show the graduate engineers the solutions they can deploy to solve them. The graduates are also allowed to implement the networks to solve these challenges and more challenges are given to the graduates in order to master the required concepts for the job. On the live environment, a graduate is assigned to an experienced engineer to show the graduate what to do and also supervise him

or her until they master the live environment operations. Computer engineering employers usually provide vendor specific trainings for employees to manage supplied devices and systems.

3.5.9 Performance criteria for engineering

The study sought to understand what aspects of work are measured and rewarded by industry. Employers were asked to share performance metrices for engineers at entry level, professional/technical level and managerial level. The most critical and widely performance metrices for entry level staff include task delivery, attitude and quality of work. For professional/ technical level staff, the most widely applied performance metrices are competence and skills, work quality while managerial staff are measure on efficiency, resource management, business performance, client satisfaction and people management.

3.6 Factors that Influence Labour Market Growth

3.6.1 Economic factors that influence market growth

The demand and supply of engineering graduates is influenced by several factors. The study sought to establish economic factors that influence labour market growth. The demand for labour i.e. availability of employment is influenced by four main economic factors at a macro level:

a. Government policy direction and spending; Government of Uganda has for many years prioritized infrastructure, energy and transport development. These three sectors primarily are sectors that employ engineers. The development and rehabilitation of road network, construction of two new hydropower generation plants, expansion of access to ICT has provided business for private sector as well as increased employment in Government departments and agencies such as NITA-U, UCC, UNRA, UEGCL, UETCL.
b. Economic Growth; According to the Annual Macroeconomic and Fiscal Performance Report 2020/21 published by Ministry of Finance, the size of the Ugandan economy expanded to USD 42 billion in Financial Year 2020/21, registering a real GDP growth rate of 3.4%. The performance of the economy dropped from remarkable 6.3% in 2017/18 and 6.4% in 2018/19 to 3.0% in 2019/20 and 3.4% in 2020/21, mostly attributed to the COVID-19 pandemic. However, prior to the pandemic, the industry grew by a remarkable 11.2% on average from 2017 to 2019. The construction industry growth translates to more business and more jobs.
c. Investment; A surge in investments in the country has led to establishment of factories and development of especially manufacturing sector. For instance, the establishment of Quality Chemicals Industries Limited to produce ARVs in the country led to the employment of electrical and mechanical engineers among others.
d. Fiscal and monetary polices; For instance, tax policies on agricultural implements which may not favour farmers affect the use and servicing of farm implements and mechanical engineering jobs as a result. According to Bank of Uganda (BOU), of the USD 5.2 billion private credit granted in 2021, Building, mortgage, construction and real estate was responsible for the largest share i.e. 20%, an indication of the growing appetite for housing development. High interest rates on loans and mortgages therefore affect significantly the housing industry and civil engineering jobs.

At the organizational level, employers cited the following economic factors;

a. Availability of new projects. New projects result into more employment opportunities for engineers. Graduate engineers are brought in often to train in advance to prepare for forecasted work. New projects are also a reflection of sustained business growth in the private sector. On the flip side, some employment positions are lost when projects are closed. New projects are influenced by government funding, development partner funding and economic growth.
b. Restructuring. Occassioned by the government's policy direction to reduce the wage bill, government of Uganda is undergoing a restructuring in which several agencies are being merged together or merged into mother ministries. As has recently been seen with Ministry of Energy, there are a number of positions at the Rural Electrification Agency (REA) that will not be assimilated into Ministry of Energy.
c. Funding. Except for manufacturing, most engineering work is funded by government. Lack of funding to government entities as such revealed by UNRA or suspension

of funding by donor agencies will affect employment of engineers.

3.6.2 Social factors that influence market growth

The study sought to establish social factors that influence labour market growth in engineering. The study revealed the following:

a. Retirement policy; Government of Uganda employees retire at 60. However, in the engineering profession several retirees remain in the labour market to do consultancy work.
b. Gender inclusivity; There have been significant campaigns to have an inclusive work environment in the science and engineering field.
c. Imported Labour; It is generally easier to work in Uganda than any other East African country. The free movement of labour promoted by regional integration has also invited other nationals into the labour market.
d. Procurement Policy; For the longest time, the procurement policy did not provide any protection for local companies. Only recently has local content been emphasized especially in oil and gas procurement opportunities. As a result, the contruction industry has been dominated by Chinese contractors and hence affecting the engineering labour market.

3.6.3 Technical factors that influence market growth

The study revealed the following technical factors that influence labour market growth in Uganda.

a. Education and Training: Currently, several new qualifications are required by employers. The oil and gas sector is demanding several qualifications and skills not usually supplied by Ugandan training institutions and experience of which is not available in the country. This has resulted into expatriates taking up jobs.
b. Technological advancement: With regards to technology, the country relies heavily on imported technology. More and more tasks in the engineering profession are being influenced by technology. For instance, design engineers use computer aided design packages. Mechanical engineers rely on plant automation.
c. The supply of labour i.e. availability of engineering graduates is largely influenced by the number of training institutions passing out engineering graduates. CEDAT graduates on average about 320 engineering students every year, most of whom seek employment for the first time. Other universities such as Kyambogo University, Busitema University, Kampala International University, Ndejje University also graduate engineers. However, there are a number of constraints which institutions like CEDAT face. Top of the list is limited infrastructure and personnel. These constraints are further discussed in Section 3.10.

3.7 Supply of Engineers

3.7.1 Engineering Graduates from Undergraduate Programmes

Since 1970, Makerere University has been providing engineering programmes and graduating engineering students. Over the 2013-2022 period, the School of Engineering graduated 2,920 alumni (599 females and 2,321 males) with Bachelors' Degree in Engineering. The number of alumni by each engineering specialization stood as follows: Civil Engineering (162 females and 702 males); Electrical Engineering (143 females and 573 males); Computer Engineering (88 females and 262 males); Telecommunication Engineering (130 females and 343 males); and Mechanical Engineering (76 females and 441 males).

Table 16- Engineering Undergraduates from School of Engineering 2013-2022

#	Graduation Year	BSc Civil			BSc Elec			BSc Comp			BSc Telecom			BSc Mechan			TOTAL		
		Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
1	2022-72nd Graduation	79	16	95	47	9	56	25	6	31	32	15	47	57	15	72	240	61	301
2	2021-71st Graduation	67	14	81	62	20	82	14	7	21	28	12	40	49	10	59	220	63	283
3	2020-70th Graduation	75	17	92	61	13	74	19	9	28	30	15	45	50	4	54	235	58	293
4	2019-69th Graduation	81	15	96	78	15	93	37	11	48	32	8	40	53	12	65	281	61	342
5	2018-68th Graduation	81	15	96	46	14	60	19	7	26	28	13	41	30	9	39	204	58	262
6	2017-67th Graduation	70	21	91	64	19	83	33	9	42	38	11	49	44	5	49	249	65	314
7	2016-66th Graduation	66	12	78	49	18	67	26	10	36	37	16	53	41	4	45	219	60	279
8	2015-65th Graduation	65	21	86	61	15	76	32	14	46	38	10	48	24	4	28	220	64	284
9	2014-64th Graduation	76	11	87	55	10	65	57	15	72	44	16	60	51	6	57	283	58	341
10	2013-63rd Graduation	42	20	62	50	10	60				36	14	50	42	7	49	170	51	221
	Total	**702**	**162**	**864**	**573**	**143**	**716**	**262**	**88**	**350**	**343**	**130**	**473**	**441**	**76**	**517**	**2321**	**599**	**2920**

Source: CEDAT Annual reports and Academic Registrar's Department

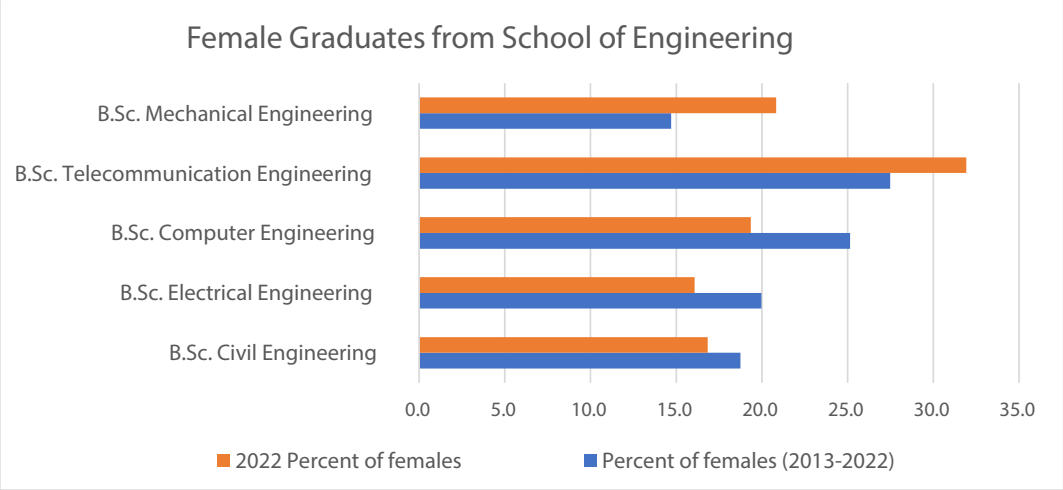

Figure 20- Female Graduates from the School of Engineering

Over the last 10 years, only 20.5% of the engineering graduates at undergraduate level are female. The highest percentage (27.5%) was for BSc. Telecommunication engineering and the lowest 14.7% for BSc. Mechanical Engineering.

3.7.2 Engineering Graduates from Graduate Programmes

Over the ten years under consideration, the School of Engineering, graduated 284 alumni (53 females and 231 males) with MSc. and Doctoral degrees. The number of alumni stood as follows: MEng. Civil Engineering (1 female and 37 males); MSc. Civil Engineering (10 females and 60 males); MSc. Electrical Engineering (6 females and 16 males); MSc. Telecommunication Engineering (2 females and 3 males); and MSc. Mechanical Engineering (3 females and 13 males); MSc. Power Systems (3 females and 9 males); MSc. Renewable Energy (10 females and 35 males); as well as MSc. Technology Innovation and Industry (17 females and 40 males). At the doctoral level, the School of Engineering graduated 19 doctoral alumni (1 female and 18 males).

Table 17- Graduate Students from School of Engineering 2013-2022

#	Grad year	MEng Civil			Msc Civil			Msc Telecom			Msc Power Systems			MEng (Electrical)			Msc Mechan			Msc Renewable			Msc Tech Innovation			PhD			TOTAL		
		Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
1	2022-72nd graduation	3	0	3	9	4	13	2	1	3	2	1	3	0	0	0	3	0	3	5	2	7	4	2	6	1	0	1	29	10	39
2	2021-71st Graduation	0	1	1	1	0	1	0	1	1	2	0	2	1	0	1	1	0	1	4	1	5	5	2	7	1	0	1	15	5	20
3	2020-70th Graduation	0	0	0	5	0	5	0	0	0	4	2	6	0	1	1	5	0	5	0	0	0	4	1	5	2	1	3	20	5	25
4	2019-69th Graduation	1	0	1	9	1	10	0	0	0	1	0	1	1	0	1	2	0	2	3	1	4	4	3	7	1	0	1	22	5	27
5	2018-68th Graduation	5	0	5	4	1	5	1	0	1	0	0	0	5	0	5	0	0	0	0	0	0	4	3	7	1	0	1	20	4	24
6	2017-67th Graduation	1	0	1	5	1	6	0	0	0	0	0	0	1	0	1	0	0	0	3	1	4	4	1	5	3	0	3	17	3	20
7	2016-66th Graduation	4	0	4	3	0	3	0	0	0	0	0	0	1	0	1	0	1	1	3	0	3	10	4	14	0	0	0	21	5	26
8	2015-65th Graduation	6	0	6	5	0	5	0	0	0	0	0	0	1	1	2	1	1	2	6	1	7	5	1	6	2	0	2	26	4	30
9	2014-64th Graduation	7	0	7	7	1	8	0	0	0	0	0	0	2	2	4	1	1	2	4	2	6	0	0	0	2	0	2	23	6	29
10	2013-63rd Graduation	10	0	10	12	2	14	0	0	0	0	0	0	4	2	6	0	0	0	7	2	9	0	0	0	5	0	5	38	6	44
	Total	**37**	**1**	**38**	**60**	**10**	**70**	**3**	**2**	**5**	**9**	**3**	**12**	**16**	**6**	**22**	**13**	**3**	**16**	**35**	**10**	**45**	**40**	**17**	**57**	**18**	**1**	**19**	**231**	**53**	**284**

Source: CEDAT Annual reports and Academic Registrar's Department

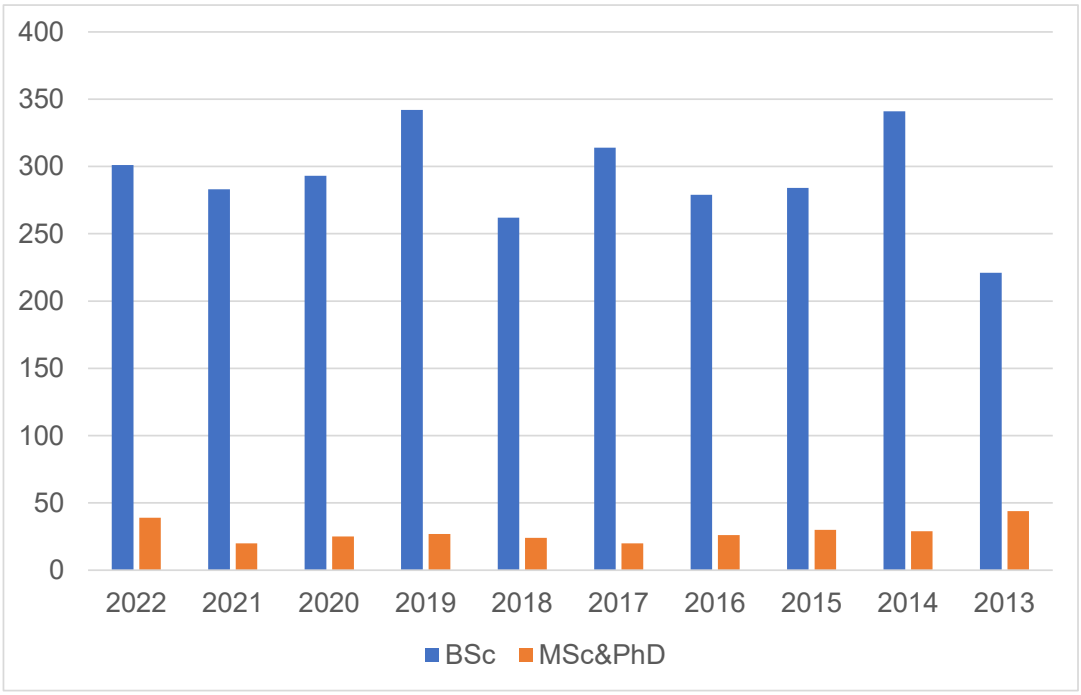

Figure 21- School of Engineering: BSc versus MSc & PhD: 2013-2022

From Figure 19, it is clear that undergraduate training dominates the School of Engineering's training. It is observed that the bulk of engineering graduates supplied to the market by the School of Engineering possess undergraduate degree. This observation is partly explained by the historical and current legal and market's requirements for engineers. Legally, a registered engineer is only required to be a member of the Uganda Institution of Professional Engineers and have a Bachelor of Science (or higher) in engineering together with relevant engineering experience of at least four years.

Given the demands of the NDP III's programmes, especially the specialisations and skills required, there is need to deliberately focus on graduate training (MSc and PhD) in line with the University's strategic direction of becoming a research-led university. The specialisations required cannot be met by the undergraduate programmes at SOE CEDAT. The current status quo shall be inadequate to satisfy demands of NDP III.

According to Uganda National Council for Science and Technology, about 68% of 2008-2012 engineering graduates had not undertaken any postgraduate training. 51% had a master's qualification after graduating, with the most popular subject being Project management. (Sebbale & Barugahara, 2016)[13].

13 Sebbale, S., and Barugahara, I., 2016. 'Tracer Study of Engineering Graduates in Uganda: An Expedition from University to Work'. Uganda National Council for Science and Technology (UNCST), Kampala.

3.7.3 Perception of the Quality of Engineering graduate

The key stakeholders were requested for their perception about the perception of the quality of graduates of engineering. The general opinion is that:

i. The engineering curricula compare favorably with similar courses in the region and beyond
ii. Makerere Students of school of engineering are 'high-flyers'
iii. Despite (i) and (ii),
    a) The university if not producing innovators, inventors, leading to a continued dependence on expatriates
    b) the graduates do not seem to be familiar with the practical aspects. The graduates have a lot of book knowledge and little hands-on exposure.
    c) The performance of the graduates straight out of university is dismal.
    d) Too much book knowledge/little hands on
    e) The University is producing engineers who are spectators, critics, who can not 'do'.

3.8 Engineering Curricula

The School of Engineering, Makerere University, is the premier engineering training at degree level in Uganda. In assessing the curricula of the programs under the school of Engineering, benchmarking has been done against 3 institutions which are ranked ahead of Makerere University globally, i.e., the University of Cape Town (South Africa), The University of Leeds (United Kingdom) and the University of Alberta (Canada).

Table 18- Ranking of Universities benchmarked against

	University of Cape Town	University of Alberta	University of Leeds	Makerere University
Quacquarelli Symonds (QS) World University Rankings	237	110	86	1201
Times Higher Education (THE) World University Rankings	183	125	127	601
Shanghai Ranking Consultancy (the Academic Ranking of World Universities; ARWU)	201	92	151	> 1000

The three Major international rankings- Quacquarelli Symonds (QS) World University Rankings, Times Higher Education (THE) World University Rankings and Shanghai Ranking Consultancy (the Academic Ranking of World Universities; ARWU) were used to select the universities ranked higher than Makerere for benchmarking purposes.

Only curricula for undergraduate courses offered by the School of Engineering, Makerere University were considered, since a Bachelor's degree is the minimum qualification for practicing engineering professionally in Uganda.

3.8.1 Program content/ Curricula

3.8.1.1 Civil Engineering

	University of Cape Town	University of Alberta	University of Leeds	Makerere University
Course offered	Bachelor of Science in Engineering in Civil Engineering	• Bachelor of Sience in Civil Engineering • Bachelor of Science in Civil Engineering-Environmental Engineering	• Civil Engineering MEng, BEng • Civil and Environmental Engineering MEng, BEng • • Civil Engineering with Project Management MEng, BEng • Civil and Structural Engineering MEng, BEng • Civil Engineering with Transport BEng	Bachelor of Science in Civil Engineering
Duration of Program	Minimum 4 years Alternative 5-year curriculum with same content, but spread out to allow more time for learning new concepts, grappling with course demands	Two types of degree programs a) Traditional program (04 years-08 terms) b) Cooperative education program (05 years. Students in addition to the 8 terms, undertake five 4-month terms of paid work experience)	An Integrated Masters (MEng, BEng) is a four-year degree that extends your studies to Masters level. BEng. Program is three years. The BEng degree course is identical to the first three years of the MEng, BEng	4 years Day program

	University of Cape Town	University of Alberta	University of Leeds	Makerere University
Content	• strong foundation in the natural sciences, mathematics and applied mechanics. • In Year II, are introduced to courses in structural engineering and • materials, water engineering, geotechnical engineering, and transportation. • In the final year, Design Project and Research Project allow students to integrate their knowledge and develop advanced problem-solving skills. • Professional aspects are covered in courses on Professional Practice and Civil Engineering practical experience. • Students pick at least one elective in the humanities, social sciences.	• All engineering students follow a common curriculum in their first year and take courses in Chemistry, Mathematics, Physics, Computing, English, Engineering Mechanics, and Introduction to the Engineering • The second-year programs include courses such as Mathematics and Humanities, common to all departments, as well as courses specific to the chosen discipline. • As students progress through the program, courses become more specialized.	• All degree courses within the School share a common first year of six compulsory modules. • Project work: Integrated design projects (IDP) run in **each year** of the programmes. • Year 3: in addition to the IDP a design/ investigative project with the use of BIM and several software. • Year 4: One undertakes an individual research project, supervised by an industrial partner • Engineering ethics taught as part of the course	Structure: • Three Core Mathematics Courses • Two Core Computer Courses • Thirty four Core Civil Engineering Courses • One Core Communication Course • Three Core Practical Courses • Three Elective Courses • Final Year Project in the first and second Semester of the Fourth Year. • Practical hours account for 26.8% of the hours allocated in the program. A total of 241 (2 days per week) are untimetabled during a semester

	University of Cape Town	University of Alberta	University of Leeds	Makerere University
Industrial placement/ Practical Experience	• Only 6 weeks. • CIV2020X Practical experience: Requires students to gain at least 6 weeks of practical experience by working during vacations. 50% in site work and 50% in design work.	• No industrial training for traditional 4-year track • 20 months over 5 years (in 4 months periods) of paid work experience for those on the Cooperative education program • Evaluation of the practical experience is based on the employer's performance appraisal, the student's work term report, and the student's ability to learn from the experiences of the work term.	• Students allowed to undertake an industrial placement year. This extends the degree by 12 months. • On successfully completing the placement, a student is awarded the 'industrial' variant in one's degree title so that one can demonstrate one's unique expertise to future employers. • The placement also counts towards the professional experience needed to become a chartered engineer.	8 weeks in Recess term of Year 1 (Workshop practice at the University). Assessment is done by university instructors 8 Weeks in recess terms of Year II and Year III (Industrial Training I & II, respectively). Students are attached to companies under which they train. 20% of the final grade is from the Employer's assessment. Students have logbooks for daily entries and are assigned a university supervisor

	University of Cape Town	University of Alberta	University of Leeds	Makerere University
Accreditation	The Council on Higher Education's permanent sub-committee-the Higher Education Quality Committee. Has a SAQA (South African Qualifications Authority) ID Degree accepted by the Engineering Council of South Africa (ECSA) as fulfilling all the academic requirements for registration as a Professional Engineer.	The Canadian Engineering Accreditation Board of Engineers Canada. Graduation can lead to registration as a professional engineer in the provincial associations of professional engineers	The Joint Board of Moderators of The Institution of Structural Engineers, Institute of Highway Engineers, The Chartered Institution of Highways and Transportation and the Institution of Civil Engineers under licence from the UK regulator, the Engineering Council. Engineers with a BEng degree are eligible for Incorporated Engineer (IEng) membership once they've had appropriate training and experience in the workplace. BEng graduates who wish to achieve Chartered Engineer status have to undertake Master's degree studies	Degree accepted by the Engineers Registration Board and the Uganda Institution of Professional Engineers as fulfilling all the academic requirements for registration as a Professional Engineer in Uganda and East Africa. Curricula are supposed to be accredited by the National Council for Higher Education (NCHE). NHCE last accredited the program in 2010, expired on 26th March 2015

3.8.1.2 Electrical Engineering

	University of Cape Town	University of Alberta	University of Leeds	Makerere University
Course offered	Bachelor of Science in Engineering in Electrical Engineering	• BSc in Electrical Engineering • BSc in Electrical Engineering - Nanoengineering Option	Electronic and Electrical Engineering MEng, BEng	Bachelor of Science in Electrical Engineering
Duration of Program	Minimum 4 years Alternative 5-year curriculum with same content, but spread out to allow more time for learning new concepts, grappling with course demands	Two types of degree programs a) Traditional program (04 years-08 terms) b) Cooperative education program (05 years. Students in addition to the 8 terms, undertake five 4-month terms of paid work experience)	An Integrated Masters (MEng, BEng) is a four-year degree that extends your studies to Masters level. BEng. Program is three years. The BEng degree course is identical to the first three years of the MEng, BEng	4 years Day/Evening program, but taught only as 'Day'

	University of Cape Town	University of Alberta	University of Leeds	Makerere University
Content	• Students able to select final year courses which allow some degree of specialization in one or more disciplines such as Control & Instrumentation, Digital Systems, Electronics, Power Electronics and Machines, Power and Energy Systems, Signal & Image Processing and Telecommunications and RF & Microwave Systems • Students pick at least one elective in the humanities, social sciences.	• All engineering students follow a common curriculum in their first year and take courses in Chemistry, Mathematics, Physics, Computing, English, Engineering Mechanics, and Introduction to the Engineering (Qualifying year)	• Year I and II: Foundation courses. • Year III: More specialised modules that focus on topics such as embedded systems, integrated circuit design and RF and microwave circuits. • Year IV: Further specialization in topics such as medical electronics, using renewable sources to generate electric power and wireless communications systems. One undertakes a substantial research project • Engineering ethics taught as part of the course	Problem Based Learning (PBL) has been inculcated into the revised curriculum Soft skills provided for Content: a) 4 Mathematical Courses b)32 Electrical/ Electronic Engineering Courses c)3 Communications Engineering Courses d) 6 Computing Courses e) 6 General Engineering Courses f) 2 Humanities Course g) 2 Research Courses h) 3 Vocational Courses Practical hours account for 27.6% of the hours allocated in the program. A total of 178 (1 days per week) are untimetabled during a semester

	University of Cape Town	University of Alberta	University of Leeds	Makerere University
Industrial placement/ Practical Experience	• 12 weeks in two sessions. • EEE1000X Practical training: Culminates in a certificate showing evidence of completion of suitable work in the basic workshop processes to the satisfaction of the Head of Department, during a period of at least six weeks in an approved workshop • EEE3000X Practical training: Opportunity for the student engineer to consolidate through practical experience, culminates in a technical report and certificate showing to the satisfaction of the head of department, evidence of completion of suitable work for a minimum period of six weeks in engineering employment at the end of the third year. The employer must certify that the student completed the work.	• No industrial training for traditional 4-year track • 20 months over 5 years (in 4 months periods) of paid work experience for those on the Cooperative education program • Evaluation of the practical experience is based on the employer's performance appraisal, the student's work term report, and the student's ability to learn from the experiences of the work term.	• Students allowed to undertake an industrial placement year. This extends the degree by 12 months. • On successfully completing the placement, a student is awarded the 'industrial' variant in one's degree title so that one can demonstrate one's unique expertise to future employers. • The placement also counts towards the professional experience needed to become a chartered engineer.	10 weeks in Recess term of Year 1 (Workshop practice at the University). Assessment is done by university instructors 10 Weeks in recess terms of Year II and Year III (Industrial Training I & II, respectively). Students are attached to companies under which they train. part of the final grade is from the Employer's assessment. Students have logbooks for daily entries and are assigned a university supervisor

	University of Cape Town	University of Alberta	University of Leeds	Makerere University
Accreditation	The Council on Higher Education's permanent sub-committee-the Higher Education Quality Committee. Has a SAQA (South African Qualifications Authority) ID Degree accepted by the Engineering Council of South Africa (ECSA) as fulfilling all the academic requirements for registration as a Professional Engineer.	The Canadian Engineering Accreditation Board of Engineers Canada. Graduation can lead to registration as a professional engineer in the provincial associations of professional engineers	Institution of Engineering and Technology (IET) on behalf of the Engineering Council for the purposes of fully meeting the academic requirement for registration as a Chartered Engineer (CEng). Engineers with a BEng degree are eligible for Incorporated Engineer (IEng) membership once they've had appropriate training and experience in the workplace. BEng graduates who wish to achieve Chartered Engineer status have to undertake Master's degree studies	Degree accepted by the Engineers Registration Board and the Uganda Institution of Professional Engineers as fulfilling all the academic requirements for registration as a Professional Engineer in Uganda and East Africa. Curricula are supposed to be accredited by the National Council for Higher Education (NCHE). NHCE last accredited the program in 2010, expired on 26th March 2015

3.8.1.3 Computer Engineering & Telecommunication Engineering

	University of Cape Town	University of Alberta	University of Leeds	Makerere University
Course offered	Bachelor of Science in Engineering in Electrical & Computer Engineering	BSc in Computer Engineering	N/A	No longer admitting students- Programs were Suspended.
Duration of Program	Minimum 4 years Alternative 5-year curriculum with same content, but spread out to allow more time for learning new concepts, grappling with course demands	Two types of degree programs c) Traditional program (04 years-08 terms) d) Cooperative education program (05 years. Students in addition to the 8 terms, undertake five 4-month terms of paid work experience)	N/A	

	University of Cape Town	University of Alberta	University of Leeds	Makerere University
Content	• Students receive good grounding in both electrical engineering and computing • Students get foundation of understanding in physical science, advanced engineering mathematics, microcomputer technology and systematic engineering design.	• All engineering students follow a common curriculum in their first year and take courses in Chemistry, Mathematics, Physics, Computing, English, Engineering Mechanics, and Introduction to the Engineering (Qualifying year)	N/A	
Industrial placement/ Practical Experience	• 12 weeks in two sessions. • EEE1000X Practical training: Culminates in a certificate showing evidence of completion of suitable work in the basic workshop processes to the satisfaction of the Head of Department, during a period of at least six weeks in an approved workshop • EEE3000X Practical training: Opportunity for the student engineer to consolidate through practical experience, culminates in a technical report and certificate showing to the satisfaction of the head of department, evidence of completion of suitable work for a minimum period of six weeks in engineering employment at the end of the third year. The employer must certify that the student completed the work.	• No industrial training for traditional 4-year track • 20 months over 5 years (in 4 months periods) of paid work experience for those on the Cooperative education program • Evaluation of the practical experience is based on the employer's performance appraisal, the student's work term report, and the student's ability to learn from the experiences of the work term.	N/A	

	University of Cape Town	University of Alberta	University of Leeds	Makerere University
Accreditation	The Council on Higher Education's permanent sub-committee-the Higher Education Quality Committee. Has a SAQA (South African Qualifications Authority) ID Degree accepted by the Engineering Council of South Africa (ECSA) as fulfilling all the academic requirements for registration as a Professional Engineer.	The Canadian Engineering Accreditation Board of Engineers Canada. Graduation can lead to registration as a professional engineer in the provincial associations of professional engineers	N/A	

3.8.1.4 Mechanical Engineering

	University of Cape Town	University of Alberta	University of Leeds	Makerere University
Course offered	• Bachelor of Science in Engineering in Mechanical • Bachelor of Science in Engineering in Mechanical & Mechatronic Engineering	• BSc in Mechanical Engineering • • Bachelor of Science in Mechanical Engineering Co-op with Biomedical Option	Mechanical Engineering MEng, BEng	Bachelor of Science in Mechanical Engineering
Duration of Program	Minimum 4 years Alternative 5-year curriculum with same content, but spread out to allow more time for learning new concepts, grappling with course demands	Two types of degree programs a) Traditional program (04 years-08 terms) b) Cooperative education program (05 years. Students in addition to the 8 terms, undertake five 4-month terms of paid work experience)	An Integrated Masters (MEng, BEng) is a four-year degree that extends your studies to Masters level. BEng. Program is three years. The BEng degree course is identical to the first three years of the MEng, BEng	4 years Day program

	University of Cape Town	University of Alberta	University of Leeds	Makerere University
Content	• BSc. Mechanical Engineering Curriculum is structured to provide students with a fundamental understanding of solid mechanics, dynamics, thermodynamics, fluid mechanics and materials, • Engineering design forms the core of the programme. • • Bachelor of Science in Engineering in Mechanical & Mechatronic Engineering, formerly Electro-Mechanical Engineering) comprises courses selected from the Electrical Engineering and Mechanical Engineering curricula. • Complementary Studies courses cover disciplines outside of engineering sciences	• All engineering students follow a common curriculum in their first year and take courses in Chemistry, Mathematics, Physics, Computing, English, Engineering Mechanics, and Introduction to the Engineering (qualifying year) • Students are given good grounding in five major areas: solid mechanics, dynamics, fluid mechanics, thermodynamics, and design. • Biomedical or biomechanical engineering is the application of the principles of engineering to the solution of problems in medicine and clinical sciences. Course builds on traditional Mechanical Engineering degree	• Year I & II: Foundation compulsory Courses • Year III: in-depth knowledge such as thermofluids and finite element methods of analysis, design & manufacture systems, use of process simulation software, large individual research project, • Year IV (MEng): Select masters-level modules and a group project in conjunction with industrial partners • Engineering ethics taught as part of the course	Structure a) 4 Mathematical Courses b) 34 core Mechanical Engineering courses c) 4 elective courses d) 2 Electrical and Electronics Engineering courses e) 3 Business courses, and f) 2 Humanities courses • New proposed courses: • •Health, Safety, & Environment • •Statistics for Engineers • •Robotics & Automation • • • • • Practical hours account for 29.7% of the hours allocated in the program. A total of 195 (1 day per week) are untimetabled during a semester

	University of Cape Town	University of Alberta	University of Leeds	Makerere University
Industrial placement/ Practical Experience	MEC1000X Practical training I: culminates in a certificate showing evidence of completion of suitable work in basic workshop processes during a period of at least four weeks in an approved industrial workshop. Students are required to cover at least the following: welding, turning, and basic Fitting MEC2000X Practical training II: Culminates in a certified employer's report showing regular timekeeping and evidence of completion of suitable work in mechanical, or electro-mechanical engineering practice. It must involve work in a registered company where a student will be exposed to "engineering activities" for a minimum period of six weeks at the end of the second year. The six weeks does not have to be continuous, however no single block may be less than three weeks.	• No industrial training for traditional 4-year track • 20 months over 5 years (in 4 months periods) of paid work experience for those on the Cooperative education program • Evaluation of the practical experience is based on the employer's performance appraisal, the student's work term report, and the student's ability to learn from the experiences of the work term.	• Students allowed to undertake an industrial placement year. This extends the degree by 12 months. • On successfully completing the placement, a student is awarded the 'industrial' variant in one's degree title so that one can demonstrate one's unique expertise to future employers. • The placement also counts towards the professional experience needed to become a chartered engineer.	8 weeks in Recess term of Year 1 (Workshop practice at the University). Assessment is done by university instructors 8 Weeks in recess terms of Year II and Year III (Industrial Training I & II, respectively). Students are attached to companies under which they train. 30% of the final grade is from the Employer's assessment, 10% logbook and 60% from the report. Students have logbooks for daily entries and are assigned a university supervisor

	University of Cape Town	University of Alberta	University of Leeds	Makerere University
Accreditation	The Council on Higher Education's permanent sub-committee-the Higher Education Quality Committee. Has a SAQA (South African Qualifications Authority) ID Degree accepted by the Engineering Council of South Africa (ECSA) as fulfilling all the academic requirements for registration as a Professional Engineer.	The Canadian Engineering Accreditation Board of Engineers Canada. Graduation can lead to registration as a professional engineer in the provincial associations of professional engineers	The Institution of Mechanical Engineers (IMechE) under licence from the UK regulator, the Engineering Council. The MEng, BEng course is accredited as fully satisfying the educational base for a Chartered Engineer (CEng). The BEng is accredited as partially satisfying the educational base for CEng status. A course of accredited further learning will be required to complete the educational base for CEng.	Degree accepted by the Engineers Registration Board and the Uganda Institution of Professional Engineers as fulfilling all the academic requirements for registration as a Professional Engineer in Uganda and East Africa. Curricula are supposed to be accredited by the National Council for Higher Education (NCHE). NHCE last accredited the program in 2010, expired on 26th March 2015

3.8.2 Industrial placement/ Practical Experience

Across the departments in the School of Engineering, provision in made in the curricula for practical experience through workshop practice (Year I, Minimum 8 weeks) in which students are exposed to work in the workshops in the School; and Industrial Training I and II (at least 8 weeks in Year II and 8 weeks in Year III). On paper, that time, once utilized as envisaged can help the students to get practical experience.

In light of the findings that the graduates from the School of Engineering were lacking in practical aspects, key stakeholders were asked for their assessment of the effectiveness of the Industrial Training as provided in the Curricula of all engineering courses.

The stakeholders observed that:

a) Technically, the students do not get trained as envisaged-they do not gain much
b) Industrial Training is largely wasted time. Most students appear for industrial training just to 'tick boxes'; they are simply aiming at finishing the training and getting marks.
c) Most companies do not have structured industrial training. For the few that give the students assignments, they give them 'low-end', 'low value' assignments so that the risk of losses is low
d) In most cases, students get placements for themselves, with preference for those where a stipend is available, near their homes or where they know someone, not necessarily where they will get value
e) The current model is not working for the majority of students
f) The period is short and the training is not focused. The lack of continuity affects the skilling that the students can pick up.
g) The timing of the Industrial Training is a bit misplaced. For example, Year II students who have not started any design works may feel misplaced in industry during training.
h) There is a risk of information overload. It is a compressed period, with the student loaded

with too much information that sometimes is not even related to what the student has learnt in the 2 or 3 years that he will have finished at university.

i) Firms do not have an incentive to help the students, since there is no working relationship with the university
j) What is done in Industrial Training has little to do with what they will eventually do after graduation
k) University supervisors do not visit the students on industrial training, thereby missing out on discussing the expectations of the university with the industrial supervisors
l) The current model is not effective. It would be best if the training was concurrent in both industry and school, like it is done in Germany; with split-times in the university and industry.

3.8.3 Curriculum Review Process

3.8.3.1 Introduction

With technology advancements in industry and the ever present need to improve the way things are done, it is crucial that Universities as higher institutions of learning review their curricula regularly to align with prevailing market demands. In Uganda, the National Council for Higher Education requires that curricula for programs offered by universities be reviewed every four years.

The curriculum review process can lead to:

a. Dissolution of a degree course;
b. Introduction of a new degree course;
c. Change in delivery format;
d. Inclusion of new course units and dropping of some (update);
e. Change in content of course units;
f. Minor administrative changes that do not necessarily change the academic content.

Different universities have different polices with regards to the review cycle of curricula, depending on several factors. The University of Reading (UK) reviews its curricula every 3 years. The Rhodes University (South Africa) recommends review of curricula be reviewed every 3 years and that at six-year intervals, an overhaul be considered. Leeds university requires its schools to review their programs of study each year. In most developing countries, it is common practice to update curricula every 5-10 years.

In Uganda, the National Council for Higher Education (NCHE), which is the regulator of higher education in Uganda requires that a curriculum review be done every four years. All degree programs are required by law to be accredited by the NCHE.Across the School of Engineering, the B.Sc. in Civil Engineering, B.Sc. in Electrical Engineering, B.Sc. Mechanical Engineering, B.Sc. Computer Engineering and B.Sc. in Telecommunication Engineering expired on 26-03-2015. The University should have reviewed its curricula before the expiry and submitted to the NCHE more than 7 years ago.

3.8.3.2 The Curriculum Review Process

In the case of School of Engineering, Makerere University, the curriculum review process starts at the department level, with a curriculum review committee set up. The committee solicits for ideas from staff members and reviews the objectives of the curriculum, subject objectives, desired competencies and desired learning outcomes. Appropriate content for desired competencies is then proposed.

The Consultation at department level is also extended to external stakeholders such as employers, the Uganda Institution of Professional Engineers, the Engineers Registration board, Uganda Association of consulting engineers, the Uganda National Association of Building and Civil Engineering Contractors and sister universities offering similar courses. Many of these organizations are staffed by the alumni of the School of Engineering and so their voice is heard.

Benchmarking is also done against universities in the country, the region and beyond to ensure that a competitive program would be on offer.

After the consultations, a draft updated curriculum is put together and a validation workshop held, with a wide range of stakeholders in order to get their final ideas about the updated curriculum and to confirm that their ideas during consultations were not misrepresented.

Once the workshop is done, the final draft is put together and sent to the school board and the College board for any comments or approval. The approval process beyond the College involves the Quality Assurance Directorate of the University, the University Senate (highest academic decision-making organ of the

University) and then to the National Council for Higher Education for accreditation. At all these stages of approval, the departmental Curriculum review team is expected to respond to any comments/requests for clarification. An updated curriculum cannot be implemented until the NCHE has approved/accredited it.

3.8.3.3 Current Status

All the programs offered by the School of Engineering at Underground level are under review. The current students are still using the curricula whose accreditation expired on 26th March 2015.

The BSc. Computer and BSc. Telecommunications Degree programs were scrapped in 2021, following a university-sanctioned study. The Department of Electrical and Computer Engineering has proposed a new program - BSc. Computer and Communications Engineering. The proposed program's curriculum was developed in November 2021, with input from all stakeholders, and the approval process is underway. Until the approval up to the NCHE, no students can be admitted to the program. The validation workshop held on 27th February 2020, was attended by representatives from the Department, College, Student body, 4 local universities with similar courses, Makerere College of Computing and information sciences, Uganda Communications Commission and 10 industry partner organizations.

The BSc. Mechanical engineering program has been reviewed and a final draft released in January 2022 and is awaiting approval. Benchmarking was done with a number of other similar programmes offered by regional and international institutions. Key stakeholders consulted included Private companies, Non–governmental organisations, professional engineers, former students, current students and governmental ministries and institutions. Gathering of information was done by use of stakeholders' surveys and a workshop that was conducted on October 5, 2017.

The curriculum review process for the BSc. In Electrical Engineering started in 2017 and a final draft released in March 2021 and is undergoing the approvals process. Key stakeholders were identified from various fields notably the academia, industry, alumni, professional bodies, government institutions and contemporary students. The department interacted with the various stakeholders through workshops and industrial training visits. A stakeholders' workshop was held on 27th September 2017.The review considered the objectives and recommendations of the Washington, Sydney and Seoul accords, the international benchmarks for Engineering professional registration.

The curriculum review process for the BSc. in Civil Engineering has been done with a draft released in March 2021 and is undergoing the approvals process. The review was conducted through desk studies, consultations with industry stakeholders and benching marking with other institutions. Stakeholders from the industry included National Water & Sewerage Corporation (NWSC), Uganda National Roads Authority (UNRA), Uganda Electricity Generation Company Limited (UEGCL), Kampala Capital City Authority (KCCA), Directorate of Water Resources Management, Uganda National Bureau of Standards, Uganda Institution of Professional Engineers, Engineers Registration Board and individual consulting firms.

3.8.3.4 Benchmarking of the Process

The curriculum review process of the School of Engineering, Makerere University is similar to the processes adopted by other universities all over the world. It is however noted that the review is not done on time, as exemplified by the fact that although the current curricula expired in 2015, the updated curricula has not been approved yet. In some departments, the review process started in 2017, and the drafts released 4 years later at which point there should have been an n+1 review in place.

The long period taken since the stakeholders' workshops in 2017 for mechanical and electrical engineering could invalidate some of the ideas advanced then since a lot could have changed in industry over the last 5 years. It would be advisable for the school of engineering to organize other stakeholder workshops to inform on future curricula.

The University of Leeds has 'Industrial Advisory Committees' which help ensure that their courses are up-to-date with the modern practices and techniques that empower one to succeed in industry upon graduation. The committee comprising representatives from industry provides insight into the Schools' Teaching, Employability of the graduates and

research impact. These prominent members are the School's ambassadors in industry. This is an idea that can be adopted my Makerere University School of Engineering to improve on the interaction with industry and bridge the skill mismatch.

3.9 Career Guidance, Student Support and Preparation of Students for the work place

3.9.1 Current Status

Students who are admitted to the School of Engineering need career guidance and mentorship in academic as well as non-academic spheres. It is not uncommon to find a student second guessing their decision to apply for engineering, when they have already done three or more semesters of the eight.

Apart from the Orientation week for fresh men and women entering the University for their first year of education (usually one session is held at the School level, and another session held at department level), there isn't any other opportunity for organized and structured career guidance for the students in their four years of study. It is left to the students to approach individual lecturers for advice.

The Makerere Engineering Society which is the engineering students' association bringing together all students in the School of Engineering, organizes talks and invites professionals of repute to come back to the University and engage students on a variety of themes. This affords the students an opportunity for career guidance. Unfortunately, the School and by extension the University is not involved in the planning and organization of these talks;it is predominantly left to the students to handle.

The Engineers Registration Board (ERB) and The Uganda Institution of Professional Engineers (UIPE) organize outreaches to engineering students.. This is also another avenue for career guidance. These outreaches are also very good opportunities to prepare the engineering students for the work place.

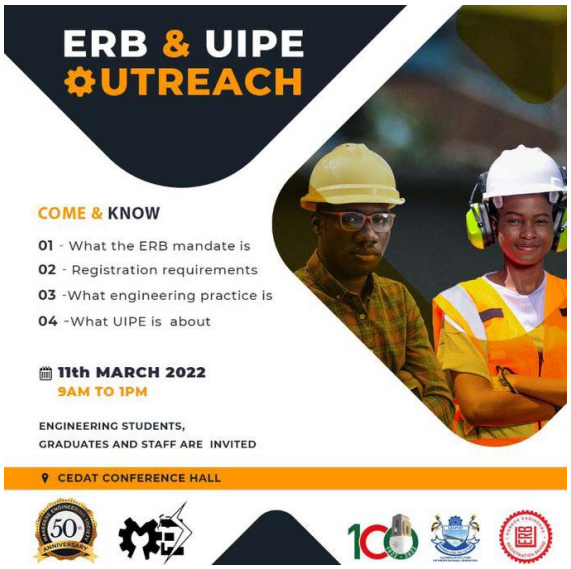

Figure 22- March '22 ERB&UIPE outreach

Figure 23- Advertorial for the UIPE Outreach in Aug 2019

Figure 24- ERB/UIPE Outreach to Makerere University, March 2022. The team was led by the ERB Vice-Chairperson, the Registrar, Secretariat staff and a UIPE Representative (Photo Credit: @ ERBUganda)

Figure 25- A cross section of engineering students at the CEDAT Day with members of ERB, March 2022 (Photo Credit: @MESMakerere)

Figure 26- Engagement of engineering students and members of the UIPE WOMEN ENGINEERS, TECHNOLOGIST AND TECHNICIANS COMMITTEE (WETT) at Makerere in April 2017 (Photo Credit: @ UIPE_Uganda)

Figure 27- The UIPE WETT panel at Makerere (April 2017) to encourage female engineering students (Photo Credit: @UIPE_Uganda

The Counselling and Guidance Centre is open to help students with personal and emotional challenges that may affect them while studying at Makerere University. The Counselling and Guidance Centre works hand in hand with the University Hospital in addressing psychological issues that may affect students.

There is not much assistance to students with regards to connection with the work place or preparation for their first job at the School of Engineering level. The few recommendations of particular students to jobs are not centralized; individual lecturers are approached for recommendation. A centralized job Centre would do a better job. Makerere University in partnership with NFT Consult, a Human resource Consultancy based in Kampala, has set up the Career Development Centre (CDC). The main objective if the CDC is to facilitate learning and practice as well as transitions and connections from academic life to professional employment. Apart from a physical address on the university website, there are no resources or opportunities available online

3.9.2 Benchmarking with Other Universities

a) **Career development resources**

The University of Alberta has an online resource vault, with free career development resources- including job search strategies, resume and cover letter writing, interview skills, networking, etc. The university of Leeds has in place an employability team which provides advice and support to help students find work experience, industrial placements and graduate positions. The team organizes employability sessions,

support during internships and placements, and presentations and workshops delivered by employers.
The University of Alberta also has a dedicated site for job linkages (CampusBRIDGE), with job opportunities for the university students and alumni. The university also has Faculty Employer Relationship Managers whose duty to help link students with job opportunities in Industry. Industry partners have access to campusBRIDGE, which acts as a self-serve recruitment platform, enabling one to post and manage one's job opportunities targeting students and alumni. The University of Leeds Careers Centre has similar capabilities and plays the same role for University Students, Alumni and Employers.

b) **Tutorials/ Students academic support/ Mentorship**

Several Universities around the world run Engineering Student Success Centres, which avail free group and one-on-one tutoring to help develop one's academic skills. These can be very helpful especially for the 1st two years of engineering, when students can easily get overwhelmed. These centres are run by teaching assistants who are mostly graduate students. Some of the universities with such support centres are the University of Alberta (Canada), California State University (USA), University of South Florida (USA), University of Calgary (Canada), among others.

Students entering school of engineering (as early as the age of 19 years) could benefit from mentors throughout their studies. The University of Leeds assigns engineering students a personal tutor and first year students also receive support from fellow students through the Peer Assisted Study Support (PASS) scheme. PASS mentors are students who are on the same course as the mentee but are in higher classes. Several universities around the world also run Peer Assisted Study Sessions, whose leaders are trained students from later years of the same course. Some of the universities that have rolled out the PASS scheme include the University of Bristol (UK), University of Michigan (USA), University of Manchester (UK), University of Adelaide (Australia), University of Birmingham (UK).

3.10 Teaching Tools, Equipment and facilities

3.10.1 Classroom Facilities

The blended mode of learning has picked up in the last 3 years partly due to the COVID lockdowns which necessitated a shift to online learning.

Only 7 classes have function projectors. Civil and Environmental Engineering has 4mobile projectors. The fact that all undergraduate courses run on the day program (8am-5pm) also compounds the scarcity of projectors. The department needs for projectors are 8 for Civil and Environmental Engineering, 7 for Mechanical engineering, and 11 for Electrical and computer engineering.
Due to a scarcity of projectors, lecturers end up resorting to the chalk and black board methodology.

Benchmarking against other universities

University of Cape Town	University of Leeds
• has flexible classrooms, fitted with Computer with CD/DVD player, Data projector(s), Document camera, Retractable screen(s), Chalkboard/whiteboard, Microphone, Lecture recording facilities, Flexible lighting options, Roll up window blinds.	• All courses at the University of Leeds are supported by blended learning technology, using online resources. • uses lecture recording system to ensure that lectures are available for students to review at their convenience.

3.10.2 Laboratory Resources-Equipment and Technicians

Many of the laboratories in the School of Engineering lack adequate space, have obsolete equipment and are under staffed. Among the identified challenges are:

a) **Limited Staff (Academic and Technicians): Low staffing levels.**

Table 19- Laboratory Staffing levels

	Mechanical Engineering		Civil Engineering		Electrical Engineering	
	Established Positions	Filled Positions	Established Positions	Filled Positions	Established Positions	Filled Positions
Chief technician	1	1	1	0	1	0
Principal technician	2	1	2	1	2	1
Senior technician	3	2	3	1	3	2
Technician	4	2	4	0	4	1
Technician II	4	2	4	1	4	0
Laboratory attendant/ assistant	4	0	4	3	4	2
Total	18	8	18	6	18	6
% Filled Positions		**44.4**		**33.3**		**33.3**

Source: RIF Study, August 2022

Of the established positions in laboratories, only 44% in mechanical engineering, and 33% in Mechanical and Electrical engineering are filled. This makes it harder for laboratory experiments to be done adequately so that students have an opportunity at learning effectively.

b) **Limited Equipment and Presence of obsolete equipment:**

Across all departments, the equipment is inadequate for training and research and some obsolete equipment is occupying space that could be used for other equipment or tutorials.

c) **Inadequate laboratory space**

Table 20- Laboratory Space in Mechanical Engineering

No.	Name of laboratory	Type of laboratory			State of lab	Capacity	
		Under-graduate	Graduate	Research	(Good/ Satisfactory / Poor)	(No. of users)	Area (m2)
1	Engineering Materials Lab (Old CEDAT Building)	√	√	√	Good	30	300
2	Engineering Materials/Energy Lab (CEDAT Building)	√	√	√	Satisfactory	10	64

No.	Name of laboratory	Type of laboratory			State of lab	Capacity	
		Under-graduate	Graduate	Research	(Good/ Satisfactory / Poor)	(No. of users)	Area (m2)
3	CNC Machine Laboratory (CEDAT Building)	√	√	X	Satisfactory	10	80
4	Fluids Mechanics Laboratory (CEDAT Building)	√	√	X	Poor	25	140
5	Training Workshop (CEDAT Building)	√	√	√	Poor	25	200
6	Thermodynamics / Energy Laboratory (CEDAT Building)	√	√	√	Poor	40	220

Source: RIF Study, August 2022

Table 21- Laboratory Space in Civil & Environmental Engineering

No.	Name of laboratory	Type of laboratory			State of lab	Capacity	
		Under-graduate	Graduate	Research	(Good/ Satisfactory / Poor)	(No. of users)	Area (m2)
1	Public Health and Environmental Engineering Lab (Old CEDAT Building)	√	√	√	Satisfactory	10	
2	Public Health and Environmental Engineering Lab (New CEDAT Building)	X	√	√	Good	5	
3	Structures/ materials Laboratory	√	√	X	Poor	10	217*
4	Geotechnical Engineering Laboratory	√	√	√	Poor		94
5	Engineering Surveying	√	√	√	Poor		
6	Highway laboratory	√	√	X	Poor	25	90***
7	Hydraulics Laboratory	√	X	X	Good	10	
8	Water Resources Modelling Laboratory	√	√	√	Poor	10	

Source: RIF Study, August 2022

Note:
*Structures Lab: Comprising of 21 sq.m for offices and Wardrobes, 34.5 sq.m for Wardrobes/ Worktops/ Fixed tables and the remaining 161.5 sq.m for the Machine/ Movement/ Free area.
**Geotechnical Engineering lab: Total space = 94 sq.m comprising of Office space of 5.3 sq.m
***Highways Lab: Total space = 90 sqm comprising of

- Equipment space = 33.0 sqm.
- Drawers/worktops under construction = 6.5 sq.m
- Office space = 24.6 sq.m
- Graduate students reading space = 12.3 sq.m
- Corridor/ partition walls= 13.6 sq.m

Table 22- Laboratory Space in Electrical & Computer Engineering

No.	Name of laboratory	Type of laboratory			State of lab	Capacity	
		Under graduate	Graduate	Research	(Good/ Satisfactory / Poor)	(No. of users)	Area (m^2)
1	Electronics laboratory	√	X	X	Satisfactory	45	
2	Telecommunications laboratory	√	√	√	Good	60	
3	Power (machines) Laboratory	√	√	√	good	50	
4	Control measurements and instrumentation laboratory	√	√	√	good	25	
5	Renewable energy lab (CREEC)	√	√	√	good	20	
6	Net labs	√	√	X	good	20	
7	Marconi Lab	√	√	√	good	30	
8	iLabs	√	X	√	poor	15	
9	ARMS	√	√	X	poor	14	

Source: RIF Study, August 2022

d) Lack of equipment operation and maintenance guidelines across the school and budget.

Some equipment is not operational due to lack of a maintenance regime and/or consumables for their use. This can be attributed to a lack of budget for equipment operation and maintenance.

3.10.3 Access to Computer and Engineering software

Students of Civil Engineering have access to the full suite of Prokon modules latest version, following an agreement between the department of Civil and Environmental Engineering and Prokon South Africa. Civil Engineering students therefore have unlimited access to one of the leading structural analysis and design softwares in the world.

The Computers available in the laboratories are not enough for the engineering students. Quite a number of students depends on the computer stations in the computer labs in the college which currently has a working stock of 105 computers for undergraduate students of School of engineering.

Table 23- Computer Infrastructure

Dec-21	Main Computer lab (3034)	E-lab old building	Main lab Old building	Total	Number of Under-G\ raduate students in college	Students: Computer ratio
Working	20	55	30	105	2869	
Not working	40	0	20	60		
MUTSIFA UG students					749	
Students using the CEDAT labs				105	2120	20

With the current numbers, each computer is used by 20 students of engineering, which is grossly inadequate. The inference is that students do not have access to computers as and when needed. The problem is further compounded by the fact that none of the computer laboratories works 24 hours a day.
The College has space to host 500 computers in all lab spaces.

The majority of students have to make do with their own personal computers for the duration of their study. Makerere university has recently signed an agreement with Stanbic Bank (U) Ltd to avail laptops to students and staff on a hire-purchase plan. The laptops will be paid for in monthly installments throughout the course duration. The laptops shall be customizable by specifications and software installation depending on one's program/course.

Benchmarking against other universities

University of Cape Town	University of Leeds
requires engineering students to have their own laptop or desktop computer in order to promote and enhance learning.	• has dedicated computer clusters including a 24-hour cluster. • Students access to industry standard software such as Revit (Building Information Modelling), IES (dynamic thermal modelling) and Robot (structural analysis). • Student develop programming skills in industry standard languages like LabVIEW and Matlab • computer suites are kitted out with CAD software and industry-standard software packages such as the Adobe Creative Suite.

3.10.4 Student-Staff ratio in the School of Engineering (Under graduate courses)

Only 53.8% of the established staffing positions in the school are currently filled.

Table 24- Student-Staff ratio

Staffing	Civil and Environmental Engineering	Mechanical Engineering	Electrical and Computer Engineering	Total for the School of Engineering
Established	44	37	51	132
Filled	26	15	30	71
Number of Students	410	419	612	1441
Students/Staff ratio	16	28	20	20
Recommended NHCE -Ideal	10			
Recommended NHCE -Good	15			
Recommended NHCE -Acceptable	20			
Unacceptable	>26			

Source: CEDAT Annual report 2021 (Student numbers quotes include students of biomedical engineering, Water and irrigation Engineering and agricultural engineering who take courses in the school of engineering in the first two years although domiciled in other colleges).

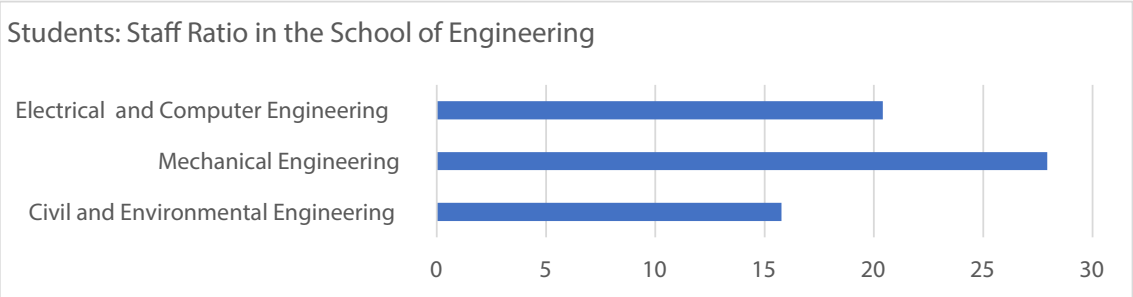

Figure 28- Student:Staff ratio in the School of Engineering

According to the National Council for higher education's quality assurance framework for universities and the licensing process for higher education institutions (NCHE,2014)[14], the recommended student: staff ratio for engineering is 10:1, with an acceptable ratio of 10:1. None of the departments meet the recommended ratio, with the mechanical department falling within the unacceptable range. The high Student: Staff ratio affect the delivery of skills to the students.

14 National Council for Higher Education (2014), Quality Assurance Framework for Universities and the licensing process for higher education institutions., Kampala

4.0 Conclusions and Recommendations

4.1 Conclusions

The following conclusions can be drawn from this study.

(a) The supply of engineers by the School of Engineering is lagging behind the demand for engineers in Uganda using the third National Development Plan (2020/21-2024/25) as a guiding framework for the national economy's requirements of engineering graduates.

(b) The School of Engineering lacks the required infrastructure and human resource capacity to effectively, deliver on her mandate. This is because there are staffing gaps across the various positions. Additionally, the school lacks the state-of-the art equipment in her laboratories.

(c) The School of Engineering is not providing continuous professional development to its academic and technical staff to enable her graduates to attain the knowledge and skills required by the Fourth Industrial Revolution labour market for engineers.

(d) There is a mismatch between what the labour market demands of engineers and what, the school of engineering is currently supplying. It is a mismatch between skills held by engineering graduates from the school of engineering and the available engineering jobs. This means that education and training by the school of engineering are not providing the skills demanded in the labour market.

(e) Although the School of Engineering is providing some of the required knowledge and skills to her alumni, the engineering graduates need to be equipped with the knowledge and soft skills required by the 21st Century labour market for engineering graduates. The most required soft skills include but are not limited to: (i) ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics; (ii) use of basic hardware; (iii) use of basic software, (iv) communication; and (v) collaboration and teamwork.

(f) The School of Engineering is not adequately collaborating with industry in the training of engineers apart from the internship of engineering students. The engineering graduates need to be trained and they need to be equipped with the relevant knowledge and skills required by the industry and the current efforts implemented by the industry alone (e.g. Uganda National Association of Building and Civil Engineering Contractors (UNABCEC and the Uganda Institution of Professional Engineers) may not be able to cater for the needs. Therefore, there is a pressing need to formulate smart partnership between universities and industry that can overcome the potential mismatch of theoretical curricular and practical problems. There is need for strategic linkages between university and industry in a form of students' internship or even faculty exchanges. The benefits expected out of these linkages are diverse ranging from student practical training to production and commercialization of new products.

(g) The School of Engineering students lack regular guidance from practitioners on the knowledge and skill demands of the engineering labour market. There is need for regular guidance of the graduates from practitioners through among other things guest lectures.

(h) The internship model being, implemented by the School of Engineering needs to be re-engineered to ensure that the engineering graduates continuously undergo practical training on a more regular basis, with industry throughout the duration of all the engineering programs (for instance, one day per week).

(i) Females are, underrepresented in the number of alumni at both undergraduate and graduate levels (MSc and PhD) across all engineering specializations.

The underrepresentation of the female gender to some degree mirrors its underrepresentation among the academic and technical staff.

(j) The School of Engineering graduates do not have enough practical and/or hands-on skills. Although they demonstrate understanding of theories, they lack hands-on skills required by employers.

4.2 Recommendations

4.2.1 Industrial Training/Practical aspects of the program

The School of Engineering should consider the introduction of an optional placement year (gap year) of paid employment, which would extend the course for those who opt for it by 12 months. Industry would then have a choice of who of the graduates to employ between those who opt for the placement year and those who don't

The School should commission a study on the feasibility of a Dual system of education, where a student spends some time every week in industry for exposure and mentorship. The current time tables allow at least 1.5 days per week in the normal working hours, which can be used for industrial exposure.

The School could also consider replacing the 20-weeks industrial training to an industrial training semester pre-graduation as students finish up their final year projects. This has the added advantage that trainees will have completed the core courses and will be looking towards the employment phase.

4.2.2 Student Support Services

The School of Engineering shpuld assign mentors (Students-through Makerere Engineering Society) and staff members (from the requisite department) or industry (through the alumni networks and the Uganda Association of Professional Engineers) to students on a voluntary basis.

Peer Assisted Study Support (PASS) schemes ran by students in upper years, should be set up and supported by the School of engineering.

4.2.3 Transition from School to the work place

The school should set up a career resource vault on the college website with job links, tips on how to be the A-candidate to help transition from school to the work environment. It should also have a link for industry to post job opportunities.

4.2.4 Collaboration with Industry

The School of Engineering should set up industry advisory committees for each course in collaboration with UIPE, ERB, UACE, UNABCEC to regularly give feedback to the school in terms of the training content and quality of skill level without waiting for Curriculum review workshops which come after a long while

The School should arrange industrial attachments for university teaching staff to empower them, since 'one cannot transfer what they do not have'

The school of engineering should encourage Visiting lecturers from industry to deliver modules in the courses.

4.2.5 ICT exposure and use in learning

The School should reach out to software manufactures for educational licenses for students following the PROKON model to allow students' exposure and use before they graduate from the university.

The School should aim at increasing its computer stock from 105 to at least 500 operational work stations, for which space is already available.

Computer Aided Design must be given prominence in the Curricula, with students allowed enough time to use it to come up with solutions to problems scoped adequately to their level.

Procure projector stock should be increased so that each course offered has a dedicated projector.

4.2.6 Post Graduate Education and meeting the demand for Specialists

The completion rates for the MSc Program are very low. These are partly due to the fact that almost all students are part-timers on a full-time program. The university can consider and integrated MEng, BEng program, a replica of the UK System, which while allowing Masters

Level Courses to be done in final year, holds on to students before they are working in industry. This could be extended to a 5-year program for the Integrated MEng.B. Eng program.

The other alternative would be to introduce a part-time track for the MSc. Courses for a longer duration than Full time, but phased in a way so that the course load is manageable alongside the work schedules of the students.

The School of Engineering should engage ERB and UIPE to incentivize the academic progression to masters' levels for engineering. Apparently, there is no incentive to do a master's degree as far as registration as a professional engineer is concerned. All that is needed is a first Engineering degree. In South Africa, the Engineering Council of South Africa requires a minimum period of three years approved practical training and experience after graduation under the guidance of a Professional Engineer before a candidate may register as a Professional Engineer. This period may be shortened by up to one year in recognition of successful postgraduate degree work. If UIPE and ERB could consider similar concession for Post Graduate students, it would encourage many of them to undertake and complete graduate studies.

4.2.7 Staffing and Laboratory Equipment Resources

The School of Engineering should acquire the requisite resources (human, equipment) in order to increase the supply of engineering graduates in line with the third National Development Plan's demand for engineering graduates.

The School of Engineering should provide continuous professional development to its academic and technical staff to enable her engineering graduates to attain the knowledge and skills required by the Fourth Industrial Revolution labor market for engineering graduates.

Departments should identify the laboratory equipment requirements for each course and start on the lobbying process for their acquisition.

The non-operational and obsolete equipment should be removed from the labs to create space for new stock.

4.2.8 Problem Solving Skilling in Students

The next Curriculum review cycle should consider mandatory design projects in each of the first three years of each course to hone problem solving skills early enough.

4.2.9 Curriculum Review processes and aligning with current trends

The School of Engineering should ensure that Curriculum review is done every 4 years as recommended by the NCHE and in time so that by the time one accreditation cycle is complete, the new cycle is approved. Internally, Curriculum review should be annual, with Students and Industry input, as building blocks into the comprehensive review every 4 years.

The School should immediately organize curriculum review workshops for all 3 departments in the school. There is no evidence that Civil & Environmental Engineering held a workshop for the current curriculum under review. The Workshops for Mechanical and Electrical & Computer Engineering were held in 2017, 5 years ago. A lot has changed in these 5 years and a validation workshop with stakeholders can enrich the curriculum.

The department of Civil and environmental engineering should move the engineering drawing course unit from year I to either Year III or IV when students have done analysis and design. In 1st year, it is abstract and students do not apply that knowledge until year III at the earliest.

The School of engineering should think of an interdisciplinary course in electro-mechanical engineering to meet the demand for electromechanical engineers

4.2.10 Gender parity

Efforts should b, made to address the underrepresentation of females in both academic and technical staff as well as engineering students at both undergraduate and graduate levels (MSc and PhD) across all engineering specializations. This can be, achieved through among other ways, career guidance of Advanced Level students doing STEM subjects by female engineers to build the confidence of prospective female engineering students.

5.0 Appendix 1: Sample

Engineering disciplines	Public Sector	Private Sector
Civil Engineering	• Uganda National Roads Authority • National Water & Sewerage Corporation • Ministry of Works and Transport • Kampala Capital City Authority • Kanungu District Local Government • Kira Municipal Council •	• Professional Engineering Consultants (PEC) Ltd • ICS Engineering and Environment • Getlab • Excel Construction Limited • Segamu 14 Consults Ltd • MBW Consulting Ltd
Electrical Engineering	• Transmission Company Limited (UETCL) • Rural Electrification Agency • Uganda Electricity Distribution Company Limited • Uganda Electricity Generation Company Limited • Ministry of Energy and Mineral Development	• Umeme Ltd • Multi-Konsults Ltd • Megger Technical Services Ltd • Electrical Controls and Switchgears Limited • M&E Associates Ltd • TESLA Technical services • Ericsson AB Uganda
Computer Engineering	• National Information Technology Authority – Uganda (NITA-U) • Ministry of ICT • Uganda Electricity Transmission Company Limited (UETCL) • Civil Aviation Authority	• Roke Telecom • Safe boda • ORIT Engineering • Technology Associates Uganda • Currently Freelance engineer • Bizit Solutions Ltd • Never Ending Solutions
Telecommunication Engineering	• Uganda Civil Aviation Authority • Uganda Electricity Transmission Company Limited (UETCL) • Uganda Telecom	• MTN Uganda • American Tower Corporation (ATC) Uganda • Airtel Uganda • UTL • Csquared Uganda • Soliton Telmec (U) Limited • Ericson Uganda Limited
Mechanical Engineering	• Ministry of Works and Transport • Uganda National Roads Authority • National Water & Sewerage Corporation • Uganda National Bureau of Standards (UNBS) • Uganda Electricity Generation Company Ltd (UEGCL)	• Car & General (U) Ltd • Vivo Energy Uganda Ltd

6.0 | Appendix 2: Survey Questionnaire

Labour Market Analysis Study Survey Questionnaire

Purpose of the Study
The purpose of this study is to assess the labour market needs across all sectors of the national economy, provide an overview of current labour market trends as well as an overall assessment of economic, social and technical drivers of market growth with an aim of providing a basis for review of curricular, upgrade of teaching equipment /tools, career guidance and transition for students from HEI to work environment.

Target Respondent
This questionnaire targets all alumni of the School of Engineering, College of Engineering, Design, Art and Technology (CEDAT), Makerere University, who completed their undergraduate studies between 2012 and 2021.

Confidentiality and Personal Data Protection
Information collected from this study shall be treated with utmost confidentiality and anonymity to respect the privacy of the respondents.

Section 1- Details of Respondent

1. Gender of Respondent
2. Position of Respondent
3. Engineering discipline studied at undergraduate

Engineering discipline	RESPONSE
Civil engineering	
Electrical engineering	
Computer engineering	
Telecommunication engineering	
Mechanical engineering	

Section 2- Details of Organisation/Institution

4. Name of Organization/Institution
5. Category
    a. Public (Government/Local Government Ministry, Department or Agency)
    b. Private
    c. Not for Profit
    d. Development Agency
    e. Multi-National Organisation
    f. Others
6. Sector of Economy (Tick all that is applicable)

SECTORS	RESPONSE
Agriculture, Forestry and Fishing	
Mining and Quarrying	
Manufacturing	
Electricity	
Road Construction	
Buildings Construction	
Water Supply	
Trade and Repairs	
Transportation and Storage	
Accommodation and Food Service	
Information and Communication	
Financial and Insurance Activities	
Real Estate Activities	
Professional, scientific and technical activities	
Public Administration	
Education	
Human Health and Social Work	
Arts, Entertainment, Recreation	
Others	

Section 3- Job Requirements

7. List engineering specializations that are most relevant to your job in the short term i.e., in the next 12 months, medium term i.e., 2 to 5 years and in the long term i.e., 5 to 10 years?

Engineering disciplines	Specialization		
	Short term	Medium term	Long term
Civil engineering	1. ..... 2. ..... 3. ..... 4. ..... 5.	1. ..... 2. ..... 3. ..... 4. ..... 5.	1. ..... 2. ..... 3. ..... 4. ..... 5. .....
Electrical engineering	1. ..... 2. ..... 3. ..... 4. ..... 5.	1. ..... 2. ..... 3. ..... 4. ..... 5.	1. ..... 2. ..... 3. ..... 4. ..... 5. .....
Computer engineering	1. ..... 2. ..... 3. ..... 4. ..... 5.	1. ..... 2. ..... 3. ..... 4. ..... 5.	1. ..... 2. ..... 3. ..... 4. ..... 5. .....

Telecommunication engineering	1. ..... 2. ..... 3. ..... 4. ..... 5.	1. ..... 2. ..... 3. ..... 4. ..... 5.	1. ..... 2. ..... 3. ..... 4. ..... 5. .....
Mechanical engineering	1. ..... 2. ..... 3. ..... 4. ..... 5.	1. ..... 2. ..... 3. ..... 4. ..... 5.	1. ..... 2. ..... 3. ..... 4. ..... 5. .....

8. By assigning a value 1 to 5, (1 being least important and 5 being most important), rate the importance of each skill listed below in your current job setting.

#	Broad Skill Set	Skills	Rank
1	Basic Skills for Green Jobs	Environmental awareness	
		Waste reduction and waste management	
		Energy and water efficiency	
2	Basic Digital Skills	Use of basic hardware	
		Use of basic software	
		Operate safely in an online environment	
3	Cognitive and Metacognitive Skills	Foundational literacies	
		Analytical and critical thinking	
		Creative and innovative thinking	
		Strategic thinking	
		Problem solving and decision making	
		Self-reflection and learning to learn	
		Collect, organize and analyse information	
		Planning and organizing	
		Career management	
4	Social and Emotional Skills	Communication	
		Collaboration and teamwork	
		Conflict resolution and negotiation	
		Emotional intelligence	

9. What other skills (not listed above) are required for your job in the short term i.e., in the next 12 months, medium term i.e., 2 to 5 years and in the long term i.e., 5 to 10 years? By assigning a value 1 to 5, (1 being least important and 5 being most important), rate the importance of each skill listed.

Other Skills	Rank

10. In your current job, do you consider yourself overqualified or underqualified?

11. Does your job require a different qualification level than that required?

12. Do you possess more skills or less skills than those demanded by the job?

13. Are you in a job unrelated to your field of study?

Section 4- Historical Job and Pay Details

14. When (month and year) did you complete your undergraduate studies?

15. When (month and year) did you get your first job after undergraduate studies?

16. How much (in UGX) did your first job pay (monthly gross pay)?

Section 5- Gaps

17. On a scale of 1 to 5, 1 being very little and 5 being adequate, to what extent had your undergraduate studies prepared you for your first job?

18. Did you undergo additional training or course during your first year of employment?

19. If yes, what trainings or courses did you attend?

20. Is your undergraduate qualification still relevant to your current job?

21. What are subject/knowledge areas you wish you had studied during your undergraduate studies?

22. What equipment or tools do you wish you had learnt how to use during your undergraduate studies?

23. What career guidance information do you wish was provided during your undergraduate studies?

24. What work environment information do you wish was provided during your undergraduate studies?

7.0 Appendix 3: Key Informant Interview Guide

Labour Market Analysis Study Key Informant Interview Guide

Purpose of the Study
The purpose of this study is to assess the labour market needs across all sectors of the national economy, provide an overview of current labour market trends as well as an overall assessment of economic, social and technical drivers of market growth with an aim of providing a basis for review of curricular, upgrade of teaching equipment /tools, career guidance and transition for students from HEI to work environment.

Confidentiality and Personal Data Protection
Information collected from this study shall be treated with utmost confidentiality and anonymity to respect the privacy of the respondents.

Section 1- Details of Respondent

1. Gender of Respondents
2. Position(s) of Respondent

Section 2- Details of Organisation/Institution

3. Name of Organization/Institution
4. Category
    a. Public (Government/Local Government Ministry, Department or Agency)
    b. Private
    c. Not for Profit
    d. Development Agency
    e. Multi-National Organisation
    f. Others
5. Sector of Economy (Tick all that is applicable)

SECTORS	RESPONSE
Agriculture, Forestry and Fishing	
Mining and Quarrying	
Manufacturing	
Electricity	
Road Construction	
Buildings Construction	
Water Supply	
Trade and Repairs	
Transportation and Storage	
Accommodation and Food Service	
Information and Communication	
Financial and Insurance Activities	
Real Estate Activities	
Professional, scientific and technical activities	
Public Administration	
Education	
Human Health and Social Work	
Arts, Entertainment, Recreation	
Others	

6. Total number of employees
7. Estimated number of engineering positions

Engineering disciplines	Number of engineers
Civil engineering	
Electrical engineering	
Computer engineering	
Telecommunication engineering	
Mechanical engineering	

Section 3- Institutional Staffing Needs

8. For each of these engineering disciplines below, how many graduates does the organization require in the short term i.e., in the next 12 months?

Engineering disciplines	Number of engineers
Civil engineering	
Electrical engineering	
Computer engineering	
Telecommunication engineering	
Mechanical engineering	

9. For each of these engineering disciplines below, how many graduates does the organization require in the medium term i.e., in the next 2 to 5 years?

Engineering disciplines	Number of engineers
Civil engineering	
Electrical engineering	
Computer engineering	
Telecommunication engineering	
Mechanical engineering	

10. For each of these engineering disciplines below, how many graduates does the organization require in the long term i.e., in the next 5 to 10 years?

Engineering disciplines	Number of engineers
Civil engineering	
Electrical engineering	
Computer engineering	
Telecommunication engineering	
Mechanical engineering	

11. For each of these engineering disciplines below, which specializations does the organization require in the short term i.e., in the next 12 months?

Engineering disciplines	Specialization
Civil engineering	1. ..... 2. ..... 3. ..... 4. ..... 5. .....
Electrical engineering	1. ..... 2. ..... 3. ..... 4. ..... 5. .....
Computer engineering	1. ..... 2. ..... 3. ..... 4. ..... 5. .....
Telecommunication engineering	1. ..... 2. ..... 3. ..... 4. ..... 5. .....
Mechanical engineering	1. ..... 2. ..... 3. ..... 4. ..... 5. .....

12. For each of these engineering disciplines below, which specialisations does the organization require in the medium term i.e., in the next 2 to 5 years?

Engineering disciplines	Specialization
Civil engineering	1. ..... 2. ..... 3. ..... 4. ..... 5. .....
Electrical engineering	1. ..... 2. ..... 3. ..... 4. ..... 5. .....
Computer engineering	1. ..... 2. ..... 3. ..... 4. ..... 5. .....
Telecommunication engineering	1. ..... 2. ..... 3. ..... 4. ..... 5. .....

Mechanical engineering	1. ..... 2. ..... 3. ..... 4. ..... 5. .....

13. For each of these engineering disciplines below, which specializations does the organization require in the long term i.e., in the next 5 to 10 years?

Engineering disciplines	Specialization
Civil engineering	1. ..... 2. ..... 3. ..... 4. ..... 5. .....
Electrical engineering	1. ..... 2. ..... 3. ..... 4. ..... 5. .....
Computer engineering	1. ..... 2. ..... 3. ..... 4. ..... 5. .....
Telecommunication engineering	1. ..... 2. ..... 3. ..... 4. ..... 5. .....
Mechanical engineering	1. ..... 2. ..... 3. ..... 4. ..... 5. .....

14. Which specializations are in short supply in the country?

15. By assigning a value 1 to 5, (1 being least important and 5 being most important), rate the importance of each skill listed below in the short term i.e., in the next 12 months, medium term i.e., 2 to 5 years and in the long term i.e., 5 to 10 years.

#	Broad Skill Set	Skills	Rank		
			Short term	Medium term	Long term
1	Basic Skills for Green Jobs	Environmental awareness			
		Waste reduction and waste management			
		Energy and water efficiency			
2	Basic Digital Skills	Use of basic hardware			
		Use of basic software			
		Operate safely in an online environment			
3	Cognitive and Metacognitive Skills	Foundational literacies			
		Analytical and critical thinking			
		Creative and innovative thinking			
		Strategic thinking			
		Problem solving and decision making			
		Self-reflection and learning to learn			
		Collect, organize and analyse information			
		Planning and organizing			
		Career management			
4	Social and Emotional Skills	Communication			
		Collaboration and teamwork			
		Conflict resolution and negotiation			
		Emotional intelligence			

16. What other skills (not listed above) are required of engineering graduates in the short term i.e., in the next 12 months, medium term i.e., 2 to 5 years and in the long term i.e., 5 to 10 years? By assigning a value 1 to 5, (1 being least important and 5 being most important), rate the importance of each skill listed.

Other Skills	Rank		
	Short term	Medium term	Long term

17. Which skills are in short supply in the country?

Section 4- Historical Staffing and Pay Details

18. From 2013 to present, how many engineering graduates has your organization hired?

Engineering disciplines	Number of new hires									
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Civil engineering										
Electrical engineering										
Computer engineering										
Telecommunication engineering										
Mechanical engineering										

19. What are the reasons for engineering graduates resigning or leaving their positions?

20. From 2013 to present, how many graduate engineers (engineering graduates with little or no prior experience) has your organization hired?

Engineering disciplines	Number of graduate engineers									
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Civil engineering										
Electrical engineering										
Computer engineering										
Telecommunication engineering										
Mechanical engineering										

21. How has the gross pay per month of the graduate engineer position (engineering graduates with little or no prior experience) changed over the last 10 years?

Engineering disciplines	Gross pay per month									
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Civil engineering										
Electrical engineering										
Computer engineering										
Telecommunication engineering										
Mechanical engineering										

22. What are these engineering position's entry requirements?

Engineering disciplines	Level of engineers		
	Graduate Entry	Professional/ Technical	Manager
Civil engineering			
Electrical engineering			
Computer engineering			
Telecommunication engineering			
Mechanical engineering			

23. By assigning a value 1 to 5, (1 being very easy and 5 being very difficult), rate the ease with which engineers that meet job specifications and requirements can be hired at the different levels?

Engineering disciplines	Level of engineers		
	Graduate Entry	Professional/ Technical	Manager
Civil engineering			
Electrical engineering			
Computer engineering			
Telecommunication engineering			
Mechanical engineering			

24. What induction trainings are graduate-entry level engineers subjected to?

Engineering disciplines	Induction trainings
Civil engineering	
Electrical engineering	
Computer engineering	
Telecommunication engineering	
Mechanical engineering	

25. What additional trainings (such as graduate training or on-the-job training programmes) and courses are engineering personnel subjected to in their first one year of employment, including equipment-use training?

Engineering disciplines	**Level of engineers**		
	Graduate Entry	**Professional/ Technical**	**Manager**
Civil engineering			
Electrical engineering			
Computer engineering			
Telecommunication engineering			
Mechanical engineering			

26. What are the employee performance measurement criteria for engineering personnel?

Engineering disciplines	Level of engineers		
	Graduate Entry	Professional/ Technical	Manager
Civil engineering			
Electrical engineering			
Computer engineering			
Telecommunication engineering			
Mechanical engineering			

27. What economic factors does your organization face that influence recruitment or laying-off of engineers?

28. What social factors does your organization face that influence recruitment or laying-off of engineers?

29. What technical factors does your organization face that influence recruitment or laying-off of engineers?

Section 5- Recommendations

30. What suggestions do you have with respect to:

    a) Reviewing of Curricula for the engineering programmes offered by School of Engineering. Feel free to use an extra sheet of paper

Engineering disciplines	Suggestions
Civil engineering	
Electrical engineering	
Computer engineering	
Telecommunication engineering	
Mechanical engineering	

b) Reviewing/upgrading of Teaching equipment and/or tools used by School of Engineering

Engineering disciplines	Suggestions
Civil engineering	
Electrical engineering	
Computer engineering	
Telecommunication engineering	
Mechanical engineering	

c) Providing career guidance services for students

Engineering disciplines	Suggestions
Civil engineering	
Electrical engineering	
Computer engineering	
Telecommunication engineering	
Mechanical engineering	

d) Preparing students (orientation) for transition from University to the work environment

Engineering disciplines	Suggestions
Civil engineering	
Electrical engineering	
Computer engineering	
Telecommunication engineering	
Mechanical engineering	

8.0 Appendix 4: Detailed Qualitative Findings and Results

Q11. Specialisations needed in the short term

Employers were asked to list engineering specialisations that were required by their organisations in the short term. In this study, short term was considered to be "the next 12 months". Specialisations were defined as branches of the five main engineering disciplines that were required to conduct business. Most employers' responses were a reflection of current activities and current demands. Employers listed the following specialisations as those needed in the short term.

Discipline	Specialisations needed in the short term
Civil	• Materials engineering • Highways engineering and pavement design • Hydrologists/ drainage engineers • Structural engineers • Project Management • Occupational health and safety • Road safety, traffic engineering, traffic control and traffic signal design • Transportation engineering • Geotechnical engineers • Cost and measurement engineers • Civil works inspectors • Contract claims specialists • Environmental engineers • Bridge engineers
Electrical	• Power system protection specialists – switchgear engineering • Power transmission systems engineering – load flow analysis, design of HV, MV and LV networks and substations, construction, operation and maintenance. • Building services- power distribution in buildings and design and installation • Solar energy/power generation and distribution- design, specification/sizing and installation • Instrumentation engineers (programming, installation and maintenance of energy meters) • Hydro power generation operation and maintenance, asset management planning, control and instrumentation, • Energy economics, technical and energy efficiency audits • Power Generation: Diesel Generator installations, ratings, synchronization of generators, calibration of electronic control units, power command controls • Electronics (automation of plants with industrial PLCs), analysis, programming, design and develop electrical circuits/boards, interpret, review and modify circuits; troubleshooting and reconfiguration of systems • Nuclear energy science and engineering • Instrumentation for condition-based maintenance

Discipline	Specialisations needed in the short term
Computer	• Traffic signalisation • Human Machine interface for traffic control centres, data collection and analysis • Computer programming • Configurations of networking equipment and Network security • Installation and configuration operation and maintenance of computer systems, network security including network servers, routers, firewalls, Computers, printers and scanners • Installation and configuration operation and maintenance of computer software • Networks and data security • Software development • Database management. • Linux operating system • Digital marketing, digital content management
Telecom	• Telecommunications network planning, operation and maintenance • Optic fibre technology, transmission, maintenance and deployment • Financial technology • Cable networks • IP data communications • Radio communications • Configuration, operation and maintenance of telecommunication software • Virtual Local Area Network (VLAN) spanning • Configurations of networking equipment and Network security • Project management
Mechanical	• Automotive • Plant automation and programming in production and manufacturing • Mechatronics • Hydraulics and pneumatics (design and failure modes) • Plant specification and sizing, operation and maintenance, parts inventory management • Engine overhauls and servicing • Machining, design of machine parts and analysis, welding and joinery , powder coating • Installation and operation of agricultural implements • Health, Safety and Environment • Chemical engineering; materials selection e.g. to suit the chemical composition of water in various areas (development of specifications); • Energy economics, technical and energy efficiency audits • Design of piping systems and implications of selected design in terms of piping losses (water hammer analysis and its mitigation); air valve design and sizing, selection of valve positioning in the system); • Bearing design, selection and installation to withstand loads in various systems; • Lubricant selection and application in various systems; • Drawing interpretation • Public procurement principles and procedures • Marine machine design; marine auxiliary machines; marine electrical power systems; naval architecture; marine control systems engineering; maritime safety • Heating, Ventilation and Air Conditioning (HVAC) engineers

Q12. Specialisations needed in the mid term

Employers were asked to list engineering specialisations that were required by their organisations in the medium term. In this study, medium term was considered to be the period 2 to 5 years. It was observed that the short term needs were applicable in the medium term as well. However, the most significant specialisations required in the medium term were analysed to include the following shown in the table below.

Discipline	Specialisations needed in the mid term
Civil	• Use of modern design software • Water and sanitation engineering • Hydrologists • Highway and pavement design engineers • Traffic control, traffic signaling and road safety engineers • Transportation engineering
Electrical	• Energy economics, energy audit and efficiency specialists • Power system protection specialists • Power systems engineering specialists • Building services specialists • Solar energy/power design and installation, operation and maintenance • Instrumentation engineers • Hydro power generation operation and maintenance, asset management planning, control and instrumentation • Nuclear energy science and engineering • Marine energy, geothermal, floating solar, wind • Machine learning • Design of electrical boards and analysis
Computer	• Design of traffic signals • Aviation control systems installation and monitoring • Advanced computer programming, • Design, installation, configuration, operation and maintenance of computer systems (software and hardware), networking equipment and network security • Database design and management • Project management of computer system projects • Search engine optimization • Software development and deployment • Data analysis and visualization • Digital content creation.
Telecom	• Telecommunications network planning and systems operations • Configurations of networking equipment and network security • Radio communications, microwave and RF optimisation • Aviation control systems installing and monitoring. • Fiber technologies, fiber network monitoring and maintenance. • IP Data communications • Financial technologies • Project management
Mechanical	• Marine engineering (Marine machine design, marine auxiliary machines, marine electrical power systems, naval architecture, marine control systems engineering, maritime safety) • Design of machine parts and analysis, welding and joinery, powder coating

Q13. Specialisations needed in the long term

Employers were asked to list engineering specialisations that were required by their organisations in the long term. In this study, long term was considered to be the period between 5 to 10 years. Some employers found it difficult to forecast labour needs beyond 5 years. Nonetheless, some respondents made an attempt. It was observed that the short term amd medium term needs were applicable in the long term as well. However, the most significant specialisations required in the long term were analysed to include the following shown in the table below.

Discipline	Specialisations needed in the long term
Civil	• Water and sanitation engineering • Transportation engineering • Traffic signalization • Channelization • Bridge engineers
Electrical	• Energy audit & efficiency specialists • Power system protection specialists • Power systems engineering specialists • Building services speciaists • Solar energy design and installation • Instrumentation engineers • Hydro power plant operation and maintenance, asset management planning, control and instrumentation • Nuclear energy science and engineering • Marine energy • Geothermal and wind energy/power generation • Machine learning • PLC and design of electrical boards and analysis
Computer	• Computer programmer • Computer systems installation, configuration, operation, optimization and maintenance including networks and security • Database design and management • Project management • Software/ application development • Quality assurance testing, management and data analytics • Cyber security • Cloud administration, Automation, Backup and recovery • Aviation control systems
Telecom	• Network planning, configurations of networking equipment and network security • Radio communications, microwave, RF deployment and Maintenance • Aviation systems engineering • Optic fiber technologies • IP Data communications. • Data analytics • Financial technologies
Mechan	• Automotive • Plant automation in production and manufacturing • Mechatronics • Marine engineering; machine design, marine electrical power systems, naval architecture, control systems engineering, maritime safety • Design of machine parts and analysis, welding and joinery , powder coating

Q14. Specialisations in short supply

Employers were asked to list the specialisations that are currently in short supply in the country. The table below shows specialization that were considered not sufficient in the Ugandan labout market.

Discipline	Specialisations in short supply
Civil	• Highway and pavement design, • Traffic engineering, traffic control, traffic signaling, • Public transport management • Municipal engineering (solid waste) and drainage engineering • Geotechnical engineering • Bridge engineers • Materials engineers • Railway engineering, • Transport planning engineers (railway, airport, ports and harbors) • Transport economists • Structural engineers • Hydrologists • Irrigation engineers • Contract claims experts, • Engineering metallurgy • Material scientists • Biomedical engineering (instrumentation, laboratories) quality control (laboratories)
Electrical	• Power systems protection specialists • Automation and programming specialists • Nuclear energy engineers • Machine learning • Floating solar power plants specialists
Computer	• Cyber security engineers • Traffic signal design engineers • Computer components designers and fabrication • Automation and embedded systems designers • Artificial Intelligence specialists • Big data analysts • Programming and system control engineers • Network infrastructure planning and design engineers • Cloud architects, enterprise architects • Software developers
Telecom	• Fintech software engineers • Aviation engineers • Network infrastructure planning and design engineers • Optic fibre engineers

Discipline	Specialisations in short supply
Mechan	• Mechatronics and instrumentation • Health, Safety and Environment certifications, • Project management certifications • Balancing of rotating masses e.g. for impellers • design for condition-based maintenance • Machine shop and production skills (e.g. milling, turning, threading, heat treatment for case hardening) • Mechatronics and automation of equipment • Drawing interpretation • Engineering design and specifications development • Marine engineering; machine design; marine auxiliary machines; marine electrical power systems; naval architecture; marine control systems engineering; maritime safety • Robotics • CAD engineers • CNC machines specialists

Q17. Skills in short supply

Employers were asked to list skills that were currently in short supply in the country. What can be noted is that due to technological advancement, most employers have cited a shortage of skills in the use of computer aided design applications. Whereas design from first principles is appreciated and should be known, most modern engineering designs are application based. Entrepreneurial skills were also among those cited as lacking amongst engineering graduates in the market. The table below shows skills that were considered not sufficient in the Ugandan labour market.

Discipline	Skills in short supply
Civil	• Project risk management • Leadership skills • Strategic thinking • Interpersonal skills • Business management skills • Use of modern CAD applications
Electrical	• Engineering drawing using CAD applications (sub-station drawing and powerline drawings) • Leadership and management skills
Computer	• Creative and innovative thinking and the ability to identify, formulate, and solve complex engineering problems by applying principles of engineering • Creative and innovative thinking skills and the ability to transform the innovative idea into a tangible product • Analytical and critical thinking skills • CAD software design and analysis skills • Concept development • Versatility

Discipline	Skills in short supply
Telecom	• Skills to handle and work with newer technologies • Concept development • Creativity and Innovation • Big data analytics • Practical and problem solving skills • Business and financial skills
Mechanical	• Design, optimisation and troubleshooting skills especially where proprietary software is involved, • power command calibration skills, • Intrapreneurship • Report writing skills • CAD software design and analysis skills

Q19. Why do engineers leave their jobs

In order to characterize the engineering labour market, respondents were asked to enumerate reasons why engineering personnel leave their jobs. Across all the engineering disciplines, the responses were similar. Better pay offers, career advancement and further studies were the most common responses. Other reasons included;

- To specialize in an area of interest
- To take up more challenging jobs
- To comply with organizational retirement policies
- As a result of organizational restructuring
- As a result of dismissal due to gross misconduct
- Non-conducive work environment and high occupational risk especially in mechanical engineering work environment
- Failure to fit in the organizational culture including poor attitude etc

The responses below indicated responses per engineering discipline.

Discipline	Why engineers leave their jobs
Civil	Career advancement To specialize in an area of interest To further studies Better pay offer To seek more challenging work
Electrical	Career advancement To specialize in an area of interest To further studies Better pay offer
Computer	Career advancement To further studies Better pay offer To seek more challenging work

Telecom	Career advancement To further studies Better pay offer To seek more challenging work To specialize in an area of interest Laid off as a result of restructuring
Mechan	Career advancement To further studies Non-conducive work environment, high work pressure and high occupational risk Better remuneration offer Retirement Poor personal attributes and failure to fit organisational culture including ethical failures

Q22a. Entry job requirements

To characterize engineering jobs to which engineering graduates are absorbed, data was collected on job requirements. The largest employers of engineering graduates offer internship positions for fresh graduates for a period of 1 to 2 years. In most organisations, these positions are called Graduate Trainee positions or Graduate Engineer position. This is seen as a means to give an opportunity to the graduate to impress prospective employers according to UIPE President, but is also a means to provide more hands-on training to the graduate before being fully employed. However, some graduates see this as a means of inexpensive employment of engineers. Engineering entry job requirements were characterized as shown in the table below.

Discipline	Entry level job requirements
Civil	Most entry positions required a Bachelors degree in civil engineering. However, some organisations did not have permanent positions for fresh graduates. For instance, Kira Municipal Council did concede that graduates could only be hired as interns. NWSC only recruits from the pool of graduate trainees.
Electrical	Most entry positions in organisations that employed electrical engineering graduates required a Bachelor's degree in electrical engineering. Some required at least 2nd class degree. UEGCL, UETCL and many other organisations require a graduate to have undergone their 2 year graduate trainee programme.
Computer	Employers of computer engineering graduates required a relevant bachelor's degree. Most of them required additional knowledge and skills to be demonstrated by the graduate, such as: • Basic knowledge in current trends in software design, architecture and web services, networking and data security • Knowledge in programming languages, server infrastructure, storage infrastructure, databases and networking skills. • Knowledge in Linux, databases, systems administration • Professional certification in ITIL It can be said that computer engineering graduates faced a lot more competition and therefore the need to differentiate themselves as several institutions offered what industry would see as "similar programmes"

Discipline	Entry level job requirements
Telecom	Employers of telecommunications engineering graduates required a Bachelor's degree in telecommunications engineering. Some employers such as UEDCL, UCCA however, considered computer engineering and electrical engineering as other similar qualifications for the entry level. Additional knowledge and skills required included; • Basic mobile communications knowledge • Transmission techniques and switching knowledge
Mechan	Requirements to entry positions for mechanical engineering graduates include a Bachelors degree. However, NWSC requires one to have completed 1-year industrial training. Another employer, Car and General Ltd, prefers one to have a Bachelors degree and diploma. According to the employer, this profile ensures employees recruited have sufficient practical experience and practical skills required for the jobs.

Q22b. Professional/supervisor job requirements

Professional and technical level job requirements hold the following characteristics. Civil engineering graduate employers require a Bachelor's degree in civil engineering field and between 2 and 10 years of experience. Most do not require personnel to be registered or certified engineer. However, senior positions (e.g. Resident Engineer at UNRA, Principal Officer in Government MDAs) require a postholder to be a registered engineer with ERB. Graduate qualifications such as Masters degree or PhD are not mandatory but if possessed give a candidate an added advantage. Among employers of Electrical engineering graduates additional qualifications such as ERA class A or B permit holder are required in addition to a Bachelors degree in electrical engineering and between 2 and 5 years of experience. Unless holding Senior government positions i.e. Principal Officer and higher, there are hardly any requirements to be a registered engineer with ERB or to possess a graduate qualification. Employers of computer engineering graduates place a lot of focus is on industry certifications for professional and technical positions. Most jobs require certain relevant certifications in addition to experience. Certifications are driven by the extent of domination of a certain technology in the market. For instance, Microsoft certifications are mostly required due to the dominance of Microsoft applications and technologies. Graduate qualifications would be an added advantage to the post holder. Telecommunications engineering employers rely on a Bachelors degree and 2 to 5 years of experience for professional and technical positions. Certifications in specific technologies is also desired. Graduate qualifications are an added advantage. Amongst mechanical engineering employers, professional positions require a Bachelors degree and 3 to 5 years of experience. In government MDAs, senior positions (Principal Officer and higher) require one to be registered with ERB and UIPE. Graduate qualifications are optional.

Discipline	Professional and technical job requirements
Civil	• Bachelors degree plus 2 to 10 years of experience • Senior Engineer in NWSC, MWE requires 5 to 10 years' experience and a post graduate engineering qualification
Electrical	• Most require bachelors degree plus 3 to 5 years of experience • A few employers require registration with ERB and UIPE. • Senior engineers at NWSC, MWE require masters degree plus registration with ERB and UIPE • Industry permits (e.g. ERA Class A or B permit) are a requirement in some positions

Discipline	Professional and technical job requirements
Computer	• Most require a bachelors degree and 2 to 3 years of relevant experience • Most require a set of relevant certifications such as proficiency in programming languages, certifications in Linux, database administration and management, • professional certifications such as JNCIA, JNCIS, CompTIA A+ and CompTIA Networks +, ITIL, CCNA, MCSE or MCSA. • Masters in any IT related field as an added advantage.
Telecom	• Bachelor's degree in electrical/telecommunications engineering • Plus 2 to 5 years experience in a relevant field e.g. for CSQUARED Group, relevant field is fiber and transmission technologies • UCAA exclusively recruits from its junior staff and must have passed all assessments in the previous years • Plus professional certifications such as CCNA, CCNP, JUNOS, MTCNA, HCIP, HCIA, Comptia+ (for networks), CISA, CISM, CCNP Security (for network security), CFOT (for optic fibre communications)
Mechan	• Most require Bachelors degree plus 3 to 5 years of experience • NWSC requires a masters degree plus registration with ERB and UIPE • UNRA requires Bachelors degree plus registration with ERB and UIPE.

Q22c. Manager job requirements

Most managerial positions across the board attract Masters degree in science field or engineering or business management or project management with 5 to 15 years of experience. Civil, electrical, mechanical graduate government employers require a candidate to be a registered engineer with ERB and a member of a professional body such as UIPE. This requirement however, is relaxed for private sector employers. Across the board, managerial positions tend to emphasize experience in non-engineering work, but rather in management aspects such as people management, risk management, project management, target setting, performance management, business management.

Discipline	Manager job requirements
Civil	All government managerial positions (Managers, Commissioners, Directors) require Master's degree in an engineering field and registration with ERB and UIPE. Some require relevant certifications such as project management certifications. The positions require between 7 to 10 years of experience. At UNBS professional registration is an added advantage.
Electrical	Most require Masters in engineering or business or project management plus 7 to 15 years of experience. As noted before, government ministry positions require registration with ERB and UIPE. In the private sector such as at Car and General Ltd, managerial position requires a Bachelor's degree plus relevant experience, plus membership with professional bodies and recognised training in people management.
Computer	Most positions require a masters degree in the field on expertise plus 3 to 6 years of relevant experience. At Commissioner level and higher, an MBA is a must. Other post graduate qualifications considered are project planning and management. In some jobs, professional certifications are emphasized.

Discipline	Manager job requirements
Telecom	At MTN, managerial positions require a management qualification or master's degree in the relevant field and 3 to 10 years of experience (i.e. engineering project management)
Mechan	Most government managerial positions (Managers, Commissioners, Directors) require master's degree in an engineering field and registration with ERB and UIPE. Some require relevant certifications such as project management certifications. The positions require between 7 to 10 years of experience. At UNBS professional registration is an added advantage. At UNRA, the masters degree in administration is preferred. At UEGCL, post graduate training in hydropower generation and business management is preferred.

Q24. Induction training programmes

The study sought to find out the nature of training programmes organized by employers to plug deficiencies is knowledge and skills of the labour market. Employers were asked the nature of induction trainings conducted at their organisations. Responses from most employers revealed that induction trainings were aimed at orienting new employees into their work environment. New employees were taken through the operations and functions of different departments and explained how their individual jobs fitted in the overall goal of the organization and what contributions they made to the success of the organization. At organisations such as UEGCL, NWSC, UETCL that undertake a graduate training programme, induction was incorporated in the training programme.

Discipline	Induction Training Content
Civil	• Health Safety and Environment • Engineering software (CAD, MS Project, MS Excel) • Use of design tools and CAD software • Preparation of reports, certificates and claims • Powerline construction standards • Operations /functions of the organization (Vivo, NWSC, UNBS) • Refresher design course on roads and structures, materials lab training • on-job labour-based training program in Mbale (MoWT) • 2 year graduate training program for recruits fresh out of university (UNRA)
Electrical	• PPE use and introduction to key tools (Car and General) • Operations /functions of the organization training by rotational attachment to departments (NWSC) • The public service code • Ethical conduct trainings • Vision, mission and core values of the company and Operations /functions of the organization (UETCL)

Discipline	Induction Training Content
Computer	• Systems design and troubleshooting • Scheduling and practical skills training • The public service code • Ethical conduct trainings • Vision, mission and core values of the company and Operations /functions of the organization (UETCL) • Systems management and Network support training. • Relevant certification in programming • System administration skills
Telecom	• Basic mobile and transmission techniques. • The public service code • Ethical conduct trainings • Training within the department with mentors and also courses assigned by the HR learning system (MTN) • Operations /functions of the organization • Hands on training especially through the fault management process (CSquared)
Mechan	• The public service code • Specific department functions, PPE use and Introduction to key tools (Car and General) • Operations /functions of the organization training by rotational attachment to departments (NWSC, UEGCL, UNBS) • Operations /functions of the organization training, site safety and environment management (UNRA)

Q25. On-the-job/strategic training programmes

The study also sought to find out the nature of on-the-job / strategic training programmes organized by employers to plug deficiencies in knowledge and skills of employees. Responses from employers revealed wide range of trainings conducted. At UCCA, new entrants are subjected to an intensive, extensive and expensive training for 5 years and gradually advance as they go up the ladder. The training is in three phases; indoctrination, specialization and experiential. The indoctrination phase aims at initiating the entrants into the aviation industry and confirm whether the graduate has the right aptitude, attitude and ambition for the industry. The specialization phase orients the graduate into the technical aspects of the training with the goal of aiding specialization and mastery in a given engineering field in the aeronautic engineering. The experiential stage is the continuous encountering of the studied aviation principles and standards both technical and non-technical to help in your aviation work and also acquire the experiences to share with the graduates who will come during your tenure. For all the training modules, a written or oral exam is conducted by the training institute with the pass mark being 70%. At ROKE Telecom, the more senior staff demonstrate different networking problems and practically show the graduate engineers the solutions they can deploy to solve them. The graduates are also allowed to implement the networks to solve these challenges and more challenges are given to the graduates in order to master the required concepts for the job. On the live environment, a graduate is assigned to an experienced engineer to show the graduate what to do and also supervise him or her until they master the live environment operations. Computer engineering employers usually provide vendor specific trainings for employees to manage supplied devices and systems.

Discipline	On-the-job / strategic training programmes
Civil	• Highway design • Material testing • Construction supervision • FIDIC contract administration • Health and safety training • Data analysis • CAD training • Contract management • Claims management • Public policy • Strategic planning and management • Monitoring and evaluation • Project Management • Use of computer aided software (ArchiCAD, AutoCAD, MIDAS nGen/Civil/ Soil, TEDS) **At Vivo Energy, the following trainings are undertaken** • HSSEQ training and subsequently certification • Hazard and Effect Management (HEMP) training • Process Safety training • Network engineering (relevant for work on fuel stations) • Reservoir engineering standards
Electrical	• Permit to work training and certification • Stakeholder management • Operation Regulations for High Voltage Systems (ORHVS) • Power line construction standards • Contract administration • Procurement • Project management • Health Safety and Environment • Fault analysis and resolution • SCADA operation and monitoring • FIDIC Contract Management • Leadership and organizational management • Communication • Performance management • Report writing • Nuclear safety and security, radiation emergency management • Technical reporting and technical report writing. • CAD software trainings, • CNC machining. • **C**ontrol, planning and design • Switch-gear training, • Vendor specific equipment and systems training

Discipline	On-the-job / strategic training programmes
Computer	**Entry level trainings** • Programming • Practical troubleshooting and system repair • Software and hardware maintenance • Systems and data security trainings • Peering technologies • Device configuration and management • Routing protocols • Communication • Customer care **Professional trainings** • Technical report writing • CCNA trainings • MCSA/MCSP • Certifications in CompTIA network + • Certifications in JNCIS • CAD software trainings • Project management • CNC machining. • Professional Certification - systems management & Network support trainings • Professional certification in Linux, system administration, database management • Server management • Storage • System administration • Networking, databases and cloud-storage trainings. • Application development **UCAA provides the following trainings:** • Standards of International Civil Aviation Organization • Testing and maintenance of the aircraft • Aviation design • Aviation communication, • Aviation systems navigation and management **Manager trainings** • Leadership and coaching • Monitoring and evaluation • Emotional intelligence • Projects management. • Safety, health and environment trainings, • Organizational and performance management, • Managing remote-based teams trainings • Communication skills • Anti-bribery and compliance training. • Continuous professional development • Management certification in the aviation space (UCAA) • Inclusion and diversity people management.
	• Inclusion and diversity people management.

Discipline	On-the-job / strategic training programmes
Telecom	Entry level trainings Entry level trainings are incorporated in graduate training 3 to 12 months graduate training by Airtel, UEDCL, UETCL and ATC **Professional and Technical level trainings** • Optical fibre training (CFOT training) • Vendor training for the new technology • Certifications in Cisco certified network associate/professional courses • Additional training in networking skills and given the network equipment to implement practical situations **Manager Trainings** • Safety, health and environment trainings • organizational and performance management, • Emotional intelligence • Mentorship trainings • Management certification in the aviation space • Soft skills in management • Virtual team management and proficient use of online work environments • Advanced optical fiber training (CFOT training)
Mechan	• Permit to work training and certification • Project Management; • Use of computer aided design software (ArchiCAD, AutoCAD, MIDAS nGen/ Civil/Soil, TEDS); • Training in auto-electronics (short courses) to improve on diagnostic skills and equipment inspection (UNRA) • Plant safety regulations • Condition-based monitoring • Plant operations and maintenance e.g. machinery vibration and realignment • Hydraulics and turbine regulations, • Switch gear maintenance and operations (UEGCL) • Supervisory and leadership skills • People management; • Conflict management • CAD software trainings • Project management • CNC machining **Vivo Energy provides the following training;** • HSSEQ training and subsequently certification • Hazard and Effect Management (HEMP) training • Process Safety training • Network engineering (relevant for work on fuel stations) • Reservoir engineering standards

Q26. Performance criteria for engineering

The study sought to understand what aspects of work are measured and rewarded by industry. Employers were asked to share performance metrices for engineers at entry level, professional/ technical level and managerial level. The most critical and widely performance metrices for entry level staff include task delivery, attitude and quality of work. For professional/ technical level staff, the most widely applied performance metrices are competence and skills, work quality while managerial staff are measure on efficiency, resource management, business performance, client satisfaction and people management.

Discipline	Entry level	Professional/Technical level	Managerial level
Civil	• Task delivery • Technical competence • how fast they attain the skills required for the job • Attitude and effort put into meeting company targets and deadlines • Quality of work • Professional knowledge/skills	• Task completion • Timeliness • Professionalism and integrity, • Punctuality for work and assignments • Work quality • Value addition • Leadership • Knowledge • Resource management	• Client satisfaction • Team management • Project performance • Human and financial resource management • Business performance (profit) • Planning, organising and coordinating, • Decision making • Communication, Integrity
Electrical	• Willingness to learning • Application of knowledge • Following safety guidelines • Innovation and creativity • Time management • Team work and collaboration • Work ethics and attitude • Timely completion of tasks • Continuous professional development • Attendance and time management, • Communication • Job knowledge • Projects progress	• Service performance • Efficiency i.e. Reduction of losses • Revenue collection • Plant availability • Knowledge sharing • Mentorship	• Business development and performance • Customer satisfaction • Resource efficiency and management • Skills transfer and development • Industrial knowledge of merging technologies • Reliability and quality • Stakeholder management

Discipline	Entry level	Professional/Technical level	Managerial level
Computer	• Time management and attendance • Understanding of the work processes • Communication • Tasks handling • Customer satisfaction. • job knowledge • Quality of work • Successful completion of the assigned tasks. • Problem solving ability • Critical thinking, • Collaboration and team work • Willingness to learn • Situation awareness, • Workload management • self-management and continuous learning. • Innovativeness • Customer care.	• Job knowledge • Quality of work • Communication • Reliability • Time management and attendance • Collaboration and team work • Report writing • Problem solving ability • Critical thinking • Collaboration and team work, time management and communication skills. • Service performance (on time delivery with utmost quality and accuracy) • Skills transfer and capacity building • Continuous professional development	• Achievement of NDP goals • time management and attendance • Revenue performance • Team leadership and feedback management. • Report writing • Delegation and decision making • Efficiency and resource management • Capacity building. • Effective organizational and performance management, • Project performance (meeting of project targets and deadlines, quality and budget) • Technical service performance • Financial management • Customer satisfaction

Discipline	Entry level	Professional/Technical level	Managerial level
Telecom	• Time management and attendance • Communication • Tasks handling and customer satisfaction • Attitude • Situation awareness, • Workload management • self-management and continuous learning. • Ability to learn and apply knowledge after training • Understanding of the job role • Correct use of the tools provided by the company • Collaboration with peers and teamwork	• Time management and attendance • Understanding of the work processes • Communication skills • Customer satisfaction. • Projects progress • Service performance (based on quality, timelines and attitude) • Situation awareness • Problem solving and decision making • Workload management • Self-management and continuous learning • Compliance with ISO standards • Knowledge sharing, skills transfer and capacity building	• Achieving the company strategic objectives and goals set per annum. • Achievement of NDP goals of a specified period. • Effective judgement • Compliance with ISO operational standards • Collaboration with peers • Knowledge sharing, skills transfer and capacity building
Mechan	• Quality of work delivered • Collaboration and team work • Continuous professional development • Attitude • Technical competencies • Customer management	• Quality of work delivered • Collaboration and team work • Continuous professional development • Attitude • Technical competencies • Customer management	• Business development and performance • Customer satisfaction • Resource efficiency and management • Team management • Project performance • Skills transfer and development • Industrial knowledge of emerging technologies • Reliability and quality • Stakeholder management

Q27. Economic factors that influence market growth

The demand and supply of engineering graduates is influenced by several factors. The study sought to establish economic factors that influence labour market growth. The demand for labour i.e. availability of employment is influenced by four main economic factors at a macro level:

e. Government policy direction and spending; Government of Uganda has for many years prioritized infrastructure, energy and transport development. These three sectors primarily are sectors that employ engineers. The development and rehabilitation of road network, construction of two new hydropower generation plants, expansion of access to ICT has provided business for private sector as well as increased employment in Government departments and agencies such

as NITA-U, UCC, UNRA, UEGCL, UETCL.

f. Economic Growth; According to the Annual Macroeconomic and Fiscal Performance Report 2020/21 published by Ministry of Finance, the size of the Ugandan economy expanded to USD 42 billion in Financial Year 2020/21, registering a real GDP growth rate of 3.4%. The performance of the economy dropped from remarkable 6.3% in 2017/18 and 6.4% in 2018/19 to 3.0% in 2019/20 and 3.4% in 2020/21, mostly attributed to the COVID-19 pandemic. However, prior to the pandemic, the industry grew by a remarkable 11.2% on average from 2017 to 2019. The construction industry growth translates to more business and more jobs.
g. Investment; A surge in investments in the country has led to establishment of factories and development of especially manufacturing sector. For instance, the establishment of Quality Chemicals Industries Limited to produce ARVs in the country led to the employment of electrical and mechanical engineers among others.
h. Fiscal and monetary polices; For instance, tax policies on agricultural implements which may not favour farmers affect the use and servicing of farm implements and mechanical engineering jobs as a result. According to Bank of Uganda (BOU), of the USD 5.2 billion private credit granted in 2021, Building, mortgage, construction and real estate was responsible for the largest share i.e. 20%, an indication of the growing appetite for housing development. High interest rates on loans and mortgages therefore affect significantly the housing industry and civil engineering jobs.

At the organizational level, employers cited the following economic factors;

d. Availability of new projects. New projects result into more employment opportunities for engineers. Graduate engineers are brought in often to train in advance to prepare for forecasted work. New projects are also a reflection of sustained business growth in the private sector. On the flip side, some employment positions are lost when projects are closed. New projects are influenced by government funding, development partner funding and economic growth.
e. Restructuring. Occassioned by the government's policy direction to reduce the wage bill, government of Uganda is undergoing a restructuring in which several agencies are being merged together or merged into mother ministries. As has recently been seen with Ministry of Energy, there are a number of positions at the Rural Electrification Agency (REA) that will not be assimilated into Ministry of Energy.
f. Funding. Except for manufacturing, most engineering work is funded by government. Lack of funding to government entities as such revealed by UNRA or suspension of funding by donor agencies will affect employment of engineers.

Q28. Social factors that influence market growth

The study sought to establish social factors that influence labour market growth in engineering. The study revealed the following:

e. Retirement policy; Government of Uganda employees retire at 60. However, in the engineering profession several retirees remain in the labour market to do consultancy work.
f. Gender inclusivity; There have been significant campaigns to have an inclusive work environment in the science and engineering field.
g. Imported Labour; It is generally easier to work in Uganda than any other East African country. The free movement of labour promoted by regional integration has also invited other nationals into the labour market.
h. Procurement Policy; For the longest time, the procurement policy did not provide any protection for local companies. Only recently has local content been emphasized especially in oil and gas procurement opportunities. As a result, the contruction industry has been dominated by Chinese contractors and hence affecting the engineering labour market.

Q29. Technical factors that influence market growth

The study revealed the following technical factors that influence labour market growth in Uganda.

d. Education and Training: Currently, several new qualifications are required by employers. The oil and gas sector is demanding several qualifications and skills not usually supplied by Ugandan training institutions and experience of which is not available in the country. This has resulted into expatriates taking up jobs.
e. Technological advancement: With regards to technology, the country relies heavily on imported technology. More and more tasks in the engineering profession are being influenced by technology. For instance, design engineers use computer aided design packages. Mechanical engineers rely on plant automation.
f. The supply of labour i.e. availability of engineering graduates is largely influenced by the number of training institutions passing out engineering graduates. CEDAT graduates on average about 320 engineering students every year, most of whom seek employment for the first time. Other universities such as Kyambogo University, Busitema University, Kampala International University, Ndejje University also graduate engineers. However, there are a number of constraints which institutions like CEDAT face. Top of the list is limited infrastructure and personnel. These constraints are further discussed in Section 3.9.

Q30a. Suggestions regarding review of curricula

The study asked respondents to make suggestions regarding current curricula for engineering programmes at the School of Engineering. The table below summarises the common opinions of respondents per engineering discipline.

Discipline	Suggestions to regarding review of curricula
Civil	**Review of curriculum process** • Engineering training should be aligned to the national development plan; • Post graduate programs should be based on industry specialization needs already captured in this study. • Make use of national manpower planning while determining student intake (admit numbers according to the needs of the market) **Nature of training delivery** • Emphasize student projects aimed at developing solutions to market or community needs such that products or solutions are marketable to relevant users and bankable (to build entrepreneurial skills , financial/ resource mobilisation and management); • Train students by application in actual projects; • Coordinate interaction of students with industry players to use infrastructure and resources such as laboratories, libraries • More emphasis on practical exposure of students by increasing more practical contact hours, bringing on board field experts as visiting/guest lecturers for some modules so that students are introduced to practical and market relevant knowledge and skills such as report writing and communication skills, computer literacy • Also attach students to various practicing engineers as mentors to support them throughout the programme • Make use of ongoing projects to provide practical teaching opportunities. For instance, the University should have contacted UNRA and requested for access to Kampala flyover, contractors and consultants to teach students about pile foundations at the time the foundation was being constructed.

Discipline	Suggestions to regarding review of curricula
	• Non engineering essentials should be emphasised e.g. the basic legal knowledge, entrepreneurship and job creation, marketing, budgeting and cost cutting, among others • There should be improved relationship between the industry and the training institutions. For instance, some of the challenges the market is facing should be sent to institutions for research and learning.
	Industrial Training • The University should structure the industrial training programme so that learning outcomes are specified when sending students out for industrial training. The Industrial training should be assessment against those outcomes. There should be more regular follow-up on student progression at industrial training. Should have an entry and exit with the supervisor where the student is adequately supervised weekly to check the learning of the student; allow for interactive feedback and report writing; • Consider 1 year attachment to a relevant organisation/industry as part of assessment for the award of the bachelor's degree similar to Medical School internship before being licensed. • structured industrial training; 1st year students work on construction site work similar to artisan, 2nd year constructions site or laboratory and do work similar to technician, 3rd year, student should work in design office • The University should lobby government to recognize private organisations that provide accredited industrial training opportunities. One such recognition may be to award points that can be used in a preferential evaluation for government tenders. • Collaborate with industry to integrate students into the large infrastructure projects done by foreign engineering firms e.g. EACOP, TotalEnergies **Programme Content** • Consider the use of MIDAS instead of AutoCAD for civil engineering drawing; • Introduce students to standards relevant to various fields e.g. standards in the oil and gas industry (Global and International Design Standards/ GIDS for retail sites, DEM for depot operations, American Petroleum Institute/ API standards, bulking standards, etc.) • Introduce basic law course; • Incorporate the following in civil engineering programme content: transport engineering principles, highway link design, traffic signals control, traffic modelling, pedestrianization, traffic management, protection mechanisms around water bodies and environmental changes; robotics, nano technology, automation; engineering drawing and interpretation and quantity surveying are sidelined and yet necessary in jobs, more emphasis in the practical aspects (design), principles of airport design, sustainability (recycling/re-use, circular economy), highways, structures, soils and materials, hydrology and drainage, transport economics. Inclusion of occupational health and safety practices • Chemical engineering in water treatment and supply • Some of the things (soft skills like communication skills) needed at the end come too early in the program, • CEDAT post graduate programmes should be reviewed. Acquiring an MSc at Makerere is difficult, putting many off. Some of the reasons are poor supervision, poor research topics, lack of scientific research in the programs meaning that the research is not useful to the market.

Discipline	Suggestions to regarding review of curricula
Electrical	**Review of curriculum process** • The school should collaborate with the private and government organizations and meet annually to come up with a research agenda containing the problems in the industry and tailor student training to solve those. • The curriculum should be designed in a problem-solving manner than empowering engineers with a lot of theory with little on practical skills **Nature of training delivery** • More practice drawing using CAD software • Collaborate and form partnerships with industry that have training schools e.g. UETCL, UMEME, HIMA to as to have industrial train some practical aspects and industrial demos for the students • Make projects more research and innovation oriented and training should be more projects-based instead of having only final year projects • Adopt duo-training where students are attached to industry throughout their period of study and mentored • Emphasis practical application of knowledge • Consider international partnerships with other universities especially for areas with no qualified lecturers e.g. nuclear energy • Collaborate (with MoUs) with industries that can provide the relevant exposure/integrated activities for more practical learning • Make the curriculum more hands on and practical by reducing the student to teacher ratio for more regular follow-up and mentorship. • The University should domesticate the courses to equip students with knowledge that can solve our local problems. **Industrial Training** • Reform industrial training. Compress the theories in the first three years and spare the fourth year for industrial training which is supervised regularly. The approach will make students to look for a good place to train from and concentrate more while there for it might an opportunity of them to be retained • Lobby government for a policy to have some projects implemented by CEDAT. These projects would provide practical training to both lecturers and students. • Industrial training should be designed in such a way the industry contributes to the assessment of the student to at least 60% extent and specify the capabilities the student has attained during the attachment, the other 40% of the assessment should be done by the University based on an agreed standard
	Programme Content • Include foundation knowledge of power automation programming • More emphasis on soft skills • Tailor courses to industry needs and emerging technologies (e.g. resource efficiency, environmental sustainability goals, regional cooperation- tariff uniformity, energy storage, floating solar plants, wind energy, hydrogel self-cooling solar panels, network planning and systems analysis, energy efficiency (energy loss reduction), electrical instrumentation (SCADA installation and commissioning, network performance monitoring), resource efficiency (energy losses reduction through optimized engineering designs and technology, smart metering technologies), power plant designs using software

Discipline	Suggestions to regarding review of curricula
	• Include nuclear energy course units and international partner countries visits • Practical understanding of modern technologies like motors and generators • Practical interaction with simulation systems and testing • Technical skills should target market needs e.g. new technology in engines (electronically driven) • integrate entrepreneurial/business skills e.g. developing BoQs, making quotations, use of LPOs, inventory management; • Incorporate technical drawing interpretation for various technologies e.g. electronic configurations, • Emphasise writing of field reports with relevant technical information • Standardisation should be introduced early in engineering programmes • Machine learning should now be a foundational course in electrical engineering
	Review of curriculum process • Before reviewing the current curricula, the university should make an assessment on what the course was intended to deliver to the students and how the lecturers are meeting the intended deliverable so as to confirm whether is the course content that needs to be changed or the methods of delivery. • The school should collaborate with the private and government organizations and meet annually to come up with a research agenda containing the problems in the industry and tailor student training to solve those. **Nature of training delivery** • Equip the students with more practical and marketable skills. Make the curriculum more hands on and practical by reducing the student to teacher ratio for more regular follow-up and mentorship • The students should be trained to apply the knowledge they acquire other than giving them a lot of theoretical concepts that can hardly solve the real-life engineering problems. The curricula should consider a method of a student identifying an engineering problem in the society and start solving it as early as second year and value addition accessed at every stage so as to produce engineers who can produce solutions or add value to the existing ones. • The school should deliver very engaging project based courses as they prompt student to carry out extensive research and learn more. • Lecturers should always be updated with the evolving technologies and draw examples from those and also form the biggest percentage of their lecture content.

Discipline	Suggestions to regarding review of curricula
Computer	• **Industrial Training** • Reform industrial training. Compress the theories in the first three years and spare the fourth year for industrial training which is supervised regularly. The approach will make students to look for a good place to train from and concentrate more while there for it might an opportunity of them to be retained **Programme Content** • Courses like artificial intelligence and data analytics, cloud computing and core storage infrastructure should be included. • Automation engineering, systems administration, backup policies and recovery strategies • Students should be introduced to machine learning technologies. • Engineering students should be trained in systems and control engineering
Telecom	**Nature of training delivery** • The universities should **collaborate** with the industry to align the important practical courses • Equip students with the relevant practical skills. • The curriculum should be designed in a problem-solving manner than empowering engineers with a lot of theory with little practical skills. • Close and clear mentorship programs to supervise the learning and guide students in their research. **Industrial Training** • The University should structure the industrial training programme so that learning outcomes are specified when sending students out for industrial training. The Industrial training should be assessment against those outcomes. There should be more regular follow-up on student progression at industrial training. Should have an entry and exit with the supervisor where the student is adequately supervised weekly to check the learning of the student; allow for interactive feedback and report writing • Lengthen industrial training duration **Programme Content** • Upgrade to teaching newer programming languages • Consider courses related to automation engineering, data analytics and artificial intelligence • Add practical courses to the curriculum in the field of aviation • Update curriculum to match the modern telecom technologies • Improve on the teaching soft skills and ICT as the world is now moving digital • Integrate financial technologies and skills with the curriculum to give engineers an exposure on how they can solve challenges in the economic world • Telecommunications engineers should be trained in control engineering systems as they have a wide range of applications across most of the engineering disciplines

Discipline	Suggestions to regarding review of curricula
Mechanical	**Nature of training delivery** • Practical interaction with maintenance procedures e.g. work orders/job cards, • Practical use of various workshop/laboratory tools • Hands-on maintenance especially with turbines, pumps; • Hands-on safety requirements in operation and maintenance of hydropower plants • Hands-on condition-based monitoring • Lecturers should take keen interest in acquainting themselves with the industry experience too in order to deliver more relevant course content • Collaboration with industries to provide some study kits (modern tools) to the university, obtain mentors for student, access to workshops and laboratories, exposure to modern technologies, opportunities to participate in project implementation and relevant research • Provide students with project-based assignments with a business view, to come up with solutions and/or products that are marketable • Train using demos and practical aids for students • collaborate (design MoUs) with industries that can provide the relevant exposure/integrated activities between classes and the market • Provide more time for students to practically interact with other systems outside the core so that they appreciate how the systems interact during design e.g. electrical systems, other building systems • Assessment of students should shift from the conventional mode of examination towards testing critical thinking and understanding of the key engineering systems • Solicit practitioners who would be willing to participate as visiting tutors for various modules • Collaborate with other universities to enhance capacity. For instance, Busitema is building capacity in marine engineering, the current market doesn't need specialisations but rather relevant exposure to modern systems as much as possible during the training to develop competences that can enable engineers fit in where the job opportunities are available.
	Industrial Training • Solicit funding to support attachment of students to various industries throughout the training • the University should aggressively solicit placements for students during industrial training so that the students can get relevant attachments • There is need for a change in attitude for both the student and supervisor to be keenly interested in what the student will achieve through the industrial training. A structure industrial training with learning outcomes should be developed. • The attitude of learners is generally becoming poorer and this has to be noted, therefore there is need to also emphasize professionalism to them and how they should conduct themselves at places of work. The University could consider 1 year of applied engagement in engineering field (industrial training) as a requirement for assessment of students before they graduate as engineers.

Discipline	Suggestions to regarding review of curricula
	Programme Content • Introduction to standardization and interaction with various standards and their applications e.g. standards in the oil and gas industry (Global and International Design Standards/ GIDS for retail sites, DEM for depot operations, American Petroleum Institute/API standards, bulking standards, etc • Focus more on engineering design, drawing and drawing interpretation • design review for cost optimisation related to generator wiring and installations • Technical skills should target market needs e.g. overhauling of mechanically driven engines (from small capacity to high capacity engines) • Integration of entrepreneurial skills e.g. developing BoQs, making quotations, use of LPOs, inventory management • Train report writing • Emphasis on design and development of specifications • Focus on applied mechanical engineering for all the key areas where mechanical engineers are employed i.e. interactions with design, specification development, installations, monitoring and evaluation of projects, troubleshooting, hands on repair and maintenance etc in areas such as marine, automobile equipment, construction equipment, air conditioning and refrigeration, oil and gas, industry and production, occupational safety and health etc;

Q30b. Suggestions regarding tools and equipment

The study asked respondents to make suggestions regarding tools and equipment for engineering programmes at the School of Engineering. The table below summarises the common opinions of respondents per engineering discipline.

Discipline	Responses
Civil	• Train students using the following modern design packages; Autodesk packages, etabs, Tekla, Prokon, Staad Pro, Epanet • The University should develop clear intellectual property (IP) policies to support innovators; • Improve laboratory facilities with modern equipment and retooled technicians to enhance practical engineering skills; • Embrace computer simulations for actual projects; • tag outputs to new laboratory equipment so that the results of enhanced laboratory capacity are demonstrable; • Establish a strong collaboration between the University and product testing centres to interact with state-of-the art laboratory equipment; • CEDAT labs should be equipped with modern machinery and laboratory space should be increased • Using digital tools to lecture and for assessment; • Use modern survey instruments

Discipline	Responses
Electrical	• Build medium and low voltage test bench with latest technologies • Frequent field visits • Modernise training lab • Purchase engineering software for teaching students (Licenses for educational purposes are usually subsidized or free). These include: Primavera, MS Projects, PSSE, load flow analysis software, simulation software like MATLAB, NX 8 CAE, Sim3D. Network planning and analysis software like Power Master, ArcMap, Power factory, Retic Master, CAAD, Bentley Power Map, PS CAAD, • Obtain diagnostic tools for various equipment, relevant software, teaching demos e.g. for different types of engines and other critical systems to help in troubleshooting, installations etc., hybrid teaching system to integrate the digital shift i.e. have smart/live class solutions to make teaching practical • Use the recent technology tools and equipment as well as simulation software. • Improve on the technology of the tools used through benchmarking with other universities in Africa.
Computer	• Acquire modern computer laboratory to enable students bring to reality what the student in theory. • The university should setup modern laboratories with the equipment needed to bring to reality the studied theoretical concepts. • More practical training with physical equipment not only simulators. • Acquire test servers for students to implement and test their systems. • Modern laboratories with equipment that can aid robotics engineering concepts. Close and clear mentorship programs to supervise the learning and guide students in their research. • Engineering students should be trained in systems and control engineering modules with a wider range of application in the engineering space. Use different simulators to design, implement and run these system and perform control engineering on them. • The university should purchase computer aided design software
Telecom	• Bring the physical equipment to class instead of using simulators alone to accomplish course work. • Improve on the technology of the tools used in school through benchmarking with other universities in Africa • Acquire modern laboratories with equipment that can aid robotics engineering concepts. • The university should set up actual test plants or advanced virtual labs.

Discipline	Responses
Mechanical	• Acquire and train students using the following software; LabVIEW, MATLAB, Solidworks • Focus on expand teaching labs, with relevant equipment and simulation facilities and ensure that labs are run by well-trained/retooled personnel; • Focus on solid modeling (CAD) to bring clarity to specifications; • Collaborate with manufacturers of various equipment to develop knowledge in use of relevant software e.g. software for sizing of pumps, etc. • Introduce diagnostic tools for various equipment • Adopt other training aids such as videos e.g. the University can collaborate with UNRA to access marine engineering training videos • There is need for robust laboratory infrastructure and this is an expensive investment e.g. for marine engineering training, the University should therefore explore partnerships to bridge these gaps such as sandwich programmes, collaboration with local laboratories/workshops under various organizations;

Q30c. Suggestions regarding career guidance

The study asked respondents to make suggestions regarding career guidance for students. The table below summarises the common opinions of respondents per engineering discipline.

Discipline	Suggestions regarding career guidance
Civil	• Mentorship should start right from the university i.e. each student should be attached to a mentor; • Collaborate with relevant organisations to hold career talks on the opportunities out there in order to shape their passion and direction; • Regularise and facilitate career tours e.g. now the oil and gas sector is developing and students need more exposure and interactions with the various sector players • University should hold career talks in secondary schools or have outreach programmes for secondary schools • Students often don't know what they want. They should be exposed to which specializations are marketable • Lobby for a more beneficial student membership with UIPE and ERB • Regularise graduate tracer studies and publish positive study findings Create a system to follow up on the engineers from entry to graduations to practitioner • Conduct regular labour market surveys and publish information for students
Electrical	• Regular industry visits • Encourage student membership with UIPE • Mentorship of students with practicing engineers, Mentorship should start right from the university i.e. each student should be attached to a mentor • Advise on specialization should be based on industry needs (regular Labour market survey and publication of results) • Encourage research partnerships with organisations

Computer	• Career guidance sessions should be given to students by experts in the engineering field for proper career management after school. • The university should reach out to primary and secondary schools • Should assign mentors to students. • Collaborate with industry to talk about different specialisations including aviation and emerging trends
Telecom	• Should assign mentors to students. • Collaborate with industry to talk about different specialisations including aviation and emerging trends
Mechanical	• Should assign mentors to students. • Career guidance should start early in the programme (during the second year) so that each student is guided more according to their key interests • Provide targeted career guidance to female students to encourage them to pursue the engineering profession and progress in it. This outreach should target female students right from primary schools

Q30d. Suggestions regarding readiness for world of work

The study asked respondents to make suggestions regarding readiness for the work environment. The text below summarises the common opinions of respondents.

- The University should look into creating a community for the students, helping students find work place by giving recommendations to industry players and creating relationship between university and companies/organizations, registering students with professional bodies
- Emphasis should be on demand driven research to enable the student to transition into the market place,
- University should encourage the students to be versatile since the market is volatile and changing and should be ready to apply themselves in multiple disciplines
- Guided Internship helps prepare students for work. There is need to improve on the internship system
- Work place ethics, professionalism and integrity should be taught in collaboration with UIPE and ERB
- The university should provide resources to train students on:
    - How to search of work
    - Inform students on specialisations required in different sectors Provide job openings and link industry to students
- Provide mentorship on completing application letters, preparing CVs, preparing for interviews,
- sitting interviews
- The university should also have a facility to handle mental health related issues
- The students should be encouraged to acquire more skills for instance in programming from online free websites.
- Train students on self-presentation and visibility on platforms like LinkedIn and twitter to market their skills.
- Promote and encourage students to engage in voluntary opportunities to acquire more technical/ practical skills.
- Sensitize students on the expectations of the employer and what employers pay for; emphasize ethics in engineering practice. This can be achieved by integrating a module on engineering in the world of work conducted as a requirement (may be in form of webinar series (not a course unit)

Other selected comments

The University should collaborate with UIPE and ERB to form a Technology Development Centre where engineers can be attached for say 6 months and assessed on their engineering capabilities, at the end of which they can be legally registered as responsible engineering professionals because the current requirement for an engineering project to register is not easy to meet for mechanical engineers (mechanical engineering projects are still scarce);
Collaborate with relevant industries/organisations to support students with final year projects that can be implemented, say over a two-year period after leaving the University. This could also contribute to professional registration with UIPE and ERB.
As CEDAT reviews its curriculum to produce more entreprenuers, the University should collaborate with industry to lobby for government policy that encourage growth of local companies e.g. access to cheap credit for business expansion to create more job, equitable tax incentive application for foreign and local companies, early retirement incentives to allow graduates take up jobs.

Makerere University College of Engineering, Design, Art and Technology (CEDAT)

P. O. Box 7062, Kampala, Uganda
Tel: +256 414 545029
Email: cedat.soe@mak.ac.ug
Website: www.cedat.mak.ac.ug
Facebook: MakerereCEDAT
Twitter: MakerereCEDAT - soe@x