UGANDA ENGINEERS REGISTRATION BOARD

ERB

For Engineering Excellence

ENGINEERS CENSUS REPORT

NOVEMBER

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EXECUTIVE SUMMARY

This report is informed by analysis of data from two major complementary sources that were utilized through a method of triangulation – that is, a census of engineers, and national labour force data, as well as other secondary data from MDAs and Universities.

The data reveals that the total engineering workforce size in Uganda is about 33,021 engineers, and the average rate of production or supply of engineers (engineering graduates) is about 1,500 engineers per annum (considering the past 6 years). The socio-demographics from this census report shows that the male is predominant in the engineering workforce, and engineers' age distribution shows that the engineering field is in sync with Uganda's demographic profile. The predominant engineering field is civil engineering – constituting more than half of the engineers, followed by electrical and mechanical engineering. The data also shows that the number of other engineering related professionals or workforce (e.g., technicians, artisans, or craftsmen) is higher than that of the graduate or core engineering workforce by more than seven-fold. There is consistency in most of engineers distribution parameters of the triangulated data, as seen through the comparison of the primary i.e., census and national labour force statistics; the two data sources reveal consistent distribution in specialty, education, age, gender, and geography. A total population of 3,321 engineers were found from engineering workforce data compiled from 22 key institutions that employ engineers in relatively larger numbers, and out of these, 1,840 were engineers with bachelor's degree and above (i.e., graduate engineers), and the rest are technicians or technologists (diploma holders).

The rate of engineers' registration is low, and among others, the major factors that explain the low rate of registration are- lack of knowledge about the registration procedure, and cumbersomeness of the process. Additionally, the major challenges to engineers' operations are - inadequate remuneration, lack of employment including contracts especially for the locals, inadequacy of infrastructure, poor prospects for career advancement, and risky or unsafe work environment among others.

Initial efforts aimed at contributing to the estimation of the Engineering Index (EI) indicates that the index reduces with a stricter science and math performance threshold under the labour force dimension of the EI, due to low level of performance in sciences and math as sub-categories of the labour force dimension of the EI. It is important that higher sciences and math performance standards is emphasized by policy, to ensure there is mastery and high level of knowledge of the subject matter as foundational elements for building stronger engineering capability in the country.

Deliberate interventions should address the challenge of low engineer registration rate, and the engineers' census will play a critical role in this. Given the census findings allude to the fact that the population of engineers in the country is high (33,021), and the number of artisans or craftsmen is higher than that of core engineers, having in place a strong regulatory mechanism to ensure and maintain standards in the industry is critical.

Lastly, this report has highlighted some deficiencies associated with the data used – i.e., the data from the engineers' census, and the national labour force data. Accordingly, more feasible approaches for censuses need to be considered with the aim of generating reliable census data. The options involve use of mixed approaches to carry out full censuses in future, and considerations for a feasible scope – for example by only focusing on the priority fields or sectors identified in the current ERB strategic plan (i.e., Public Service, ICT, Engineering Firms, and Contractors). Focusing on the priority areas can help to ensure complete coverage of the engineers in a census, in an economical manner. The mixed approaches entail the use of physical interviews with provisions for wider coverage, telephonic interviews, and continuous triangulation with data from UBOS, as well as creation of a digital engineers' database that is hosted at ERB. The report highlights the key census methodological steps that can be undertaken.

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LIST OF ACRONYMS

EI	–	Engineering Index
ERB	–	Engineers Registration Board
GDP	–	Gross Domestic Product
GECR	–	Global Engineering Capability Review
GRAMS	–	Global Research Administration and Management Services
MDAs	–	Ministries, Departments and Agencies
NDP	–	National Development Plan
ICT	–	Information Communication & Technology
ILO	–	International Labour Organization
ISCO	–	International Standard Classification of Occupations
ODK	–	Open Data Kit
RAE	–	Royal Academy of Engineering
UACE	–	Uganda National Examinations Board
UBOS	–	Uganda Bureau of Statistics
UIPE	–	Uganda Institute of Professional Engineers
UNEB	–	Uganda National Examinations Board
FY	–	Financial Year

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1.0 CHAPTER ONE: INTRODUCTION

The engineering sector plays a vital role in the economy, with great potential to facilitate economic growth and development – it is considered an important vehicle for economic and social development (Cebr & RAE, 2016). The sector's contribution should not be looked at merely in the form of buildings and bridges, it traverses enhancements in renewable energy technologies and solutions through to global health challenges- all these are critical aspects of the economy (ibid). The Royal Academy of Engineering has demonstrated that the channels through which the engineering sector fosters growth of the economy or improved Gross Domestic Product (GDP) are multifaceted, spanning from infrastructural investments such as digital infrastructure, transport, bridges, energy, water for production and dams, communication, waste management, and water supply and sanitation. Driven by engineering, developing transport and communications systems or infrastructure facilitates movement of goods and services to the markets as well as linkage of workers to the job market. It also enhances the facilitation of business processes and decisions via well-established communication infrastructure.

Engineering censuses are a popular tool for providing up-to-date and detailed dynamics of the engineering industry and its current workforce. It provides invaluable and contemporary industry data that is paramount for responding to the needs of engineers, addressing engineering skills needs, and generally for guiding policy discussions for the development of the sector (Blumenthal & Fantini, 2021). By getting a better understanding of engineering workforce size and demographics, policy makers get to- understand trends better, and make informed decisions to address skills gaps, effectively regulate the industry, and also identify opportunities for strengthening the sector or generally plan for the future of the sector including the engineers working in the sector (*ibid*).

In Uganda, the statutory regulator of the engineering sector is the Engineers Registration Board (ERB). The board was 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. Accordingly, the function of the Board is to regulate and control engineers and their activities in the country, and to advise Government in relation thereto. It has wide ranging powers to register, deregister, restore registration, suspend registration, hold inquiries, hear appeals, and appear as respondents against a case brought against it in the High Court.

The current ERB Strategic Plan (FY 2020/2021 – 2024/25), which is themed "Improved and well-regulated engineering services for National development" clearly states that "at the moment registration rates are far below the rate of engineers entering the market". Most of the engineers, including their capabilities, are therefore not known. This greatly compromises the efforts to regulate the engineering services – the popular adage in measurement goes – "what you cannot measure, you cannot control or regulate".

Efforts towards generating research-based information about the engineers in the country are therefore paramount in providing detailed understanding of the engineering workforce in the country. This is also useful for generating insights that can guide the interventions targeting engineers' registration, and engineers' censuses are of vital importance in this.

In particular, according to the second strategic objective of the current ERB strategic plan, there is a deliberate intent to increase the rate of registration of engineering professionals and firms in the country (ERB, 2020). Overall, this is expected to facilitate effective regulation of the sector. To achieve this, the government, through ERB, has prioritized carrying out the Engineers' Census as one of the key strategic interventions. According to the plan, key priority areas within the engineering field were identified to be covered in the census. These are; Public Service, ICT, Engineering Consultancy Firms, and Contractors. This is seen as a key tool for aiding the development and implementation of an action plan for registration of the engineers, especially in the identified areas or sectors.

Against this background, the Engineers Registration Board commissioned an engineers' census to generate data that would help in understanding nuances about engineers in the country including the population of engineers, as well as determine the Engineering Index (EI) for Uganda- a measure of the country's ability to conduct key engineering activities in a safe and innovative way. This report therefore provides insights from an engineers' census conducted this year and estimates the EI which is measured across six categories (as detailed in the methodology), but with emphasis on performance in sciences and math under the labour force dimension of the EI.

From the policy stance, the engineers' census offers valuable insights on the overall population and profiles of engineers in the country, to aid planning and policy decisions for the engineering sector. It is also envisaged that the information generated from the census will further the understanding of engineering strengths or capability and weaknesses and skills for safety priorities in the country. Therefore, through the census, information pertinent to policy makers to enhance domestic engineering capability and capacity is furnished. The insights help in understanding the country's engineering capability and capacity gaps, which policy makers can make use of in crafting interventions to address specific engineering capability issues.

Particularly in regard to Uganda's development planning framework, generation of disaggregated data on Engineers is essential for informing and influencing policy on national development, where 12 of the 18 programs in the current National Development Plan (NDP III) are Engineer-led and Engineer-driven.

1.1 Objectives of the Engineers' Census

The general objective of the census is to provide detailed understanding of the engineers and engineering capability in Uganda. The specific objectives are to:

i. Carry out a census of engineers in Uganda.
ii. Develop a methodology for censuses in the future (a methodology that should deliver rapid, accurate and regular censuses).
iii. Collect data on relevant indicators to determine the Engineering Index for Uganda FY 2022/2023.

The rest of the report is organized as follow; chapter two is the engineering census methodology that was adopted to generate data on engineers in the country, and chapter three presents the findings of the census, as well as information on the supply of engineers through the University system in the country. The last chapter is conclusion and recommendations.

2.0 CHAPTER TWO: METHODOLOGY

This section of the report discusses the methods used to carry out the engineers' census exercise. These include the data sources, coverage or scope, and the approaches used in the analysis of the data.

2.1 The Data Sources and Collection Methods

The report utilized two sources of data to address the objectives of the engineers' census as presented below.

2.1.1 Primary Data Collected from Engineers

The first is primary data that was collected covering 4,522 engineers across the country. The primary data for the census was collected through electronic methods of data collation, using a combination of the Open Data Kit (ODK) implemented through use of tablets for conducting face-to-face interviews with the engineers, and online survey through the Google forms survey tool. In addition, phone-based interviews were conducted. All the three methods (ODK, Google forms, and phone interviews) used the same questionnaire of the engineers' census.

The primary data collection was aimed at capturing key details of the engineers in the country that cannot be found in existing data – for example their contacts, the conditions under which engineers are working (e.g., availability of infrastructure), registration status with engineering authority and factors affecting registration, challenges being faced by engineers in the labour market as well as their operation among others. The aim was to enumerate all the engineers in the entire country.

As stated above, the target of the primary data collection was to cover all the engineers in the country in all the four regions. However, due to operational budget constraint, we managed to only cover 4,522 engineers. The budget constrain could not allow the enumerators to reach more engineers in all parts of the country. We relied majorly on phone calls to reach out to the Engineers, particularly using a list of engineers that was provided by ERB. Physical interviews were also conducted, however, a larger and/or sufficient coverage beyond the physical interviews carried out was not plausible due to the budget (financial) limitations.

Because of the budget constraints faced in reaching out to more engineers beyond the list provided by ERB, and therefore owing to the fact that there is a high likelihood of the number of engineers reached being below the target coverage of the census as well as the expected number of engineers in the country, we obtained complementary secondary data that was used to triangulate the findings of the census. The complementary secondary data is discussed below.

2.1.2 National Labour Force Data

The national labour force data was used to triangulate or complement the data obtained from the engineers' census. It was necessary to complement the census data, given the associated limitations highlighted above.

Because of the limited coverage of the census, it was imperative that an alternative data source is used in order to provide an indication of the estimate of the overall or total population of the engineers in the country based on the most plausible recent data that is nationally representative.

The national labour force data provides an opportunity to do this. However, the challenge with using the national labour force survey data is that the survey was not designed specifically to capture detailed data on engineers in the country. It is very broad, and captures the entire work force situation in the country, beyond the scope suitable for capturing only engineers. This implies that although this alternative data can allow us to estimate the total population of engineers in the country, there are numerous issues of interest in the engineers' census that are not captured in it. This therefore necessitates planning for a more feasible approach for conducting the engineers' census in future.

The national labour force data used in this report is from the latest National Labour Force Survey (NLFS) conducted by the Uganda Bureau of Statistics – see details about the NLFS and its methodology in the NLFS 2021 report by UBOS (2022). We extracted data from the report and performed analysis to arrive at estimates for the engineers in the country.

The survey follows the methods, concepts, and definitions of the 20th International Conference of Labour Statisticians (UBOS, 2021). It uses a multistage cluster sampling design through selection of Enumeration Areas (EAs) and selection of household in each EA, based on the 2014 National Population and Housing Census as the sampling frame (*ibid*). A total of 11,000 households were covered, and according to UBOS, this is representative of the population living in Uganda (UBOS, 2021), and thus by extracting the engineering work force from it can yield engineering workforce statistics that is representative of the overall number of engineers at national level.

In the triangulation of the data, we used estimations based on survey weights in order to generate the total number of engineers in the country based under the different engineering categories or professionals derived or guided through the classification of engineering profession – the International Standard Classification of Occupations (ISCO) – i.e., ISO-08. The ISCO framework was developed by the International Labour Organization (ILO).

Other sources of secondary data include databases and documents that were reviewed – for example, the ERB database for registration of engineers, the NLFS 2021 report, NDPIII, the current ERB strategic plan (2020/21-2024/25), Engineering Registration Act, and the ILO ISCO classification and coding system. Data was also obtained from engineering workforce databases of 22 selected Ministries, Departments and Agencies (MDAs) and other key institutions whose core activities involve engagement of engineers (e.g., Ministry of Works and Transport, National Water & Sewerage Corporation - NWSC, Uganda National Roads Authority, Umeme, and UPDF among others). These are institutions that employ relatively the largest number of engineers in the country. It is important to note that data from NWSC is not complete because it only captures engineers with membership in Uganda Institute of Professional Engineers (UIPE): a complete data set received after analysis is attached in the appendices (5). Lastly, data on the supply of engineers through the university system is obtained from university graduation databases for a total of 7 public and private universities in Uganda – i.e., Makerere University, Kyambogo University, Mbarara University of Science and Technology, Gulu University, Busitema University, Kabale University, and Ndejje University. The readily available data from the Universities cover the period 2017 to date, however, data for the current year (2023) is not complete because some Universities had not yet conducted graduation at the time the data was accessed.

2.2 Data Analysis

The data from the engineers' census was transmitted from the ODK and Google forms into a central data processing server hosted by GRAMS. Data from both the engineers' census and the national labour force data were processed and analysis was conducted through STATA statistical software.

The data analysis majorly followed use of descriptive statistics, including cross tabulations, graphical analysis, and computation of standard descriptive statistical parameters. For the case of the national labour force data, we made use of survey statistical analytical approach based on application of survey weights to ensure that the statistics generated are representative of engineering workforce in Uganda.

Based on the ISCO coding system, the engineering workforce captured in the national labour force data was categorized into two. The first is core engineering professionals or workforce. This captures mainstream engineering professionals such as; civil engineers, mechanical engineers, and telecommunications engineers. The rest (i.e., other engineering related workforce) are mainly comprised of technicians and mechanics – these include; engineering technicians in the different disciplines or fields of engineering, mechanics, fitters, civil engineering technicians, civil engineering labourers, and servicers among others.

The data from engineering workforce databases of MDAs was summarized by computing the total number of engineers, and further disaggregated by gender and engineering field of specialty, as well as by qualification.

2.2.1 The Engineering Index

The report adopts the framework developed by the Global Engineering Capability Review (GECR) – see GECR (2019)[1], for measuring the Engineering Index (EI). The EI is defined as a measure of the extent to which a country or countries are able to conduct engineering activities in a safe and innovative way (GECR, 2019). The EI is a tool used to help understand the factors that determine overall engineering capability across countries.

According to the framework, there are six key dimensions that are considered in the estimation of the EI. These are – knowledge, labour force, engineering industry, infrastructure, digital infrastructure, and safety standards. The detailed description of each of the six EI dimensions is in the table below (Table 1). Although this report highlights four dimensions based on data availability, emphasis was placed on the performance in science and mathematics (math) among 15-year-olds

[1] **https://reports.raeng.org.uk/global-engineering-capability-review/what-is-the-engineering-index-2019/**

under the labour force dimension. One of the weaknesses is that the standard EI measurement framework emphasizes use of performance metrics by 15-year-olds in sciences and math, however, the reality is that in Uganda, there are some students who sit for UACE examinations when they are above 15 years. Therefore, we do not use a very strict definition attached to the 15-years. We consider UACE results, which may capture science and math results even for those slightly above the 15-year mark. However, most graduates of UACE do not have very large variations with the 15-year-old mark.

In this version of the report, the data available enabled inclusion of four dimensions, although focus is placed on the labour force dimension. The first, which is the dimension of focus, is labour force. This is measured based on mean performance in sciences and math among 15-year-olds. We rely on the latest results from Uganda National Examinations Board (UNEB) to capture this, based on UACE results (UNEB, 2023). According to UNEB, performance is measured based on two key categories of grades – grade A, which is the best performance in a subject, depicting the highest level of knowledge of the subject matter. Another category is A-E, depicting principal level pass. Beyond E, it is categorized as failure. We account for both A and A-E grades for sciences and math, to compute the EI, hence two EI statistics depending on the performance level in sciences and math.

The rest of the dimensions highlighted in this report (depending on data availability) are infrastructure, digital infrastructure, and safety standards. The data for these dimensions come from the data collected from the engineers' census. To compute the EI, scores of 0-100 are assigned to each of the dimensions. Since each dimension has more than one indicator, we use average scores for each, and later on compute the overall mean score for all dimensions, which also ranges between 0 and 100. We assume equal weight for each of the dimensions. Since the emphasis in this report is on the mean performance in sciences and math, we do not delve much into discussions of the overall EI. We instead focus on discussing how the science and math component affects the EI.

Table 1: Dimensions of Engineering Index

Dimension of Engineering Index	Description
Knowledge	This measures the contribution to and advancement of knowledge in engineering and technology. This can be captured through the H-Index.
Labour force	This is measured through the availability and diversity of engineers in the economy.
Engineering industry	This captures the strength and sophistication of the engineering industry.
Infrastructure	This captures the ability of infrastructure to support and demonstrate engineering activities. In this study, we consider energy, telecommunication, and water supply infrastructure.
Digital infrastructure	This captures the ability of digital infrastructure to support and demonstrate engineering activities.
Safety standards	This captures safety in engineering- intensive sectors

Source: Compiled based on the Engineering Index framework by GECR (2019).

3.0 CHAPTER THREE: FINDINGS FROM THE ENGINEERS' CENSUS

This section presents the findings of the report based on two main bodies of data viz - the engineers' census, and the national labour force data. The engineers' census captures data on 4,522 Engineers across the country, with some unique data elements that are not captured elsewhere. Results from the national labour force data triangulates the Engineers' census data by providing the national picture of the Engineering profession or work in the country. By applying weights to the national labour force data, we generate information that is nationally representative of the Engineers working in Uganda, and hence derive estimates for the total population of engineers in the country in order to guide planning and policy, as well as future censuses.

Information generated from analysis of the data from the Engineers' census – also referred to as surveyed engineers in the report[2] provides indicative insights for stimulating policy discourse on the Engineering workforce in the country. It also illustrates what the realities are, for carrying out the engineers' census in Uganda. Meanwhile the information from the national labour force data provides the overall picture of the Engineering work force at national level, which complements the data and analysis of the engineers' census.

The section begins with the socio-demographic characteristics of the surveyed Engineers (i.e., the engineers covered/interviewed during the census, and subsequently presents Engineers' fields of training reported in the census, Engineers' field of work, current status of employment, and registration status with ERB. These are triangulated with the national labour force data which we have used to provide the overall idea about national level Engineers' situation including estimates of the total number of Engineers in the country. The last part of the section discusses challenges faced in the Engineering field and highlights the key dimensions of the EI with focus on the labour force aspect.

3.1 Socio-demographic Characteristics of Engineering Professionals: Insights from the Engineers' Census

As shown in Table 2, majority of the Engineers (close to 100%) are Ugandans by nationality. The average age of the engineers is 36 years, with the youngest and eldest being 19 years and 88 years respectively. The Engineers are relatively young, and this age distribution shows that the Engineering field is in sync with Uganda's demographic profile, where the majority of the population is young.

Most Engineers are associated with operating in urban and peri-urban areas (over 80%), and there is a male domination of the Engineering profession – 87% are male, compared to only 13% female.

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[2] **NOTE: As pointed out earlier under the methodology section, in this report, especially the section on presentation and discussion of results, we use the phrase "surveyed engineers'" to mean the same thing as the first phase of the engineers' census. The phrase "surveyed engineers" is used because the first phase of the engineers' census was not a full coverage of the engineers in the country. Full coverage will be attained when the implementation and analysis of the second phase of engineers' census is completed.**

Lastly, pertaining to education, most of the Engineering professionals surveyed have attained Bachelor's degree – about 60%, and master's degree – 20%, and diploma (12%).

Table 2: Socio-Demographic Characteristics of the Engineering Professionals

Main attribute	Descriptor	Statistics
Nationality	Ugandan, %	99.29
	Non-Ugandan, %	0.71
	N (observations)	4,522
Age	Mean	36
	Median	33
	Min.	19
	Max.	88
Location of work	Rural	15.88
	Urban	64.46
	Peri-urban	17.56
	NA	2.1
	N (observations)	4,522
Gender	Female, %	13.36
	Male, %	86.64
	N (observations)	4,522
Education	Certificate, %	1.55
	Diploma, %	12.25
	Bachelor's degree, %	59.73
	Master's degree, %	19.75
	Post-Graduate Diploma, %	5.42
	Doctorate, %	1.30
	N (observations)	4,522

Source: Author's calculations based on data from the 2023 Engineers' census

3.2 Engineering Specialty

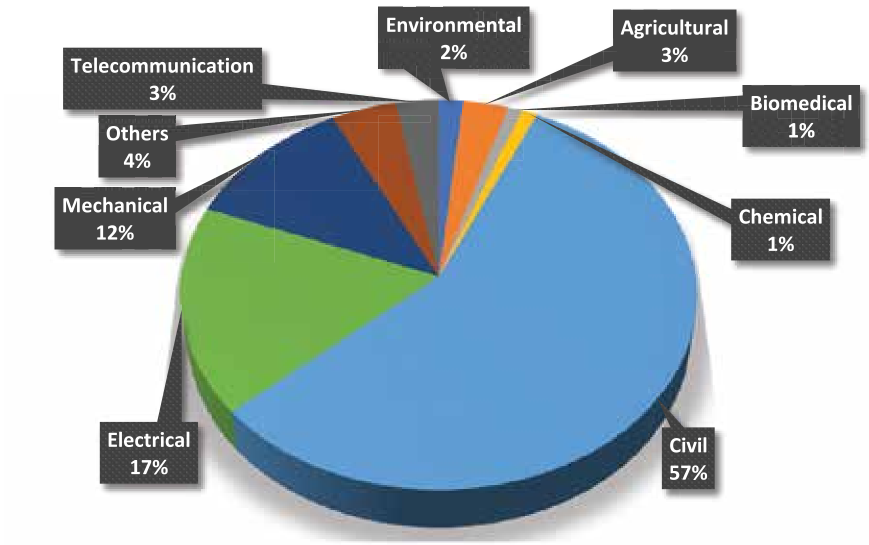
This sub-section discusses specialty in the field of training of the engineers interviewed during the census. The sub-section also presents specialty in terms of the fields of practice of the engineers.

3.2.1 Specialty in Training of Engineering Professionals

Overall, the majority of the interviewed respondents (engineering professionals) are reportedly trained in Civil Engineering (57%), followed by electrical and mechanical engineering – 17% and 12% respectively (Figure 1).

The fields of training having relatively more female include biomedical engineering (27%), environmental engineering (26%), and telecommunication engineering (23%). The results show that civil engineering is the field with the most training. Among both female and male, civil engineering was the most prominent field in which training is reported – 53% and 57% for female and male respectively. This is followed by electrical engineering which was reported as a field of training by 16% and 18% of the females and males respectively. Overall, the least training is observed in the fields of biomedical and chemical engineering. Among the females, the least reported field of training was chemical engineering (1%), and among the male was biomedical engineering (0.84%) – details are summarized in Table 3 and Figure 1.

Figure 1: Engineering Fields (Specialty) of Training



Source: Author’s calculation using the 2023 Engineers’ census data

Table 3: Distribution of Engineering Specialty (Field of Training) by Gender

		Environmental	Agricultural	Biomedical	Chemical	Civil	Electrical	Mechanical	Others	Telecommunication	Total
		Proportion of male and female - cross tabulation by column									
Female	%	25.68	15.83	27.27	16.67	12.60	12.45	9.75	21.61	22.56	13.44
Male	%	74.32	84.17	72.73	83.33	87.40	87.55	90.25	78.39	77.44	86.56
	N	74	139	44	48	2,548	779	523	199	133	4,487
Cross tabulation by row											
Female	N	19	22	12	8	321	97	51	43	30	603
	%	3.15	3.65	1.99	1.33	53.23	16.09	8.46	7.13	4.98	100
Male	N	55	117	32	40	2,227	682	472	156	103	3,884
	%	1.42	3.01	0.82	1.03	57.34	17.56	12.15	4.02	2.65	100
All	N	74	139	44	48	2,548	779	523	199	133	4,487
	%	1.65	3.10	0.98	1.07	56.79	17.36	11.66	4.44	2.96	100

Source: Author's calculation using the 2023 Engineers' census data

3.2.2 Specialty in Practice – Sectoral Perspective

Pertaining to the field of work, most of the surveyed or interviewed engineers reported that they are practicing engineering in the construction (23%), energy (11%) and general engineering (9%) sectors, followed by consultancies (8%), as illustrated in the table below – see statistics in Table 4. All these are dominated by the males compared to females – i.e., 89%, 85%, 90%, and 86% in construction, energy, general engineering, and consulting (Table 4). Similarly, the males are as well predominant in the rest of the sectors – both public and private, as shown in Table 4.

Compared to all the sectors, telecommunication has the highest proportion of female engineers (27%). This is followed by medical (19%), education (18%), and aviation (18%) – Table 4, panel B. However, among the females, the construction and energy sectors have the highest proportions – 18% and 12% respectively. A similar distribution is observed among the male, whereby 24% and 11% of the males are engaged in the construction and energy sectors respectively – Table 4, panel C.

Table 4: Distribution of Engineering specialty by Field / Sector of Work and Gender

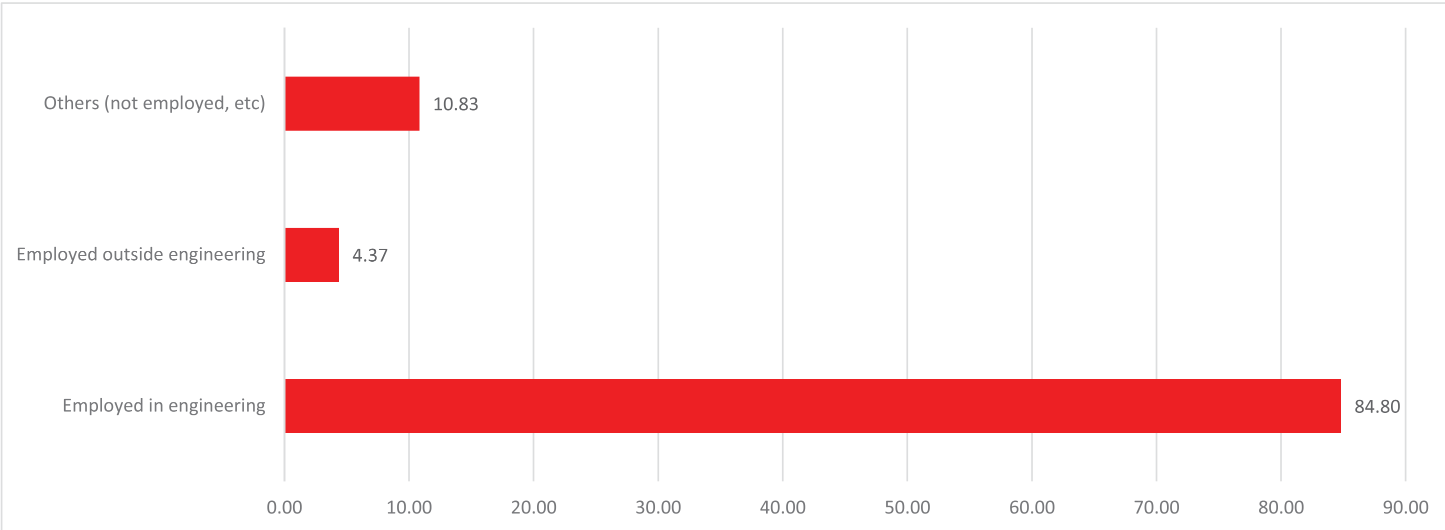
		Armed Force	Aviation	Banking	Construction	Consulting	Not working currently	Education	Energy	General Engineering	Govt Ministries	Loc Govt	Manufacturing	Mechanical	Medical	Oil & Gas	Printing	Qual. Assurance	Road construction	Tech	Telco	Water	Total
Overall distribution by field/sector of work: A																							
All (N=4,522)	%	1.24	1.26	0.35	22.84	8.25	4.16	3.14	10.75	8.93	3.91	4.6	4.98	1.77	1.15	2.61	0.09	1.06	7.83	1.48	1.95	7.65	100
Proportion of male and female - cross tabulation by column: B																							
Female	%	7.14	17.54	0	10.65	13.67	26.06	17.61	14.61	9.9	15.82	10.58	8.89	12.5	19.23	12.71	0	16.67	13.56	14.93	27.27	14.16	
Male	%	92.86	82.46	100	89.35	86.33	73.94	82.39	85.39	90.1	84.18	89.42	91.11	87.5	80.77	87.29	100	83.33	86.44	85.07	72.73	85.84	
	N	56	57	16	1,033	373	188	142	486	404	177	208	225	80	52	118	4	48	354	67	88	346	4,522
Cross tabulation by row: C																							
Female	N	4	10	0	110	51	49	25	71	40	28	22	20	10	10	15	0	8	48	10	24	49	
	%	0.66	1.66	0	18.21	8.44	8.11	4.14	11.75	6.62	4.64	3.64	3.31	1.66	1.66	2.48	0	1.32	7.95	1.66	3.97	8.11	
Male	N	52	47	16	923	322	139	117	415	364	149	186	205	70	42	103	4	40	306	57	64	297	
	%	1.33	1.2	0.41	23.56	8	3.55	2.99	10.59	9.29	3.8	4.75	5.23	1.79	1.07	2.63	0.1	1.02	7.81	1.45	1.63	7.58	
All	N	56	57	16	1,033	373	188	142	486	404	177	208	225	80	52	118	4	48	354	67	88	346	4,522
	%	1.24	1.26	0.35	22.84	8	4.16	3.14	10.75	8.93	3.91	4.6	4.98	1.77	1.15	2.61	0.09	1.06	7.83	1.48	1.95	7.65	100

Source: Author's calculation using the 2023 Engineers' census data

3.3 Employment Status and Experience of Engineering Professionals

The data reveals that most of the interviewed engineering professionals (85%) are employed within the engineering field (Figure 2), signaling minimal cases of mismatch between jobs and the training of the engineering professionals. Those who are employed outside the field of engineering are only 4%- these could be associated with cases of inadequacy of jobs in the field, or due to other challenges faced by engineering professionals in the labour market – some of the key challenges are discussed in a subsequent section of this report.

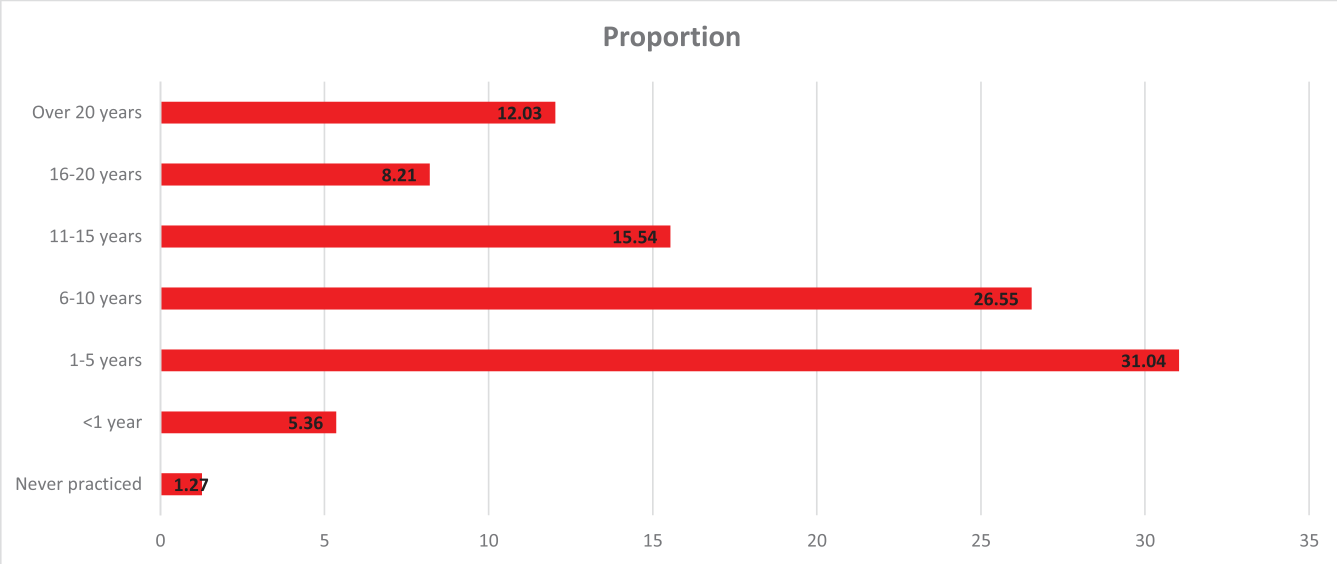
Figure 2: Current Employment Status, %



Source: Author's calculation using the 2023 Engineers' census data (N=4,487)

The majority of those who are employed have work experience of utmost 5 years (Figure 3). Those with the highest level of experience (at least 20 years) comprise 12%. Accordingly, most of the engineers in the labour market are young, with minimal or mid-level amount of engineering experience. This is consistent with the age distribution of the surveyed engineers; however, it may present a challenge of inadequate extensively experienced Engineers who can provide mentorship or in-field training of the young Engineers.

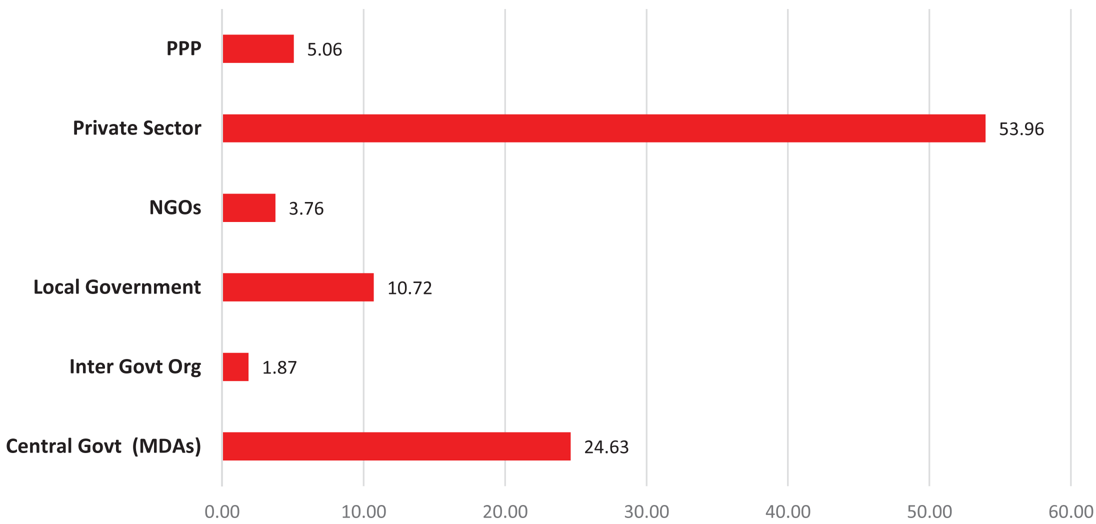
Figure 3: Engineering Professional's Years of Experience, %.



Source: Author's calculation using the 2023 Engineers' census data (N=4,407)

The census evidence shows that the majority of the Engineers (more than half) are employed in the private sector. Specifically, based on responses on the type of organizations or institutional arrangements where the Engineers are employed, the findings reveal that the private sector employs 54%, followed by the public sector (35). In the public sector, the central government or Ministries, Departments and Agencies (MDAs) employ the largest fraction of the Engineers (24.63%), meanwhile the local government employs 10.72%- Figure 4. The rest are employed in Public-Private-Partnership institutional arrangements (5%), Non-Governmental Organizations (11%), and intergovernmental organizations such as the United Nations (UN) agencies (1.87%).

Figure 4: Type of Institutional Arrangement, %



Source: Author's calculation using the 2023 Engineers' census data (N=4,385)

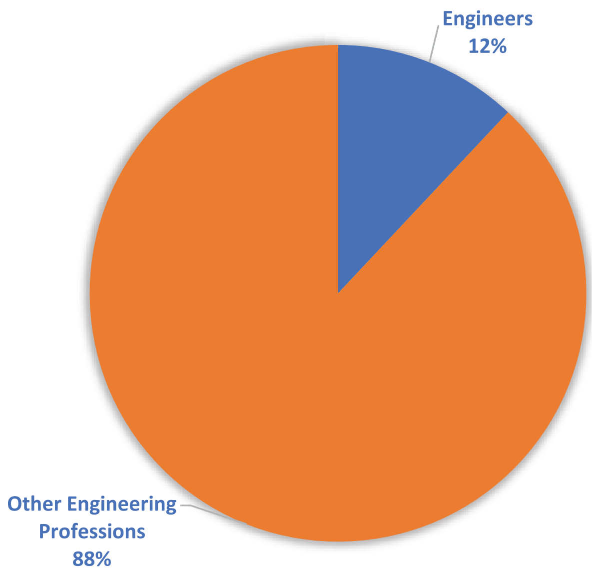
3.4 Insights from Analysis of National Labor Force Data

This section of the report encapsulates results from the analysis of Uganda's national labour force data. As mentioned earlier, the statistics generated from this analysis provides a nationally representative set of results at the population level of the Engineering workforce in Uganda. The population level results therefore offer insights into the overall distribution and number of the engineering workforce in the country.

3.4.1 Overall Distribution of Engineering Professionals

According to the findings, the total estimate of the number of all engineering related professionals – i.e., considering core engineering work or professionals (graduate engineers) and other engineering related work or professionals in Uganda is 274,275 – the details are captured in the next sub-section as well as Tables 5 and 6. Out of these, the core engineering professionals (graduate engineers rather than artisans) comprise only 12%, and the majority (88%) are in the category of other engineering related work/professionals (Figure 5). Expectedly, the category of other engineering related work/professionals are the majority. This is primarily a junior component (most of them are artisans or craftsmen) of the engineering workforce that work under the guidance of the core engineers in the design, installation, implementation, and maintenance of various engineering systems – for example engineering technicians in the different disciplines or fields of engineering, mechanics, fitters, civil engineering labourers, and servicers among others.

Figure 5: Proportion of Core and Other Engineering Related Work / Professionals, %



Source: Author's computation using the data extracted from National Labour Force report (weighted N=274,276)

3.4.2 The Core (Graduate) Engineering and Other Engineering Related Professionals

The core engineering professionals or graduate engineers constitute about 33,021 as shown in Table 5. From the results in Table 5, the largest proportion of core engineers comprises civil engineers (55.76%), representing about 18,414. Others are mechanical engineers that constitute about 1.23% (representing 406), telecommunications engineers (9.84%) which is an equivalence of about 3,250, and marine engineers (7.49%) – representing 2,474 engineers. The rest (others) constitute 25.67%- about 8,477. We are cognizant that electrical engineers could not have been effectively captured in the national labour force data. This is why it is missing as part of the core engineering workforce discussed using the statistics in Table 5. There is a possibility that the data on electrical engineers was captured as part of "other engineering related work force" under ISCO classification such as- electrical engineering technicians, building and related electricians, and electrical mechanics. In this report, we present these and the rest of the engineering related work force together in Table 6.

Table 5: Core Engineering Professionals, by ISCO Coding

ISCO category	ISCO code	Freq.	Percent
Civil engineers	2142	18,414	55.76
Mechanical engineers	2144	406	1.23
Telecommunications engineers	2153	3,250	9.84
Marine (ships') engineers	3151	2,474	7.49
Others[3]	-	8,477	25.67
Total	**-**	**33,021**	**100**

Source: Author's calculations from the data extracted from National Labour Force report of 2021.
NOTE: Core engineers is majorly composed of graduate engineers.

The next category, which makes up other engineering related works or professionals is comprised of a workforce of 241,255 (Table 6). In practice, this is the junior component of the engineering workforce, constituting labourers who work under direction or guidance of the core or qualified engineers – they are primarily artisans or craftsmen. These are more than the main or core engineering workforce by more than seven times. This suggests the need for an effective regulatory mechanism to maintain standards in the industry.

The most predominant engineering artisan-like (or craftsman) workforce here are Motor vehicle mechanics and repairers (44.7%), Electrical mechanics and fitters (15.46%), Roofers (7.31%), and Plumbers and pipe fitters (7.11%). Others are- Electronics mechanics and servicers (4.06%), civil engineering technicians (3.46%), Electrical engineering technicians (2.59%), Construction

[3] Includes Architectural and Surveying.

supervisors (1.75%), Mechanical engineering technicians (1.64%), Electronics engineering technicians (1.11%), Chemical and physical science technicians (0.28%), Air conditioning and refrigeration mechanics (0.18%), Building and related electricians (0.13%), and other craftsmen[4] (9.68%).

Table 6: Other Engineering Related Professionals (e.g., Technicians and Craftsmen), by ISCO Coding

ISCO category	ISCO code	Frequency	Percent
Engineering mgt (e.g., construction managers)	1323	1,213	0.5
Chemical and physical science technicians	3111	671	0.28
Civil engineering technicians	3112	8,347	3.46
Electrical engineering technicians	3113	6,241	2.59
Electronics engineering technicians	3114	2,667	1.11
Mechanical engineering technicians	3115	3,964	1.64
Construction supervisors	3123	4,328	1.79
Roofers	7121	17,627	7.31
Plumbers and pipe fitters	7126	17,148	7.11
Air conditioning and refrigeration mechanics	7127	430	0.18
Motor vehicle mechanics and repairers	7231	107,830	44.7
Building and related electricians	7411	321	0.13
Electrical mechanics and fitters	7412	37,309	15.46
Electronics mechanics and servicers	7421	9,799	4.06
Others	-	23,361	9.68
Total		241,255	100

Source: Author's calculations from the data extracted from National Labour Force report of 2021.

In terms of regional distribution, majority of both the core and other engineering related professionals are in the central region – 69% and 44% respectively, and western region – 26% and 21% respectively (Table 7). The eastern and northern regions have the least proportions of engineers. An overwhelming proportion of the core engineering professionals are in urban areas (90%), meanwhile for the other engineering related category, the gap between the urban and rural areas in terms of their presence or availability is not very large as compared to the core engineering category (58% are in urban and 42% are in rural areas).

On the gender dimension, the male is still predominant in the engineering profession. The gender distribution is similar for both the core and other engineering related professionals, whereby the male constitutes the highest proportion – 97% in core engineering and 96% in other engineering related work. The average age of the core engineering professionals is 41, and that of the other engineering professionals/work is 34.

[4] For example, those involved in plastering and painting.

Table 7: Distribution by Selected Parameters

		Core (Graduate) Engineering Professionals		Other Engineering related Professionals/Workforce (Artisans or Craftsmen)	
		Value	Weighted observations (N)	Value	Weighted observations (N)
Region	Central, %	58.27	19,241	44.45	107,228
	Eastern, %	4.43	1,461	20.19	48,700
	Northern, %	8.10	2,674	15.04	36,280
	Western, %	29.21	9,644	20.33	49,047
	All	100	33,020	100	241,255
Rural-urban location	Rural, %	21.02	6,942	41.19	99,368
	Urban, %	78.98	26,078	58.81	141,887
	All	100	33,020	100	241,255
Gender	Male, %	97.50	32,193	96.28	232,283
	Female, %	2.50	827	3.72	8,972
	All	100	33,020	100	241,255
Age	Mean (years)	40	33,020	34	241,255
	Min. (years)	22	-	16	-
	Max. (years)	57	-	80	-

Source: Author's calculations from the data extracted from National Labour Force report of 2021.

3.4.3 Distribution of the Engineering Professionals: Comparison Using the Primary Data and National Labour Force Data

The results from the triangulation, through a comparison of the statistics generated from the primary data and the national labour force statistics reveal a number of similarities and/or consistencies in the findings (see Table 8). First and foremost, is in terms of engineering specialty, where both data reveal the predominance of civil engineers in Uganda's engineering workforce. From the primary data, 53% of the engineering workforce are civil engineers, and similarly, the national labour force data shows that 56% of the core engineering workforce are civil engineers (Table 8).

Other areas that demonstrate consistency are; the nationality, age, work location, gender, and education distribution of the engineers. In terms of nationality almost all (100%) of the engineers are Ugandans – both the primary data and labour force survey data demonstrate that. The age distributions are also similar – the engineers are relatively young on average (between the age of 36 and 40 years respectively based on the primary and labour force survey data respectively), and the median ages for the engineers using both data sources is close have only slight variations (Table 8). Pertaining to geographical location, both the primary and labour force data show that more than half of the engineers are urban-based. By gender, more than three-quarters of the engineers are males based on statistics from both the primary and labour force data. The pattern of consistency is also seen in the education level of the engineers – both the primary data and labour force data reveal that more than half of the engineers have bachelor's degree and above.

Table 8: Engineering Professional's Distribution – A Comparison by Data Source

A Main attribute (parameter)	B Descriptor	C Statistics (Primary census data)	D Statistics (National labour force data – core engineering)	E Statistics (National labour force data – all engineering and engineering related workforce)
Nationality	Ugandan, %	99.29	100.00	99.71
	Non-Ugandan, %	0.71	0.00	0.29
	N (observations)	4,522	33,020	274,275
Age	Mean	36	40	34
	Median	33	38	33
	Min.	19	22	16
	Max.	88	57	80
Location of work	Rural	15.88	21.02	38.76
	Urban (includes peri-urban in D)	64.46	78.98	61.24
	Peri-urban	17.56	-	-
	NA	2.1	-	-
	N (observations)	4,522	33,020	274,275
Gender	Female, %	13.36	2.50	3.57
	Male, %	86.64	97.50	96.43
	N (observations)	4,522	33,020	274,275
Education	Certificate, %	1.55	-	-
	Diploma, %	12.25	-	-
	Bachelor's degree, %	59.73	-	-
	Master's degree, %	19.75	-	-
	Post-Graduate Diploma, %	5.42	-	-
	Doctorate, %	1.30	-	-
	Post-secondary specialized training, %	-	18.06	-
	Degree & above, %	-	53.02	-
	Others, %	-	28.92	-
	N (observations)	4,522	22,020	-
Specialty of training	Civil, %	52.84	55.76	-
	Electrical, %	17.36	-	-
	Mechanical, %	11.66	1.23	-
	Telecommunication, %	2.96	9.84	-
	Environmental, %	1.65	-	-
	Agricultural, %	3.10	-	-
	Chemical, %	1.07	-	-
	Biomedical, %	0.98	-	-
	Architectural engineers, %	-	1.04	-
	Surveying engineers, %	-	24.63	-
	Marine (ships') engineers	-	7.49	-
	Others, %	8.38	-	-
	N (observations)	4,522	33,021	-

Source: Author's computation using 2023 census data national labor force survey

3.5.1 Population of Engineering Professionals in Selected MDAs and Other Institutions

This section provides a summary of the total number of engineering professionals in 22 selected MDAs and other institutions. These are key institutions that employ engineers in relatively larger numbers compared to other institutions in the country. For example, the MDAs and institutions involved in roads construction, utility service delivery (e.g., water supply and energy distribution), building and construction, and aviation among others (see Table 9 for full list of MDAs or institutions).

The statistics (see summary in Table 9) show that the total number of engineers (at degree and diploma levels) from the 22 MDAs and other institutions is 3,321 (excluding certificate holders). Of these, 1,840 are graduate engineers and above (Table 9), and the remaining number of engineers (1,481) are technicians and technologists (diploma holders) (Table 10). Just like the results from the primary data and national labour force data, the data from these institutions also show a male dominance of the engineering workforce- more than 80% of the engineers in these institutions are male.

Among the 22 selected institutions, those that have the largest proportion of degree-level (bachelors and above) engineers are in the order – Uganda National Roads Authority (22.55%), Ministry of Water and Environment (19.29%), Umeme Ltd (11.58%), Uganda People's Defense Force (7.83%), Ministry of Works and Transport (6.09%), National Water and Sewerage Corporation (6.09%)[5], Civil Aviation Authority (5.54%), and the Ministry of Energy and Mineral Development (3.97%). Others that are Kampala Capital City Authority, National Enterprise Corporation, National Building Review Board, and Uganda National Oil Company (Table 9).

In terms of fields of specialty (see details in Appendix), civil engineers are also predominant in the selected MDAs and institutions (close to 30% of the degree-level and above engineers). This is followed by electrical and mechanical engineers – with proportions of 13% and 7% respectively (Appendix).

[5] **NOTE: The data obtained from NWSC was not up to date at the time of analysis. The updated data of the same is attached in Appendices 5**

Table 9: Population of Graduate Engineers in Key Selected MDAs and Other Institutions (Bachelor's Degree & Above)

S/N	ORGANISATION or MDA	Total Number	Male	Female
1	Uganda Road Fund	9 (0.49)	8	1
2	National Building Review Board	25 (1.36)	19	6
3	Uganda National Oil Company (UNOC)	25 (1.36)	19	6
4	National Social Security Fund (NSSF)	8 (0.43)	8	0
5	Alliance Consultants Ltd	13 (0.71)	10	3
6	National Enterprise Corporation (NEC)	43 (2.34)	32	11
7	National Agricultural Research Laboratories	7 (0.38)	6	1
8	Uganda Investment Authority	4 (0.22)	3	1
9	Ministry of Water & Environment	355 (19.29)	286	69
10	Ministry of Works & Transport (MoWT)	112 (6.09)	96	16
11	Uganda National Roads Authority (UNRA)	415 (22.50)	369	46
12	Uganda Civil Aviation Authority	102 (5.54)	77	25
13	Ministry Energy & Mineral Development	73 (3.97)	56	17
14	Guaff Consultants Uganda Ltd	20 (1.09)	17	3
15	Praus Consulting Engineers Ltd	6 (0.33)	5	1
16	Professional Engineering Consultants	21 (1.14)	16	5
17	Standard Gauge Railway Project	12 (0.65)	11	1
18	MBW Consulting Ltd	65 (3.53)	45	20
19	UMEME Ltd	213 (11.58)	186	27
20	Kampala Capital City Authority (KCCA)	56 (3.04)	45	11
21	National Water & Sewerage Corporation (NWSC)	112* (6.09)	91	21
	Total 1	1,696	1,405	291
22	Uganda People's Defense Force (UPDF)	144 (7.83)	-	-
	Total 2	1,840	-	-

Source: Compiled by Authors using data from MDA & other institution's databases of Engineers. UPDF data was not disaggregated by gender. The figures in parentheses are the proportions (%) out of the total number of engineers. *The data obtained from NWSC was not up to date at the time of analysis (it only includes engineers with membership in UIPE). The updated data of the same is attached in Appendices 5.

Table 10: Other Engineering Professionals- Technicians and Technologists (Diploma Holders) in Selected MDAs and Other Institutions

S/N	ORGANISATION or MDA	Total Number	Male	Female
1	National Social Security Fund (NSSF)	10	10	0
2	Alliance Consultants Ltd	6	4	2
3	Nation Enterprise Corporation (NEC)	20	13	7
4	National Agricultural Research Laboratories	2	2	0
5	Ministry of Works and Transport	17	16	1
6	Uganda National Roads Authority (UNRA)	38	38	0
7	UMEME Ltd	886	840	46
8	Kampala Capital City Authority (KCCA)	12	11	1
	Total 1	991	934	57
9	UPDF	490	-	-
	Total 2	1,481	-	-

Source: Compiled by Authors using data from MDA & other institution's databases of Engineers. UPDF data was not disaggregated by gender.

3.5.2 The Supply of Engineering Professionals in Uganda (2017-2023)

The supply of engineering professionals (graduates) in the country is driven by the University system. Over the past six years for which data is available, a total of 9,730 engineers were supplied through the university system into the market (see details including the engineering fields in Table 11), and the average production or supply is about 1,500 engineers per annum (Figure 6) – considering the past 6 years. These are large numbers of engineers produced for entry into the labour market every year. It is important that engineers' registration initiatives make use of these statistics regarding new entry into the market in order to inform coverage of registration efforts.

Out of the different fields of engineering specialty, civil engineering has the highest rate of production and supply of engineers into the market (30%), as shown in Table 11. This is consistent with the findings from the primary census data as a well as the national labour force data. The results show that there is a generally an increasing trend in the number of engineers supplied into the market – with the exception of 2020 when the education system was disrupted by COVID-19 restrictions and shut down of the education system (Figure 6).

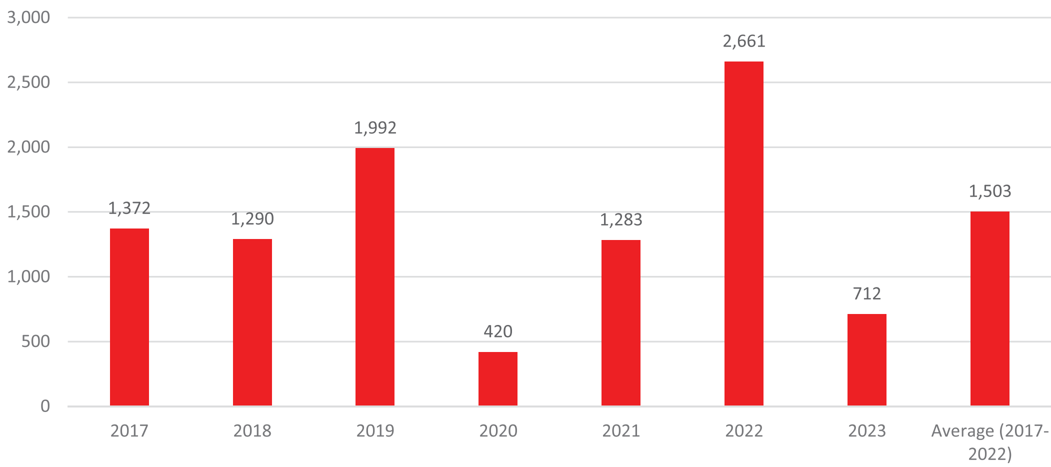
Table 11: Engineering Graduates by Engineering Programme (Public & Private Universities)

	2017	2018	2019	2020	2021	2022	2023	Total	Percent
Agricultural Engineering	66	17	51	0	34	52	59	279	2.87
Agro-Processing Engineering	14	0	21	0	15	16	14	80	0.82
Auto Mobile & Power Engineering	45	51	27	0	0	40	0	163	1.68
Bio Systems Engineering	0	19	13	18	14	10	13	87	0.89
Biomedical Engineering	19	61	52	0	14	109	68	323	3.32
Chemical Engineering	0	0	7	0	3	167	0	177	1.82
Civil Engineering	271	392	665	104	551	918	57	2958	30.40
Computer Engineering	154	87	123	27	61	69	63	584	6.00
Electrical Engineering	64	140	182	4	157	367	78	992	10.20
Engineering in Automotive & Power	46	46	51	0	0	76	0	219	2.25
Environmental Engineering & Mgt	45	38	64	0	0	38	0	185	1.90
Geomatics Engineering	0	0	14	0	31	37	0	82	0.84
Ginning and Industrial Engineering	4	0	7	0	6	2	1	20	0.21
Industrial Engineering & Mgt	63	59	58	0	0	61	0	241	2.48
Manufacturing Engineering	0	0	7	0	0	0	0	7	0.07
Mechanical Engineering	123	187	154	55	44	260	20	843	8.66
Mining Engineering	10	0	25	0	14	13	12	74	0.76
Petroleum Engineering	0	0	0	0	0	24	31	55	0.57
Structural Engineering	0	0	2	0	0	0	0	2	0.02
Telecom Engineering	354	127	367	212	262	291	227	1840	18.91
Textile Engineering	7	0	12	0	15	10	10	54	0.55
Water Engineering	87	66	90	0	62	101	59	465	4.78
Total	**1,372**	**1,290**	**1,992**	**420**	**1,283**	**2,661**	**712**	**9730**	**100.00**

Source: compiled using University Engineering Database (2017-2023).

Note: Most Universities had not yet graduated in 2023 at the time of data collection.

Figure 6: Trend in Graduation – All Engineering Programmes (Number)



Source: compiled using University Engineering Database (2017-2023)

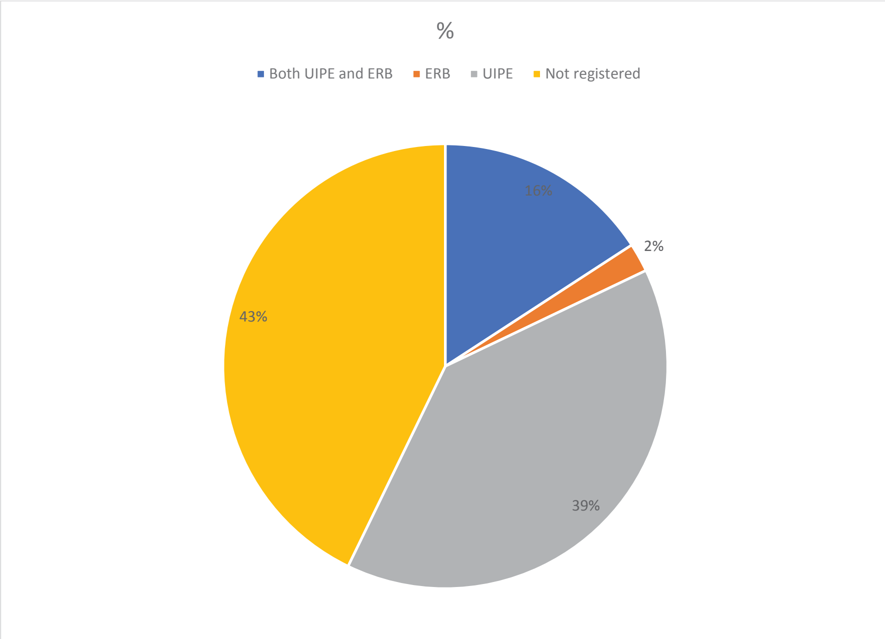
3.6 Registration and Membership with Professional Agencies

3.6.1 Self-reported Registration Status

Self-reported registration is based on responses of the engineering professionals interviewed during the census. The responses covered – no registration at all, membership and registration with both UIPE and ERB respectively, membership with UIPE only, and registration with ERB only. However, it should be noted that registration is only done at ERB. What was reported under UIPE by the engineering professionals during data collection as registration is membership in UIPE.

Slightly more than half of the surveyed Engineers reported that they are not registered in any of the bodies. This is seemingly high because both agencies (UIPE and ERB) are taken into account. It is also possible that the list of engineers obtained from ERB influenced the results. Of the registered engineering professionals, the largest proportion (39%) reported that they are registered with the UIPE (note that this is membership), 2% with the ERB, and 16% with both UIPE and ERB (Figure 7). Considering only ERB registration, the responses indicate that the registration rate is too low (i.e., only 2%). Overall, the findings of the registration status from the Engineers' survey show that the Engineers' registration rate is still very low, considering specific registration at ERB only. This implies that registration efforts at ERB needs to be strengthened or made more effective for better understanding of existing engineering professionals in the country and planning as well as regulation. This should however be interpreted with caution, because as discussed in the methodology, the coverage of the census was highly constrained, hence some of the registered engineers could not have been reached.

Figure 7: Registration and Membership Status (Self-reported)



Source: Author's calculation using the 2023 Engineers' census data (N=4,487)

3.6.2 ERB's Records of Registration

The low registration rate observed in the self-reported registration status is consistent with the registration status based on the registration status in the ERB database. A summary of the ERB registration status is compiled in Table 12, using the registration database of the ERB.

The latest registration data shows that a total of 1,698 engineers are registered at ERB, considering the period 1969- 1977 and 1978 – August 2023. Out of these, the majority are male (91%), consistent with results discussed earlier. The higher proportion of the registered males compared to the female may relate to the fact that most of the engineering professionals are male as shown previously in Table 7 based on the national labour force data (engineering component). Most of the registered engineers at ERB (67%) are civil engineers, followed by electrical (17%) and mechanical engineers (13%).

Table 12: ERB Registration Status

Period	Civil	Mechanical	Electrical	Telecommunication	Agricultural	Chemical	Electro – mechanical	Mining	Marine	Automotive & power	Environmental	Electronic	Female	Male	TOTAL
1969-1977	122	36	41	-	-	1	0	1	0	0	0	0	0	201	201
1978-2023 (Aug)	1,003	179	247	20	31	5	1	1	1	3	5	1	159	1,338	1,497
TOTAL	1125	215	288	20	31	6	1	2	1	3	5	1	159	1,539	1,698

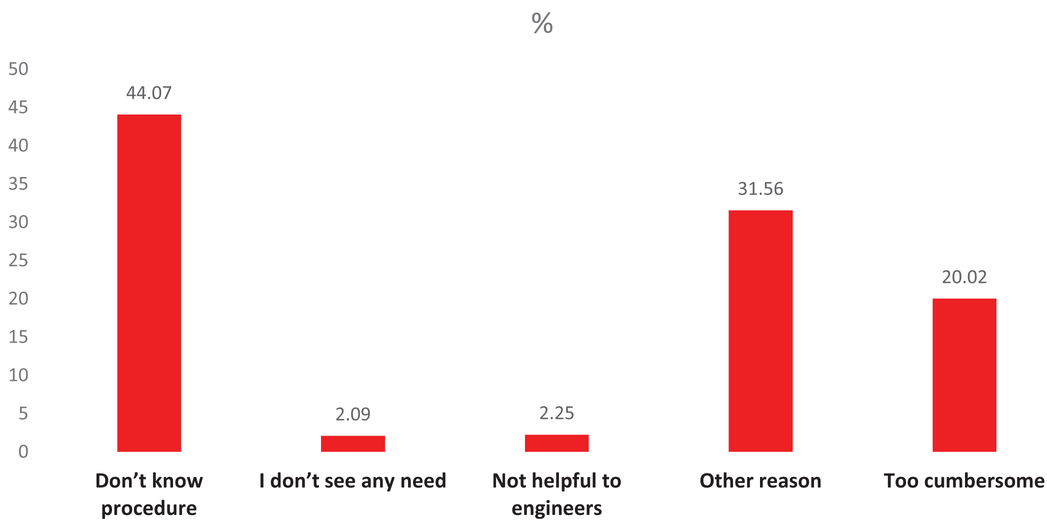
Source: Author's compilation using ERB registration database (1969 – Aug 2023).

3.7 Factors Affecting Registration of Engineering Professionals with Professional Agencies

The interviewed unregistered engineers were asked to provide the key reasons or factors that explain why they were not registered. The responses from the surveyed Engineers reveal three major categories of the factors that explain why they are not registered with a registration agency or authority (ERB or UIPE). These three key factors behind lack of registration are; lack of knowledge about registration procedure (44%), cumbersome registration process (20%), and other factors or reasons (32%) – see Figure 8.

The lack of knowledge about procedure may be related to inadequate level of awareness creation among the engineers, or lean structures of ERB and UIPE in that their presence on the ground is not felt or known by most engineers, especially those based upcountry or in rural areas. The cumbersomeness of the registration process could relate to complicated and perhaps bureaucratic, inefficient, and archaic system or processes of registration.

Figure 8: Reasons for Not Registering



Source: Author's calculation using the 2023 Engineers' census data (N=4,487)

The other factors or reasons for not registering (the 31.56%) include the following- the service is not readily available especially upcountry, difficulty in accessing registration information, yet planning to register (i.e., in process), challenges associated with subscription fee (cost of registration or high charges, lack of money to pay, arrears of subscription to pay), and the professionals being too busy or not having time to register. Some engineers reported that they are not sure if other engineering fields such as telecommunication engineering, chemical engineering, and construction management can also register or are eligible to register. Another factor relates to the benefits of registration not being clear to engineers. Other engineers mentioned that the engineers' registration is not a serious requirement by their other employers, so they can do without registration. Others indicated that they are not registered because- they don't have formal employment, they lack some of the registration requirements, their disciplines are not well represented (e.g., at the registration bodies), and registration agencies do not put emphasis on addressing the problems of engineers among others.

Lastly, in addition to the three major categories of the factors that explain why the engineers are not registered, some are not registered because they feel that the registration is not helpful to engineers (2.25%), and for others it is because they don't see any need to register (2.09%).

3.8 Adequacy of eEngineering Infrastructure

The surveyed engineers were asked about the extent of adequacy of the infrastructure or engineering facilities in their current workplace. Emphasis was on three broad types of infrastructure or facilities that form part of the dimensions of the Engineering Index. The first is Infrastructure 1 which is composed of energy, telecommunication, and water supply related infrastructure. The second is Infrastructure 2, which captured digital infrastructure. The last is Infrastructure 3, which covered provisions for engineering work.

The findings, as reported by the engineers (Table 13), show that the least level of adequacy is in the provisions for engineering work, which has 40% of the engineers reporting adequacy level of 40% or less. The second least adequacy is observed in digital infrastructure, where 37% of the engineers reported adequacy level of 40% or less. Energy, telecommunication, and water supply is the infrastructure category with the highest level of reported adequacy among the engineers – here, 76% of the engineers reported an adequacy level of between 41% and 100%.

Table 13: Infrastructure Adequacy

	Adequacy (41% - 100%)	Adequacy (<=40%)	No opinion	N	Details
Infrastructure 1	76	22.87	1.14	4487	Energy, telecommunication, water supply
Infrastructure 2	61.33	37.33	1.34	4487	Digital infrastructure
Infrastructure 3	63.05	35.99	0.96	4487	Provisions for engineering work

Source: Author's calculation using the 2023 Engineers' census data

3.9 Summary of the Dimensions of the Engineering Index

As highlighted in the methodology section, four of the six dimensions of the EI had readily available data for analysis at the time of preparing this report – these are; labour force, infrastructure, digital infrastructure, and safety standards. The findings under the dimensions of infrastructure, digital infrastructure, and safety standards are discussed in the preceding sub-section of the report.

For the case of the labour force dimension, where the emphasis of this report is, a total of 51,217 candidates sat for sciences (physics, chemistry and biology) and mathematics. Of these, 44,57% and 1.95% obtained A-E and A grades or scores respectively under sciences (see details in Appendix 2), and 65.2% and 9.5% obtained A-E and A grades or scores respectively under mathematics (math)- details are in Appendix 2. Considering both sciences and math, to constitute the current definition of labour force, the mean performances were 55.14 and 5.73 considering A-E and A grades respectively. Based on these available data and/or statistics, the overall indicative figure for the EI is 63.78 – based on A-E grades under labour force (mean sciences and math performance), and 51.43 – based on A grade (stricter performance threshold) under labour force (mean sciences and math performance) – Table 14. However, this should not be considered as the Engineering Index for Uganda because the computation of the EI was not the main objective of this this report, and the data concerning other EI dimensions was not collected hence not included in the analysis. The main focus of the report pertaining to the EI was only to compile statistics on the labour force dimension of the EI.

Table 14: Scores for Engineering Index

Dimension	Description	Score/100
Infrastructure 1	Energy, telecom, water supply	76
Infrastructure 2	Digital infrastructure	61
Safety standards	Provisions for engineering work	63
Labour Force	Mean performance in sciences and math among 15-year-olds – based on latest UACE results (A-E scores)	55.14
	Mean performance in sciences and math among 15-year-olds – based on latest UACE results (A scores)	5.73
Knowledge	H-index	-
Engineering industry	-Medium-large scale engineering companies as % of all medium-large scale companies -Value of engineering exports -Medium & high-tech industries including construction (% manufacturing value added)	-
Overall Index 1 – out of 100		63.78
Overall Index 2 – out of 100		51.43

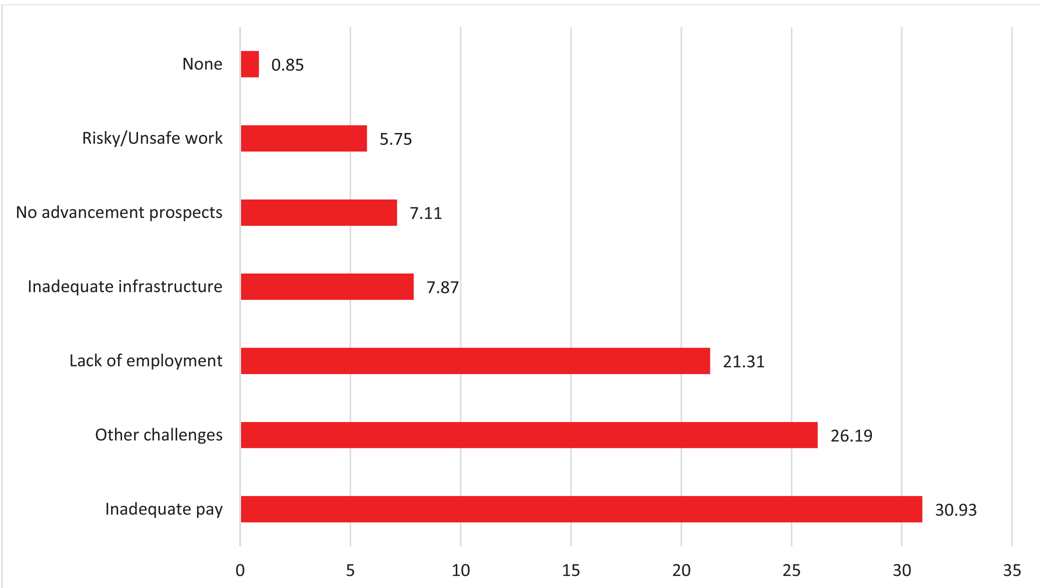
Source: Author's computation using data from various sources captured in the methodology section of the report.

It is important to note that the mean performance in sciences and math is relatively lower, based on the higher (stricter) performance threshold, and this influences the EI downwards; the stricter performance threshold. From a policy angle, efforts should be directed to ensuring higher achievement in performance in sciences and math, with the highest level of knowledge of the subject matter.

3.10 Major Challenges in Engineering Profession

The surveyed engineers also reported the major challenges that they face in their engineering work. From the results presented in Figure 9, the most pressing challenge faced by the majority (31%) of the engineers is inadequate remuneration and/or pay. Other challenges reported include – lack of employment including contracts (21%), inadequacy of infrastructure (8%), poor prospects for advancement or career development (7%), and risk or unsafe work environment (6%). The rest of the engineers (26%) reported other challenges apart from those highlighted above.

Figure 9: Challenges Faced in the Engineering Profession, %



Source: Author's calculation using the 2023 Engineers' census data (4487)

These include the following. Lack of investment in engineering related Research and Development (R&D), lack of integrity among young professionals, lack of modern engineering equipment, lack of knowledge on new technology, lack of mentorship by ERB and UIPE and experienced engineers especially for supporting young professionals, and inadequate regulatory framework and policy including their enforcement/implementation for the profession. Cited among the other challenges also include - inadequate supervision by ERB and UIPE, delayed or late payments in contract execution, limited training opportunities, and increase in fake (unqualified or unskilled) engineers

- infiltration of the field. The engineers also reported that most contracts are offered to foreigners thus leaving local engineers without jobs. They also cited the lack of minimum wage, and lack of protection from exploitation of engineers. The remaining challenges are- political interference and /or political pressure in technical works, and competition from individuals who are trained on the job without formal engineering qualifications.

3.11 Limitations of the Study and Data Gaps

i. Insufficiency of data from the engineers' census

The coverage of the census was limited, due to financial constraints – based on the resources we had, the census covered a limited scope. Because of this, not all the engineers were reached as per strict census requirement or definition. Although in the current report we attempt to close the coverage challenge by making use of the national labour force data to generate the population of engineers in the country which yields an equivalence of what a census would generate, it is paramount to consider adequate investments for complete coverage in similar future undertaking of censuses.

ii. Deficiencies in the National Labour Force data

First and foremost, it is important to note that the national labour force survey was not conducted with the aim of addressing the objectives of an engineers' census exercise. Because of this, some key details cannot be obtained from the data – for example engineers' contacts, registration status, and other information relevant for the census. Further, it was a survey, and the estimated overall population of the engineers reported here is computed by weighting the survey data – the limitation is that the data is incapable of enumerating each and every engineer in the country up to the tune of the reported population of the engineers. The weighted data can only generate a reliable number of the total population, but not the details of each of the item (engineer) in that total number. Also, the non-weighted data is incapable of providing the required information that a census can generate. Otherwise, the national labour force data is not a perfect replacement of the entire census, given the highlighted deficiencies.

iii. Deficiencies in engineering workforce data from MDAs

Efforts to obtain data from the Ministry of Public Service (MoPS) were unsuccessful, as the data was not availed. This is a key limitation because the MoPS would provide the most comprehensive data on the engineering workforce in public service. In addition, data from the NWSC is incomplete because it captures only engineers who have membership in UIPE. A complete data set received after the analysis was made is attached in the appendices as five (5).

4.0 CONCLUSION AND RECOMMENDATIONS

According to the socio-demographics from both the surveyed engineers and the national labour force data, male continues to be predominant in the engineering workforce. The age distribution shows that the engineering field is in sync with Uganda's demographic profile, where the population is young. Most Engineers operate in urban and peri-urban areas, compared to rural areas. Pertaining to the educational level, majority are bachelor's and master's degree graduates (about 80% combined).

In terms of training specialty, the predominant engineering field is civil engineering – constituting more than half of the engineers, followed by electrical and mechanical engineering. Concerning specific specialty in practice, the predominant fields of practice are in the order of construction, energy and general engineering sectors, followed by consultancies. Most of the engineers are employed in the private sector, followed by the public sector (MDAs). Comparing training specialty and practice, the findings show minimal cases of mismatch between jobs and the training of the engineering professionals.

Estimates based on the national labour force data show that there is a total of about 33,021 engineering professionals that constitute the engineering workforce (i.e., engineers in core engineering professions/work – graduate engineers) in the country, and the average supply rate of engineers (engineering graduates) into the labour market is about 1,500 engineers per annum (considering the past 6 years). There is consistency in several engineers' distribution parameters, based on the triangulated data (through comparison of the primary i.e., census and labour force survey statistics). The first and key one is the predominance of civil engineers in Uganda's engineering workforce as illustrated by both data. Other areas that demonstrate consistency are; the nationality, age, work location, education, and gender distribution of the engineers. The consistency pattern in the data is confirmatory that the results obtained from this analysis based on the triangulation of data are reliable. We, however, note that artisans or craftsmen are more than the core engineering workforce by more than seven-fold, which necessitates establishment and enforcement of a strong regulatory mechanism to ensure and maintain standards in the industry.

A total population of 3,321 engineers were found from engineering workforce data compiled from 22 key institutions that employ engineers in relatively larger numbers, and out of these, 1,840 engineering professionals have bachelor's degree and above (graduate engineers), and the rest are technicians and technologists (diploma holders). The predominant field of specialty is civil engineering, as in the case of the primary data as well as the national labour force data.

We observe that the registration rate of engineers is low, and the major factors that explain the low rate of registration include - lack of knowledge about registration procedure, and cumbersomeness of the registration process. Other factors reported by the engineers include lack of registration service in upcountry areas, unaffordability of subscription fee, and lack of clarity on whether other engineering fields (e.g., telecommunication engineering, chemical engineering, and construction management) are eligible to register. Among others, some engineers are not registered because they feel that it is not helpful to register, and so they do not see any need to register.

According to the available data, the estimates to support computation of the Engineering Index shows that the EI reduces with a stricter science and math performance threshold under the labour force dimension of the EI, and the index increases when a less strict sciences and math performance threshold is used. The strict performance threshold relates to the best performance associated with highest level of engineering related foundational knowledge of the subject matter (sciences and math). The mean performance rating based on the strict performance threshold is low in both sciences and math. It is important that higher sciences and math performance standards is emphasized by policy, to ensure there is mastery and highest level of knowledge of the subject matter as foundational elements for building stronger engineering capability in the country.

Lastly, the major challenges being encountered by the engineers in their operations are - inadequate remuneration, lack of employment including contracts especially for the locals, inadequacy of infrastructure, poor prospects for career advancement, and risky or unsafe work environment among others.

Following the findings, further recommendations are made, in addition to some of the already highlighted ones in the preceding paragraph(s). Emphasis should be placed on efforts towards improving the engineers' registration rate. The engineers' census will play a critical role in this, as it generates research-based evidence that provides relevant insights to inform strategies for the registration. Some of the strategies should aim at mass registration information dissemination and easing the registration processes to make it less cumbersome. The estimate shows that the population of engineers in the country is high (about 33,021) – which is higher than the anecdotally reported population of 20,000, and the number of other engineering related workforce is even higher, hence the need for effective engineering regulatory measures to ensure adherence to engineering standards in the country.

Lastly, this report has highlighted the deficiencies associated with the data used – i.e., the data from the engineers' census, and the national labour force data. Going forward, more feasible approaches for censuses need to be considered.

Based on the lessons learnt from this current census, including the data limitations, as well as considering the need for a methodology that can deliver rapid, accurate and regular censuses, we propose the following options.

First, the engineers' census can be implemented using a mixed approach of methodology. The mixed approaches entail - physical reach of companies or institutions where engineers work for physical interviews with wider coverage, phone-based interviews, and triangulation with nationally representative data from UBOS. Following the data deficiency arising from the limited reach in the just concluded census, there is need to collect more concrete data covering the areas that were not reached due to resource constraints.

Going forward, the options involve use of mixed approaches to carry out a fully complete census, and the census should be conducted within a manageable scope – for example future censuses can only focus on the priority fields or sectors identified in the current ERB strategic plan (i.e., Public Service, ICT, Engineering Consultancy Firms, and Contractors). Focusing on the priority field/areas can help to ensure complete coverage of the engineers in a census, in an economical manner.

This report therefore draws recommendations for future engineers' censuses, based on two key factors. These are:

i. The lessons learnt from this current census.
ii. Considering the need for a methodology that can deliver rapid, accurate and regular censuses.

Following the above considerations, the following is recommended.

- Census using a mixed approach of methodology. The steps will involve;

The Key Census Methodological Steps

i. Identifying and producing a master list of priority sectors and institutions on an annual basis. Place focus on sectors or institutions where engineers are most found (i.e., Public Service, ICT, Engineering related firms, and contractors). This helps in determining a feasible scope of the censuses. Periodic update of the master list is key (e.g., annually), before any census data collection commences.
ii. Compile the addresses and details of the institutions in each identified sector of priority.
iii. Carry out enumeration of engineers in the identified sectors and respective institutions. This is primary data collection through a combination of face-to-face interviews and telephonic interviews.
iv. Census data transmission from the enumeration of the engineers. Data capture and transmission should be digitized – e.g., using any type of Computer Assisted Personal Interviewing technology. Such systems can be fully implemented at the ERB premises to allow for more visibility of the Board into the census processes.
v. Census data processing, data analysis, and report writing.
vi. Triangulation of results from primary data with secondary data (e.g., data from UBOS and other MDAs as well as engineers' training institutions). However, it is important that ERB collaborates with key MDAs by establishing an engineering professional's data sharing Memorandum of Understanding (MoU) – for example with Public Service which is expected to house a large number of engineers, among others. Data from secondary sources should be captured using a standardized tool, which should then form the basis for the development of an electronic database.
vii. Creation of a digital (electronic) engineers' database. This database should allow for incremental ingestion of data from the identified MDAs and private sector. With this database, sufficient data should be gathered based on the MOUs already signed by ERB

and other MDAs and private sector to augment census data collected using primary data collection methods. The developed database should also have capacity to store the final data after analysis.

viii. Lastly, the engineers' census can follow specified frequency. The frequency can be informed by engineers' data need or it can be aligned to the ERB strategic plan – for example annually (in case of annual data need to support registration efforts), or following the time period of the ERB strategic plan.

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APPENDIX 1: CROSS TABULATION OF ENGINEERS' GENDER AND EDUCATION

Gender	Bachelor's	Certificate	Diploma	Doctorate	Masters	Post Graduate Diploma	Total
Female	378 62.58	2 0.33	59 9.77	10 1.66	120 19.87	35 5.79	604 100
Male	2,323 59.29	68 1.74	495 12.63	49 1.25	773 19.73	210 5.36	3,918 100
Total	2,701 59.73	70 1.55	554 12.25	59 1.3	893 19.75	245 5.42	4,522 100

Source: Author's calculation using the 2023 Engineers' census data (N=4,487)

APPENDIX 2: MEAN PERFORMANCES IN SCIENCES AND MATH AMONG 15-YEAR-OLDS (LATEST UACE RESULTS CONSIDERED)

	Female			Male			All	Mean performance			
	Number (candidates)	A, %	A-E, %	Number (candidates)	A, %	A-E, %	Total - all candidates.	Mean performance (A, %)	Mean performance (A-E, %)	Avg. sciences A-E(A)	Avg. Math A-E(A)
Physics	2451	0.9	54	10543	2.2	51.5	12994	1.55	52.75	44.57(1.95)	65.2(9.5)
Chemistry	6631	2.8	52.1	13598	5.4	54.4	20229	4.1	53.25		
Biology	6379	0.3	23.9	11615	0.1	31.5	17994	0.2	27.7		
Mathematics	11930	8.5	66.6	26507	10.5	63.8	38437	9.5	65.2		

Source: Author's computation suing data from UNEB (2023) – latest UACE results. Figures in parentheses in the last two columns represent scores based on A grade.

APPENDIX 3: POPULATION OF ENGINEERS IN MDAS WITH BACHELOR'S DEGREE

Sno	ORGANISATION	Total number of Engineers	Male	Female	Civil	Electrical	Mechanical	Electro - Mechanical	Agricultural	Telecommuni cation	Motor Vehicle	Geo-technical	Automotive & Power	Transport Planning	Boat Building & Marine	Industrial	Automobile
1	Uganda Road Fund	9	8	1	9	0	0	0	0	0	0	0	0	0	0	0	0
2	National Building Review Board	25	19	6	12	7	5	1	0	0	0	0	0	0	0	0	0
3	Uganda National Oil Company (UNOC)	25	19	6	4	2	13	0	0	0	0	0	0	0	0	0	0
4	National Social Security Fund (NSSF)	8	8	0	6	2	0	0	0	0	0	0	0	0	0	0	0
5	Alliance Consultants Ltd	13	10	3	11	1	1	0	0	0	0	0	0	0	0	0	0
6	Nation Enterprise Corporation (NEC) Construction Works and Engineering Ltd	43	32	11	28	10	5	0	0	0	0	0	0	0	0	0	0
7	National Agricultural Research Laboratories	7	6	1	0	0	0	0	7	0	0	0	0	0	0	0	0
8	Uganda Investment Authority	4	3	1	4	0	0	0	0	0	0	0	0	0	0	0	0
9	Ministry of Water and Environment (MWE)	355	286	69	NA	NA	NA	0	0	0	0	0	0	0	0	0	0
10	Ministry of Works and Transport (MoWT)	112	96	16	72	6	33	0	0	0	0	0	0	0	0	0	0
11	Uganda National Roads Authority (UNRA)	415	369	46	334	6	64	0	1	0	3	1	2	1	1	1	1
12	Uganda Civil Aviation Authority (UCAA)	102	77	25	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
13	Ministry of Energy and Mineral Development	73	56	17	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14	Guaff Consultants Uganda Ltd	20	17	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15	Praus Consulting Engineers Ltd	6	5	1	5	1	0	0	0	0	0	0	0	0	0	0	0
16	Professional Engineering Consultants (PEC)	21	16	5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
17	Standard Gauge Railway Project (SGR)	12	11	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
18	MBW Consulting Ltd	65	45	20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
19	UMEME Ltd	213	186	27	0	192	1	0	0	20	0	0	0	0	0	0	0
20	Kampala Capital City Authority (KCCA)	56	45	11	44	6	6	0	0	0	0	0	0	0	0	0	0
21	National Water & Sewerage Corporation (NWSC)	112	91	21	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

APPENDIX 4: POPULATION OF ENGINEERS IN MDAS WITH DIPLOMA

Sno	ORGANISATION	Total Number	Male	Female	Civil	Electrical	Mechanical	Motor Vehicle	Agricultural	Automobile	Telecommunication
1	NSSF	10	10	0	NA	NA	NA	NA	NA	NA	NA
2	Alliance Consultants Ltd	6	4	2	6	0	0	0	0	0	0
3	Works and Engineering Ltd	20	13	7	2	8	10	0	0	0	0
4	National Agricultural Research Laboratories	2	2	0	0	0	2	0	0	0	0
5	Ministry of Works and Transport	17	16	1	0	1	15	0	0	0	0
6	Uganda National Roads Authority (UNRA)	38	38	0	11	0	22	2	2	1	0
7	UMEME Ltd	886	840	46	0	881	2	0	0	0	3
8	KCCA	12	11	1	8	2	2	0	0	0	0

APPENDIX 5: NATIONAL WATER AND SEWERAGE CORPORATION (NWSC) ENGINEERING DATA SET

Classification by Education Qualifications

GENDER	MASTERS HOLDERS	BACHELORS HOLDERS	DIPLOMA HOLDERS	TOTAL
MALE	77	308	302	687
FEMALE	27	66	34	127
TOTAL	104	374	336	814

Classification by Engineering Field

GENDER	CIVIL	ELECTRICAL	MECHANICAL
MALE	308	71	101
FEMALE	66	78	6

Note: The NWSC dataset was received in November 2023 after the census datasets had been analyzed.

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