ENSURING THE EXPERTISE TO GROW SOUTH AFRICA

Identify Challenges for Registration from Candidate to Professional Registration

ENGINEERING COUNCIL OF SOUTH AFRICA
Tel: 011 6079500 | Fax: 011 6229295
Email: engineer@ecsa.co.za | Website: www.ecsa.co.za

ECSA

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EXECUTIVE SUMMARY

The Engineering Council of South Africa (ECSA) is a statutory body established in terms of the Engineering Profession Act, 46 of 2000 (EPA). ECSA's primary role is to regulate the engineering profession in terms of the EPA. ECSA's core functions are the accreditation of engineering programmes, registration of persons as professionals in specified registration categories and regulation of practice of registered persons. ECSA is the only body in South Africa authorised to register engineering professionals who meet the 11 outcomes for professional registration and to regulate their practice.

In 2019, ECSA, appointed a Research Study Group, the main aim and focus was to investigate the root cause of why engineering professionals below the age of 39 years, who are already registered as candidates, are not getting registered as professionals in their respective categories. This was triggered by the fact that 83% of registered Candidates are below the age of 39 years and 58% of registered professionals are white males over the age of 50 years, with 34% of them being retired (over 70 years).

The research's main objective is to recommend mitigating measures that ECSA can introduce to assist engineering professionals that are registered in the Candidate category to overcome the challenges they face so they can be registered in their respective professional categories. The recommendation should also assist with attracting upcoming novice engineering professionals to register with ECSA as regulator of choice and to unlock the bottleneck between the Candidate and Professional categories.

The data gathering methodology used was the creation of questions that not only probed the perceived hurdles to registration, but also the managerial and technical activities related to Candidate's world of work and types of activities Candidates are involved in. The purpose of the 'world of work' questions was to gauge the potential degree of mismatch between a Candidate's world of work and ECSA's expectations for registration. The questions were divided into two categories: span of control questions and open-ended questions. The survey tool used, Survey Monkey, was used to distribute the questions using ECSA's database. The criterion used for the sample selection from ECSA's registration database was graduates who had been registered in

the candidate category from December 2017 to January 2020, with a total of 7 916. The survey was emailed to all 7 916 Candidates because that way the inputs from industry cover all categories (engineers, technologists and technicians) and all disciplines from the different employers offering engineering services. The different employers are public, private, parastatal and other sectors, with 64% of the respondents being in private practice. The comprehensive list of recommendations from this research are captured in Chapter 6. They are a steppingstone to mitigation measures that ECSA can introduce to increase the number of registered persons in the Professional category.

The key findings can be summarised as follows; first, Candidates are struggling to write the engineering report (ER) which is understandable because it is a detailed report covering all 11 outcomes; second is exposure to complex engineering activities and systems which contribute to the three core outcomes in Group A which influence the ER; and third is mentoring support. A key observation made from interrogating the registrations statistics is that majority of mentors were registered under the legacy system; as such, they are not fully conversant with the NRS requirements.

This research scope included all different categories and disciplines of engineering practitioners so the recommendations on how ECSA can offer support to assist engineering professionals to move from being registered as Candidate to be registered as Professional in their respective categories are applicable to all Candidates and engineering Professionals who wish to become registered in professional categories. The enhancement of registration of these different categories of professionals will have measurable impact on any organisation's professional environment as it will compel them to abide by the code of ethics of engineers and the increased number of registered persons will entail an increased number of competent engineering practices which in turn will translate to improve quality of engineering work within communities.

1. INTRODUCTION

1.1 Problem statement

The aim of this study is to determine the root causes of why Candidate engineers do not register as Professionals. The population used, drawn from ECSA's registration database, was Candidates that have not registered as Professionals after being Candidates. The search for the root causes was achieved by engaging all 7 916 candidates on the ECSA CRM system and distributing structured questionnaires in the form of a survey. The platform used to distribute questions was Survey Monkey. A secondary aim of the study is to propose interventions to overcome these barriers and increase the number of professionally registered persons.

1.2 Objective

ECSA's main goal is to proactively mitigate the challenges that registered Candidates face in acquiring their professional registration. This will be achieved by introducing active measures such as the registration academies in engineering companies (still under development) that will perform the same function as the legacy commitment and undertaking (C&U) programme.

An explanation of a C&U as extracted from R-01-P Policy on Registration in Professional Categories) reads: a C&U is an agreement entered into between an employer and ECSA under which the employer commits to the training of candidates to the standard required for registration in an identified professional category . A C&U may be entered into for one or more, or all the professional categories. In entering a C&U, the employer signifies the intent to [1]:

- structure and execute the training of Candidates in accordance with the competency statements, policies and guidelines laid down by the ECSA for the applicable category of registration;
- ensure adequate supervision of Candidates by registered persons;
- register mentors with the ECSA and ensure adequate mentoring of Candidates; and
- provide regular guidance to the Candidates through competent supervisors and mentors.

1.3 Background

ECSA is a statutory body which acquires its mandate from the Engineering Profession Act, 46 of 2000 (EPA). The focus of the EPA is the promotion of public health and safety and all aspects relevant to the actions of persons registered with ECSA. ECSA's main legislative mandate is to register engineering practitioners into professional engineers, technicians and technologists [2]. The registration of engineering professionals plays a vital role in the quality of work that engineers produce for the socio-economic development of the country. As such, these engineering professionals undergo a rigorous process that tests their knowledge, experience, capabilities and expertise in various fields of practice. These professionals, once registered, should abide by the code of conduct as outlined in the EPA for as long as their registration with ECSA remains. However, registration with ECSA is not a compulsory injunction and is undertaken by engineering professionals whose job conditions require professional registration.

The objective of this report is to assess the current challenges that Candidates face and to see whether the registration requirement needs to be modified or whether it should include other engineering experience such as engineering management. The source of gathering information and challenges is a survey emailed to Candidates who have been registered as Candidates but are still not registered as Professionals. Special focus was given to the sample of deferred/abeyance applications because the reasons for abeyance will provide insight into the areas where the Candidates face the biggest challenges.

2. LITERATURE REVIEW

In this chapter, data on graduates in higher education institutions (data is sourced from the Department of Higher Education and Training, Education Series Volume V Higher education and skills in South Africa, 2017 Report: 92-01-05 (2 Report-92-01-052017 Stats SA) [3], Department of Basic Education, as well as the General Household Survey 2017 and ECSA registered Candidates are presented in terms of the gender, age and race composition.

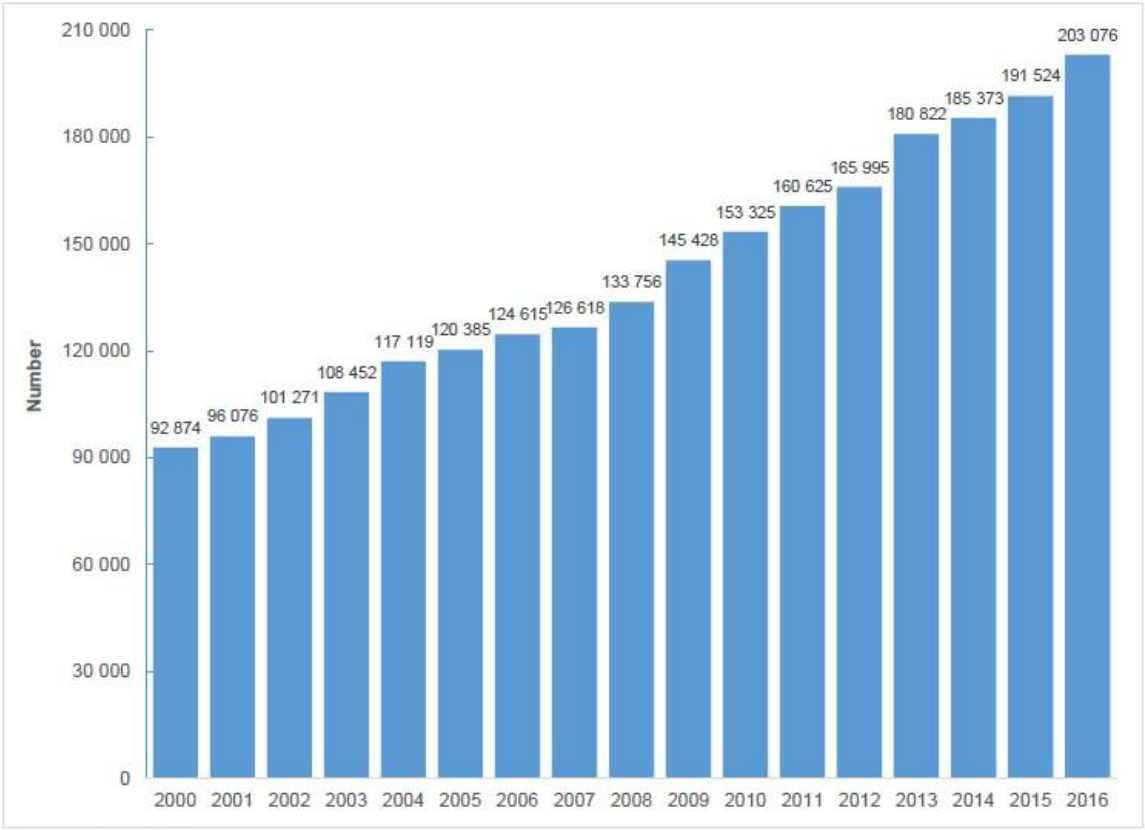
2.1 Higher Education

South Africa has a constitutional commitment to equality of educational opportunities for all citizens. The National Development Plan (NDP) further articulates country's the national goals by stating that government should provide support for the higher education system by building a strong and coherent set of institutions for delivering quality education . The NDP recognises that education is the engine of social mobility and will increase social justice and democracy. The higher education system is therefore expected to play a significant role in producing the skills and knowledge the country needs to drive its economic and social development. Major progress has been made in South Africa in improving gender and race equity in access to higher education [4].

2.1.1 Graduates

The majority of students enrolled in post-secondary programmes are registered for long undergraduate programmes requiring three to four years of study. However TVET colleges offer the most needed short cycle vocational programmes. Many students attending higher educational institutions do not complete on time and a high proportion drop out, while very few students progress to advanced levels of study. The next section presents the trends in levels of progression and educational outcomes in South Africa[5].

As shown in **Figure 2.1**, the number of public higher university (universities/technikons) graduates more than doubled between 2000 and 2016. While the growth in graduates remained steady over the years, 2009, 2013 and 2016 were the years where most growth occurred.



Source: DHET (HEMIS)

Figure 2.1: Trends in university and technikon (UoTs) graduates, 2000–2016

2.1.2 Classification of Educational Subject Matter category

Table 2.1 describes the percentage of graduates by Classification of Educational Subject Matter (CESM) category and university graduates in the key STEM fields of study accounted for only 29% of all graduates. Attention is given to the engineering and it is clear to see that it is a field with a growing percentage of graduates over the years. This is observation is of great benefit to the country, ECSA and the engineering profession, however mitigation measures should be put in place to ensure that graduates stay in engineering. At the moment engineering has a leaking pipeline.

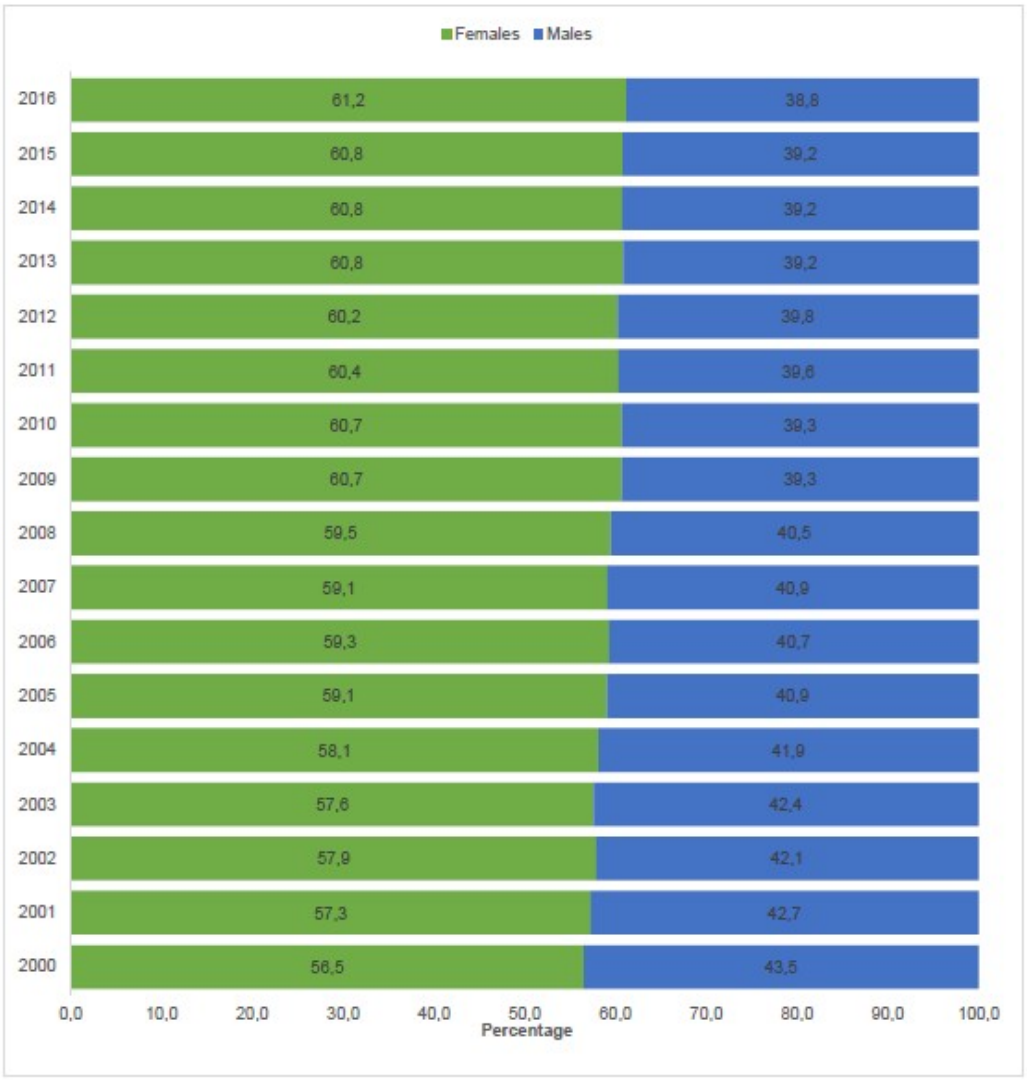
Table 2.1: Graduates from public universities and technikons by CESM category, 2000–2016

	2000	2002	2004	2006	2008	2010	2012	2014	2016
Agriculture, agricultural operations and related sciences	1,7	1,6	1,7	1,8	1,8	1,7	2,0	2,1	2,2
Architecture and the built environment	1,7	1,7	2,0	2,1	2,4	1,9	1,9	1,7	1,8
Visual and performing arts	2,0	1,9	2,0	2,0	1,8	1,9	1,9	1,7	1,5
Business, economics and management studies	21,4	24,4	25,0	24,2	23,9	27,2	28,1	27,2	27,8
Communication, journalism and related studies	1,7	1,6	1,6	1,7	1,8	1,9	2,2	2,2	2,0
Computer and information sciences	3,7	4,5	4,2	3,6	3,3	3,1	3,6	3,7	3,3
Education	20,2	23,5	25,7	23,6	23,0	24,7	21,6	20,0	20,7
Engineering	4,3	5,1	5,1	6,2	7,0	6,7	7,1	7,6	7,1
Health professions and related clinical sciences	8,3	7,5	7,2	7,8	7,8	7,3	7,3	6,8	6,9
Family ecology and consumer sciences	0,8	0,9	1,0	0,9	0,8	0,3	0,3	0,4	0,4
Languages, linguistics and literature	3,9	2,6	2,3	2,3	2,0	1,6	1,9	1,9	1,6
Law	5,9	5,4	4,1	4,3	4,2	3,5	3,7	3,9	4,2
Life and physical sciences	3,7	3,6	3,8	4,1	4,2	5,6	4,9	6,4	6,4
Mathematics and statistics	1,5	1,4	1,5	1,7	1,8	1,3	1,3	1,4	0,9
Military sciences	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Philosophy, religion and theology	1,6	1,4	1,2	1,1	0,9	0,8	0,8	0,7	0,7
Psychology	4,9	4,1	3,5	3,5	3,3	3,4	3,4	3,7	3,3
Public management and services	4,5	3,2	2,8	3,6	4,2	3,0	3,4	3,4	3,9
Social sciences	8,2	5,6	5,4	5,6	5,9	4,1	4,4	5,3	5,2
Total	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**

Source: DHET (HEMIS)

2.1.3 Gender

Figure 2.2 shows the distribution of graduates from public universities and (technikons34) by gender. The highest percentage of graduates were female and their percentage relative to males has been rising since 2000. In 2000, more than half of the total graduates were female (56.5%), while the percentage of male graduates was 43.5%. In 2016, close to six out of 10 graduates were female.



Source: DHET (HEMIS)

Figure 2.2: Graduates of public universities and technikons by gender, 2000–2016

2.1.4 Race

Table 2.2 shows the field of study by population group for 2000 and 2016. Attention is given to engineering where the proportion of black African graduates in engineering, life and physical

sciences almost doubled over the 16 years; however, STEM fields such as computer science, data processing and mathematical sciences did not show growth in the percentage of graduates.

Table 2.2: Graduates according to CESM category of specialisation by population group

CESM category	2000				2016			
	Black African	Coloured	Indian/ Asian	White	Black African	Coloured	Indian/ Asian	White
Agriculture and renewable resources	1,6	0,6	0,2	2,3	2,5	0,9	0,5	2,3
Architecture and environmental design	1,3	2,0	2,0	2,6	1,4	1,6	2,5	2,9
Arts, visual and performing	1,6	2,3	1,0	3,9	1,1	2,5	1,0	3,0
Business, commerce & management studies	17,6	25,7	28,6	27,2	27,6	26,5	33,1	26,9
Communication	1,9	1,1	1,4	1,8	2,2	1,8	1,2	1,4
Computer science and data processing	3,1	5,4	5,9	4,6	3,4	3,5	4,1	2,6
Education	29,8	8,1	6,3	5,8	23,3	19,5	13,3	14,9
Engineering and engineering technology	2,7	4,5	6,5	6,4	6,9	4,6	8,9	8,3
Health care and health sciences	6,7	9,2	16,0	10,0	5,7	9,3	11,6	8,8
Home economics	1,1	1,0	0,7	1,1	0,4	0,3	0,4	0,6
Language, linguistics, and literature	4,1	3,7	2,2	3,4	1,5	2,4	1,0	2,1
Law	4,7	7,6	7,3	7,0	3,6	5,2	5,2	5,7
Life sciences and physical sciences	2,8	5,1	4,4	4,7	5,7	6,2	7,7	8,8
Mathematical sciences	1,2	1,0	1,8	2,0	0,9	0,5	1,0	1,2
Military sciences	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Philosophy, religion and theology	1,1	2,5	1,0	2,2	0,5	1,3	0,4	1,3
Psychology	3,7	5,7	4,8	6,4	2,4	5,2	4,9	5,4
Public Administration and social services	6,2	6,0	2,4	1,9	5,0	3,5	1,4	0,8
Social sciences and social studies	8,9	8,3	7,3	6,7	6,1	5,1	1,9	2,8

Source: DHET (HEMIS)

2.2 Candidates and professional registration

The data presented and analysed in **Section 2.2** has been extracted from the Central Registration Committee (CRC) report presented at the meeting held 11 October 2019 [6]. CRC is a High Impact Committee of Council responsible for registration at ECSA. Among others, the CRC's function is to ensure that due process during the application process is followed; it also plays an oversight role over the registration business unit. CRC has delegated the registration function to the relevant and designated Assessors, Moderators and Reviewers as the persons responsible for assessing

the competence of applicants for a category or discipline within a category as per Policy on Registration in Professional Categories, R-01-POL1, Revision No.: 2: 15 March 2018.

The population used for this research comprises four categories: Engineers, Technologists, Technicians and Specified Categories. Disciplines represented are Agriculture, Chemical, Civil, Electrical, Mechanical, Lift Inspectors, Lifting Machinery Inspector and Mechatronics. Due to diversity of engineering professionals in South Africa race, age and gender composition is also analysed.

2.2.1 Age and race of Candidates

At the time the CRC report was used, 22 231 candidates were registered with the highest representation being Africans with 61%, followed by Whites with 28%, then Indian with 8% and lastly Coloured with 3%. What is critical to note from **Table 2.3** and **Figure 2.3** is that 83% are engineering professionals below the age of 39, with 52% being Candidates between the ages of 30 to 39 and 48% being Candidates below 29 years. The targeted age profile is Candidates who have been working for more than six years – as such, this points to 52% of all Candidates regardless of race. This total of 83% being Candidates below 39 years is the trigger and catalyst for ECSA commissioning this research project to discover the root cause of why they are not registering in the respective professional categories. This high percentage clearly indicates that Candidates are facing challenges that make registering as Professionals appear unmanageable.

Interesting to also note is that 79% (40 years and above) of all registered professionals were registered under the legacy system. A substantial pool of our mentors in industry therefore are not familiar with the new registration system (NRS) requirements endorsed by the Council in March 2017. This data clearly indicates that one of the causes could be a lack of adequately informed mentors on the NRS system. Another interesting aspect ECSA should probe is which system was the 19% of registered professionals between the ages of 30 to 39 registered under.

Two key guiding questions to investigate are:

- Which system did they register in, legacy or NRS?

- Which registration system is the pool of assessors, moderators and reviewers registered through?

The answers to these questions will conclusively inform which mitigation measures ECSA can commission to assist Candidates, e.g. training of mentors in industry.

Table 2.3: Total number of ECSA registered candidates by race and age

Candidate Category Age Analysis				
AGE Groups	African	Coloured	Indian	White
20-29	5425	328	919	2211
30-39	6456	281	715	2173
40-49	1487	57	162	747
50-59	194	11	26	626
60-69	9	2	3	237
70+	1	3	1	152

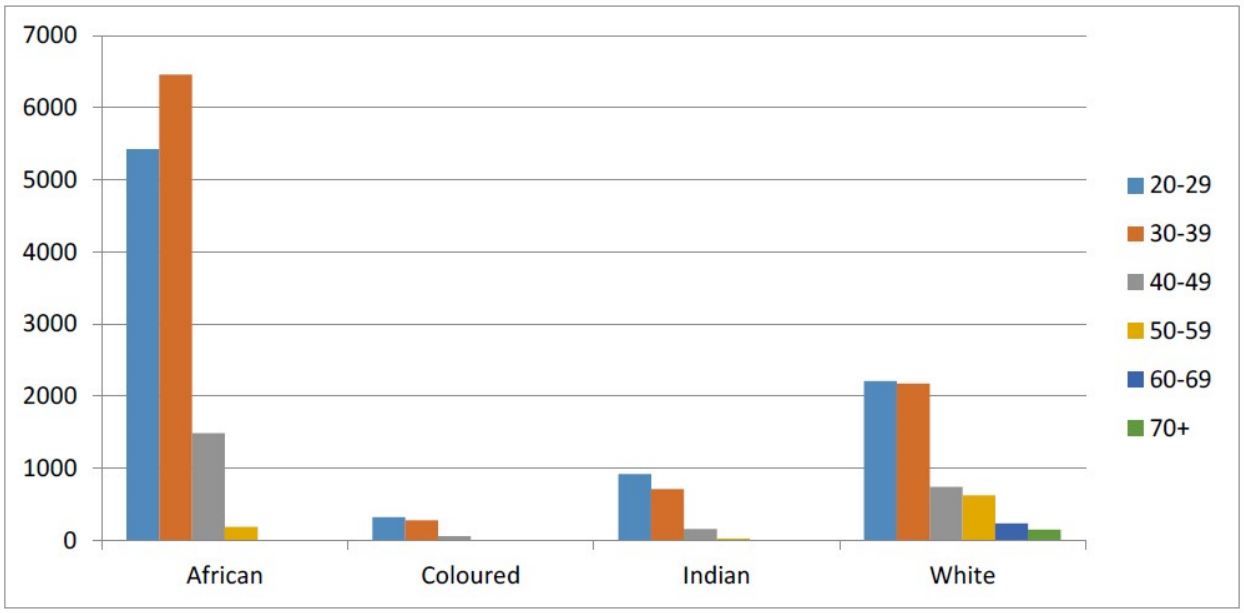


Figure 2.3: Total number of ECSA registered candidates by race and age

2.2.2 Age and Race of professionals

At the time the CRC report was analysed, 34 492 professionals were registered across all categories. The highest representation being professionals above 70 years with a total of 35%, followed by professionals below 39 years with 19%, then professionals below 49 years contributing 18.%, followed by professionals below 69 years with 13.% and lastly professionals below 29 years with 1%. The mitigation measure for this finding is for ECSA to increase the number and frequency of the “road to registration” presentations, more specifically because they are currently offered on request from companies and events such as conferences.

What is critical to note from **Table 2.4** and **Figure 2.4** is that 35% of all registered engineering professionals are retired (above 70 years) and the percentage contribution from the targeted group (age 20 to 39) is literally non-existent with 1%.

Attention should be given to a worrying observation circled in red in **Table 2.4**, where 34% of all registered professionals are white retired males. This is a red flag for ECSA as the main source of income is registration fees. When this percentage is combined with the 12% of registered professionals that are between 60 to 69 years, this amounts to a staggering 46%. This high percentage further supports the objectives of this research project, because it seeks to introduce support programmes to assist candidates to overcome challenges they face with registering as professionals. At the moment, the incoming pipeline of registered professionals seems stagnant with professionals below 39 years across all races only contributing 20% of all registered professionals. If we break this 20% of the targeted group into race, Africans lead with 51%, followed by Whites with 35%, then Indian with 10% and lastly Coloured with 4%. The contribution of 51% from African agrees with data shown in **Table 2.3** and **Figure 2.3** where Africans contribute 53% of the target group (20 to 39 years) of all registered candidates.

Table 2.4: Total number of ECSA registered professionals by race and age

Professional Category Age Analysis				
AGE Groups	African	Coloured	Indian	White
20-29	240	17	35	139
30-39	3351	232	639	2380
40-49	2344	291	560	3086
50-59	652	118	221	3915
60-69	154	39	55	4084
70+	28	13	10	11889

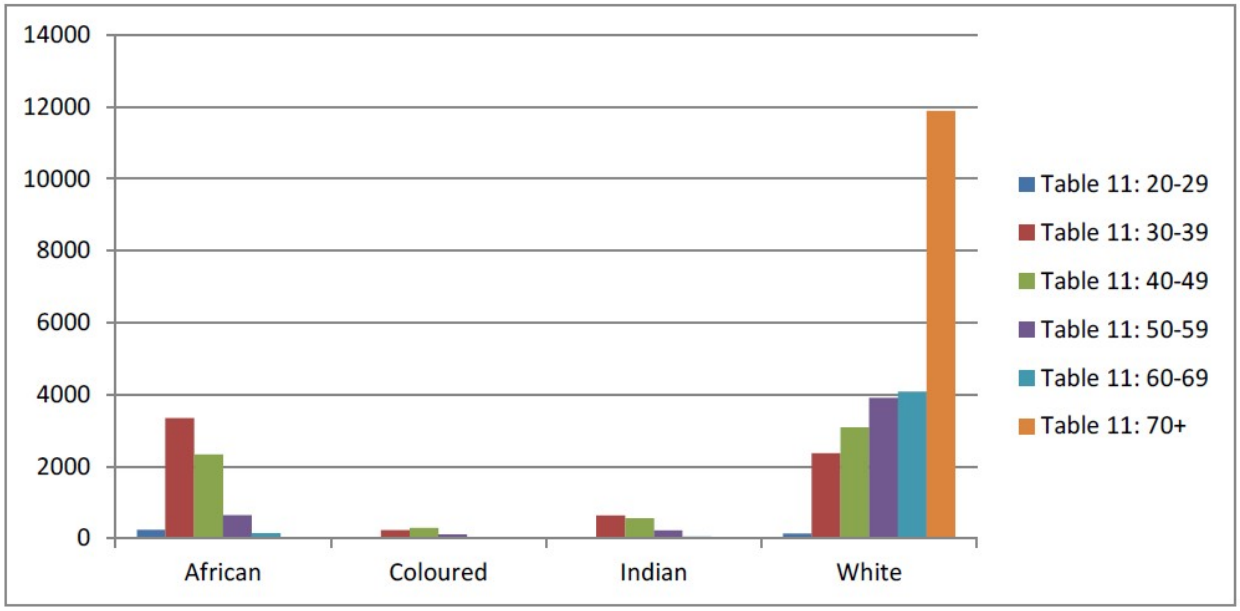


Figure 2.4: Total number of ECSA registered professionals by race and age

The statistics presented in **Table 2.5** and **Figure 2.5** on the specified category supports the worrying observation made from **Table 2.4** and **Figure 2.4** where 34% of all registered professionals are white retired males, here 10% are white retired males – circled in blue. When this percentage is combined with the 16% of registered white male professionals in the specified

category that are between 60 to 69 years, this totals to 26%; thus the pipeline of young professionals should be boosted via recruiting more Candidates to consider these categories. The general recommendation that can be made is for ECSA to increase promotion of the specified categories to industry.

Table 2.5: Total number of ECSA registered specified categories

Specified Category Age Analysis				
AGE Groups	African	Coloured	Indian	White
20-29	2	1	1	17
30-39	54	8	10	128
40-49	53	19	17	206
50-59	25	10	12	271
60-69	5	5	4	189
70+				111

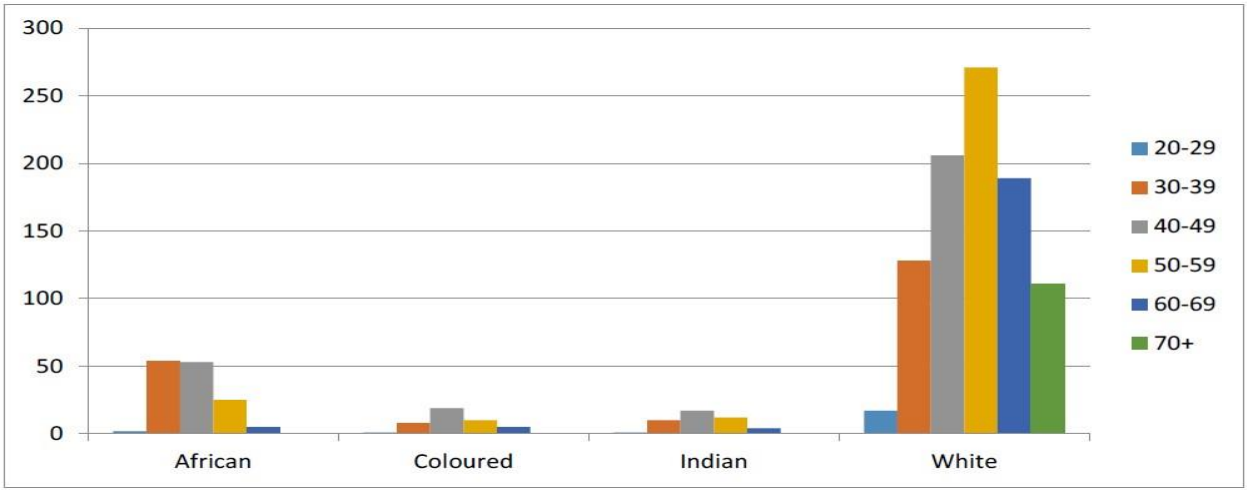


Figure 2.5: Total number of ECSA registered Specified Categories

2.2.3 Statistics of graduates who do not register

The statistics for graduates who study engineering but do not register with ECSA as Candidates was not covered in the scope of this research for the following reasons:

- Some leave the engineering industry.
- Some companies currently do not require registration so their employees do not register and will not register until the profession is fully regulated.
- The challenges under investigation can only be revealed by engineering professionals who are registered as Candidates because they are the ones facing the challenges of becoming professionally registered.
- The survey was distributed using the ECSA database, so the graduates who were not registered could not be reached as ECSA does not have their contact details.

2.3 Applications in abeyance (90)

As explained in Section 2.2, the target group is a population of engineering graduates who are registered in the Candidate category. The source of data used in this section is an Excel spreadsheet of the consolidated applications in abeyance. The pool is made up of a mix of Candidates who were deferred under the old legacy system (pre-March 2017) and those who were put in abeyance in NRS. The key difference in the two systems, which can be summarised as the structuring of the outcomes, does not affect the scope of this project because the insight into why the Candidates are stuck does not change (identification of challenges they face). It is critical to mention that the core requirements for professional registration are the same in both registration systems and going forward everyone will be registered using NRS. The reason for zooming in on these applications is to get insight on the main reasons that contribute to Candidates not meeting the requirement for professional registration, as per the assessor's finding during the experience appraisal process. Experience appraisal is a paper-based assessment where the assessor checks the candidate's experience for evidence that addresses the 11 outcomes required for professional registration. If one or more of the outcomes are not met, the Candidate is advised to take an additional 12 months to fill in the gaps.

The sections below describe the findings from analysing the data. The reporting is divided according to disciplines, categories, gender, race and reasons for abeyance.

2.3.1 Disciplines

The results below are for the applications in abeyance broken down in terms of the different disciplines. At the time of receiving the spreadsheet, 90 applications were in abeyance. As can be observed from the discipline breakdown below, the highest contributor is mechanical with 31%, followed by civil with 30% and then electrical with 21%.

- Agriculture – 1
- Chemical – 3
- Civil – 27
- Electrical – 19
- Mechanical – 28
- Lifting Machinery Inspector (LMI) – 10
- Mechatronics – 2.

The ECSA registration team should probe the root cause in each of these disciplines and mitigate the findings accordingly.

2.3.2 Category

The results below are for the applications in abeyance broken down in terms of the different categories. At the time of receiving the spreadsheet, the applications in abeyance classified per category were 80. As can be observed from the category breakdown below, the highest contributor is Engineers with 37%, with the Mechanical discipline contributing 62%, followed by Technologists with 31%, with the Civil discipline contributing 56% and then Technicians with 15% and the civil discipline contributing 67%. As expected, the Engineers category is leading due to the complexity of the work experience required. This is further supported by the dominant contributor being Mechanical because mechanical Candidates are required to submit a comprehensive design they have completed before registering as Professional. What is alarming is the dominance of civil in both the Technologists and the Technicians categories.

- Professional Engineering Technologist – 25 (Civil – 14)
- Professional Engineer – 39 (Mechanical – 24)
- Professional Engineering Technician – 12 (8 – Civil, 4 – Electrical)
- Professional Certificated Engineer – 4.

The ECSA registration team should probe the root cause of the abeyance in the following cases and mitigate the findings accordingly.

- Civil discipline in both the Technologists and Technicians category.
- Assess the fairness of the additional requirement for the Mechanical discipline in the Engineers category

2.3.3 Gender

The results below are for the applications in abeyance broken down in terms of gender. At the time of receiving the spreadsheet, the gender marked applications in abeyance totalled 90. The gender breakdown below indicates that males are facing more challenges than females. Males contribute 87% to the total. Of the remaining 13%, 67% are African females.

- Female – 12 (8 African)
- Male – 78.

This could be because women in general pay more attention to detail, which is a handy trait to have when submitting evidence against each of the 11 outcomes.

ECSA can mitigate this by emphasising the importance of the Candidates reading the outcomes thoroughly and fully understanding them before writing reports during the “road to registration” presentations. Candidates should be encouraged to ask any and all questions related to the outcomes they do not fully understand because there is no stupid question.

2.3.4 Race

The results below are for the applications in abeyance broken down in terms of race. At the time of receiving the spreadsheet, the race marked applications in abeyance totalled 90. The race

breakdown below indicates that African is the highest contributor with 56%, where 84% are males. This is easy to comprehend because English is not their first language. The second contributor is Whites with 35%, where 91% are males.

- African – 51 (43 male)
- Coloured – 1 male
- Indian – 5
- White – 32 (29 male)
- Blank – 1.

ECSA should mitigate the underlying message from these results by encouraging Candidates to attend technical report writing courses as part of their initial professional development (IDP).

2.3.5 Reasons for abeyance

The results below are for the applications in abeyance broken down according to the reasons for abeyance. At the time of receiving the spreadsheet, the applications marked with the reason for abeyance totalled 79. The main reasons for abeyance are listed below:

- Engineering report – 50 (Mechanical – 25, Civil – 14, Electrical – 15)
- Engineering report and training and experience – 7
- Training and experience report, engineering report and referee report – 4
- Engineering report and an additional referee report – 1
- 3 referee reports – 1
- Referee report from a Pr Certificated Engineer – 1
- Number of years after completing B Tech and national Diploma – 1
- Load test and course certificate – 1 (LI)
- Course certificate – 2 (LMI)
- Load test and course certificate – 8 (LMI)
- GCC validation and referee report from a Pr Cert Eng – 3.

The biggest contributor is the engineering report with 63%, followed by the combination of the engineering report and training and experience which contribute 9%. This is understandable because the engineering report is a comprehensive report that requires evidence of all 11 outcomes in one report; as such, it tests the Candidate's competence in report writing. ECSA can mitigate this key leading reason for abeyance by encouraging Candidates to attend technical report writing courses as part of their IDP. A more effective measure would be for ECSA to arrange to present soft skill courses such as technical report writing and offer them free to the Candidates as they do with "Road to registration" presentations where the presenter is paid by ECSA and target number for attendance is limited by the venue capacity.

2.4 Declined applications

The pool of declined candidates was not included in the scope of this research because the core reasons are initially the same as applications in abeyance. The two main reasons for applications being declined are the following:

- The candidate has not met the requirements during the stipulated abeyance period.
- The candidate has not submitted the missing information before the abeyance period lapses.

As such, the recommendation made for Candidates who apply and those in abeyance will be applicable to the Candidates that apply at a later stage.

2.5 Comparison with other countries

Since ECSA's new registration system (NRS) is still in infancy stage (3 years+), it is necessary to eliminate doubt around the registration process and requirements by mentioning that NRS is benchmarked against the best registration systems globally, so the NRS can be compared with other members of the International Engineering Alliance (IEA) Agreements. All members of the Agreements use substantially equivalent Competency Standards that define a number of outcomes that an applicant must achieve at a stated level, before they can be judged competent to register in a professional category. Substantial equivalence at the competence level as per the IEA Definition is as follows *"The overall outcomes achieved whilst not identical, are repeatable*

and effectively to the same standard, even if the means by which the outcomes are achieved or assessed are not similar."[7]

ECSA is a member of three Agreements:

1. International Professional Engineers Agreement (IPEA)
2. International Engineering Technologist Agreement (IETA)
3. Agreement for the International Engineering Technicians (AIET).

The outcomes and criteria that ECSA uses to evaluate competence are therefore fair and transparent.

3. DATA GATHERING

3.1 Procedure for selecting the sample from the population in ECSA's database

The criterion used for sample selection from ECSA's registration database is graduates who have been registered in the Candidate category from December 2017 until January 2020, with a total of 7 916.

3.2 Surveying method

The survey was emailed to all 7 916 Candidates. Surveying all Candidates is preferred as it covers all categories and disciplines. It also afforded all affected Candidates an opportunity to give feedback on their personal frustrations and challenges. The Candidates were given two weeks to respond to the survey and this time frame was extended to a month.

It is critical to mention that no specific percentage target was set for responses received from the population. Responses received at the time of survey closure were used to formulate results, findings, conclusion and recommendations.

3.3 Survey questions

The questions not only probed the perceived hurdles to registration, but also the managerial and technical activities related to Candidate's world of work and types of activities Candidates are

involved in. *The purpose of the 'world of work' questions was to gauge the potential degree of mismatch between a Candidate's world of work and ECSA's expectations for registration.* Dimensions such as span of control and managerial knowledge and responsibilities were also probed.

The technical knowledge part of the survey focused on selected outcomes defined by the IEA agreements. Only the most salient dimensions identified by the team, which included the dimensions most emphasised in the ECSA submission for professional registration, were probed. It was deemed that the inclusion of more dimensions would not add value and would push the total time to complete the questionnaire beyond 15 minutes.

The questions that were issue via Survey Monkey are listed below:

1. In which sector are you currently working?
Public
Private
Parastatal
Other
2. Tell us about your span of control:
There is currently no one directly reporting to me
I'm responsible for a team of 9 persons or less
I'm responsible for a team of 10–30 persons
I'm responsible for a team of more than 30 persons
3. What are the key managerial and leadership skills required from you in your workplace?
4. What are the key technical (as opposed to managerial) skills required from you in your workplace?

5. Is there a registered person in your environment who is assisting you on your registration journey and formally or informally mentoring you?
Yes, and the person's guidance is valuable
Yes, there are such persons in my environment, but I'm not mentored
No, there are no mentors available in my environment
No, I know what to do and don't need additional assistance
6. Do you think that the skills you acquired in your company created a strong foundation for candidates to professionally register and to mentor junior candidates?
Yes
To some extent
Not sure
7. Do you think that supporting development towards registration can ensure that there is a self-sustaining system of skills transfer and experience within your sector?
Yes
Not sure
No
8. Do you think the development of engineering graduates to the point of registration should be a national priority, requiring targets, policy, and funding?
Yes
To some extent
Not sure
9. What type of engineering activities are you primarily engaged in within your day-to-day work?
Activities involving diverse resources, interacting significantly and extending beyond the use of existing materials and techniques.
Activities involving limited resources, having limited interaction and requiring standard materials and techniques.

Activities involving a variety of resources requiring the use of new materials and techniques in novel ways.
10. Do you think engineering professionals should be exposed to deep technical work before moving into consultation and management roles?
Yes
Not sure
Should not be a pre-requisite
11. Of which types of engineering professionals are there a shortage in your environment?
Engineers
Technologists
Technicians
Artisans
There is no shortage
12. With which type of problems are you mainly dealing within your workplace?
Concrete problems with few conflicting constraints, which can be solved using standard codes and procedures
Unfamiliar problems with a significant degree of uncertainty and many conflicting constraints with no obvious solution
Problems with some uncertainty and conflicting constraints where the solution partially falls outside standard codes and procedures
I deal mainly with problems related to project management and the management of resources
13. What type of knowledge is most needed for the kinds of problems you are dealing with in your workplace?
I need in-depth theoretical knowledge and analytical skills and to comprehend and apply advanced knowledge of widely applied principles.

I need a sound knowledge of principles and knowledge embodied in widely accepted procedures, processes, systems or methodologies.
I need limited theoretical knowledge but need extensive practical knowledge embodied in standardized practices and procedures.
My work is more engineering management related. I need knowledge related to project management, finances, contracts, tenders, etc.
14. To what extent does engineering design play a role in your work at present?
I regularly use sophisticated strategies and tools to design and oversee potentially very complex systems, components, and processes.
I mostly execute intermediate design functions and contribute to the design of systems, components or processes.
My work is more engineering management related. Engineering design is not the main focus of my work.
15. To what extent are tests, test procedures and experiments part of your work?
I design and execute standard or routine tests and measurements to arrive at conclusions.
If needed, I mainly execute standard or routine tests and measurements to arrive at conclusions using standard codes and procedures, but this is not the main focus of what I do.
The design of simulations, tests, and experiments, and the analysis and synthesis of complex information to arrive at conclusions are part of what I do.
My work is more engineering management related. Simulations, tests and experiments are not a core part of my work.
16. Tell us about the engineering tools you use to execute your work
I regularly use modern engineering tools to solve engineering problems
I need to select and use modern engineering tools, including those involving some modelling and prediction, to solve engineering problems.
My main function is to create, select and use modern engineering tools, including those involving modelling and prediction, to solve engineering problems.
The tools I use relate more to engineering and project management than engineering design. My main focus is to deliver large projects within budget and on time.

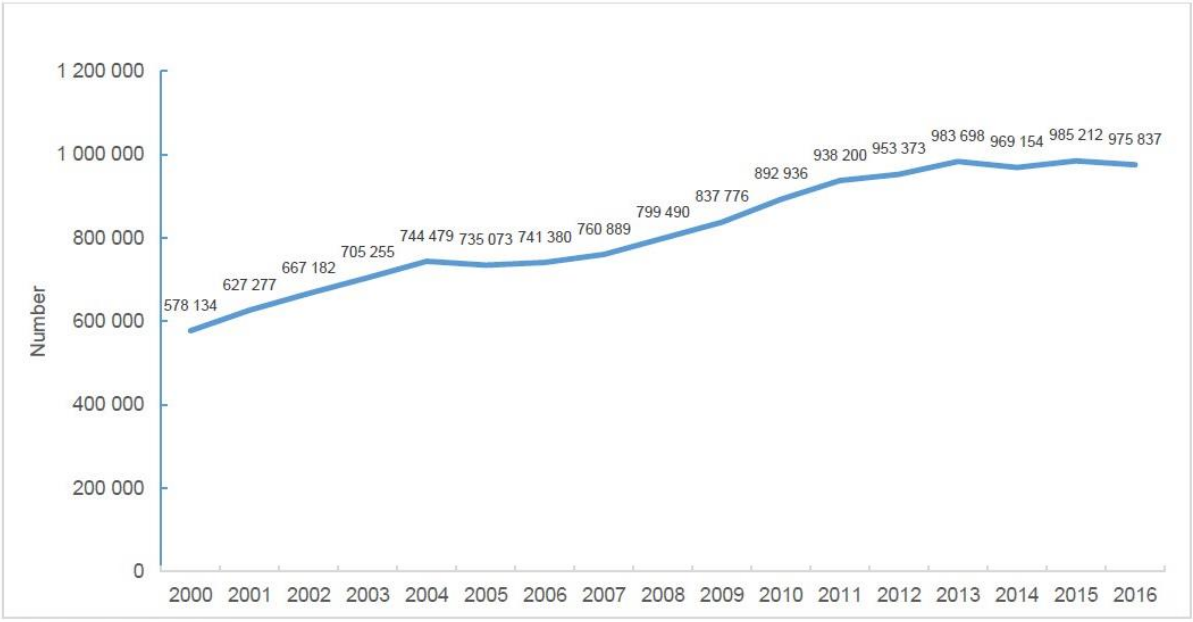
17. To what extent should engineering students be made aware of the Engineering Council's Code of Conduct during or after the completion of their studies?
Detailed awareness
Limited/some awareness
Not necessary
18. What could ECSA do to better assist candidates that want to register as professionals?
19. What challenges have you faced that have prevented you from applying for professional registration?
20. In conclusion, how do you think your current role could accommodate competencies that you have not been exposed to?

4. RESULTS AND FINDINGS

4.1 Higher education

Sources used indicate that participation by females over the last two decades in higher education has improved significantly. Improved access to higher education has also resulted in proportionally more women moving up the educational ladder. Overall, women now outnumber and outperform men in most educational fields. This also supports the finding in Section 2.3.3 where females were found to perform better than males.

Figure 4.1 shows a substantial increase in enrolment was observed from 2000 to 2016 among Black African (106.9%), followed by Coloureds (103.4%) and Indians/Asians (27.8%). During the same period there was a decrease of 6.2% in White enrolments. This also supports the finding in Section 2.2.1 where Africans were found to be the dominant race among Candidates.



Source: DHET (HEMIS)

Figure 4.1: Trends in enrolment at universities and technikons, 2000–2016

The percentage of enrolled students increased by 38.2% between 2000 and 2008 and by 22.0% between 2008 and 2016. **Table 4.1** shows the number of students enrolled in the sciences, technology, engineering and mathematics (STEM) fields constitutes close to 27%.

According to **Table 4.1**, the notable difference between male and female students was in the field of engineering, where 6.1% of females compared to 19.1% males were enrolled in this programme.

The finding here is that engineering as professional still requires much promotion and marketing at high school. ECSA is recommended to increase participation in schools through the Engenius programme.

Table 4.1: Enrolment at universities and technikons by CESM categories and gender, 2000

	University					Technikon					Total	
	Male		Female			Male		Female				
CESM categories	Number	%	Number	%	Total	Number	%	Number	%	Total	Number	%
Agriculture and renewal resources	2 405	60,0	1 603	40,0	**4 008**	3 338	64,2	1 858	35,8	**5 196**	9 204	1,6
Architecture and the built environment	2 032	64,6	1 113	35,4	**3 145**	4 209	73,7	1 504	26,3	**5 713**	8 858	1,5
Visual and performing arts	1 378	32,0	2 922	68,0	**4 300**	1 239	44,4	1 550	55,6	**2 789**	7 089	1,2
Business, economics and management studies	40 277	53,6	34 826	46,4	**75 103**	29 958	45,8	35 441	54,2	**65 399**	140 502	24,4
Communication, journalism and related studies	1 757	29,9	4 129	70,1	**5 886**	1 431	34,6	2 703	65,4	**4 134**	10 020	1,7
Computer and information sciences	7 834	61,4	4 916	38,6	**12 750**	11 258	55,1	9 161	44,9	**20 419**	33 169	5,8
Education	19 459	29,3	47 056	70,7	**66 515**	5 998	50,8	5 819	49,2	**11 817**	78 332	13,6
Engineering and engineering technology	8 972	84,9	1 597	15,1	**10 569**	19 824	80,9	4 687	19,1	**24 511**	35 080	6,1
Health care and health sciences	10 682	33,6	21 070	66,4	**31 752**	1 691	31,8	3 624	68,2	**5 315**	37 067	6,4
Home Economics	62	5,1	1 151	94,9	**1 213**	477	16,8	2 363	83,2	**2 840**	4 053	0,7
Industrial Arts, Trades and technology	93	53,8	80	46,2	**173**	561	41	808	59,0	**1 369**	1 542	0,3
Languages, linguistics and literature	5 860	32,4	12 228	67,6	**18 088**	2 852	51,9	2 638	48,1	**5 490**	23 578	4,1
Law	19 732	55,4	15 885	44,6	**35 617**	4 604	53,2	4 054	46,8	**8 658**	44 275	7,7
Libraries and museums	973	32,1	2 055	67,9	**3 028**	192	25,4	564	74,6	**756**	3 784	0,7
Life science and physical sciences	7 236	48,7	7 628	51,3	**14 864**	2 047	41,1	2 937	58,9	**4 984**	19 848	3,4
Mathematical sciences	6 879	59,6	4 669	40,4	**11 548**	2 034	77,2	602	22,8	**2 636**	14 184	2,5
Military sciences	2	100,0	0	0,0	**2**	0	0	0	0,0	**0**	2	0,0
Philosophy, religion and theology	3 466	54,7	2 876	45,3	**6 342**	9	29	22	71,0	**31**	6 373	1,1
Physical education, health education and leisure	799	47,3	889	52,7	**1 688**	405	63,1	237	36,9	**642**	2 330	0,4
Psychology	5 960	27,4	15 831	72,6	**21 791**	449	42,6	605	57,4	**1 054**	22 845	4,0
Public management and social services	3 442	37,3	5 789	62,7	**9 231**	12 720	61,2	8 070	38,8	**20 790**	30 021	5,2
Social sciences and social studies	16 261	42,8	21 776	57,2	**38 037**	2 519	42,9	3 356	57,1	**5 875**	43 912	7,6
Total	**165 559**	**44,1**	**210 088**	**55,9**	**375 647**	**107 816**	**53,8**	**92 604**	**46,2**	**200 420**	**576 067**	**100,0**

Source: DHET (HEMIS)
Note: Unspecified gender was excluded from the analysis

According to **Table 4.2** on tertiary enrolment in 2000, Black African students had the highest number of enrolments at universities (193 318) and technikons (145 738) consisting of 52.1% of overall university enrolments and 72.7% of overall technikon enrolments. The number of White university students was 128 650 which consisted of 34.7% of overall university enrolments, while technikons enrolled 33 962 white students which represented of 16.9% of all students. The Coloured population group had the lowest number of enrolments at university (17 969) compared to the other population groups. The breakdown of CESM Categories by population group agrees

with findings in **Section 2.2.1** where Coloured was found to be the lowest race in the Candidate category.

Table 4.2: Enrolment by population group and CESM categories for university and Technikons

CESM category	University				Technikon			
	Black African	Coloured	Indian/Asian	White	Black African	Coloured	Indian/Asian	White
Agricultural. and renewable resources	62,6	1,1	0,8	35,5	57,2	2,4	0,9	39,5
Architecture and environmental design	30,3	3,9	6,4	59,4	58,3	7,2	5,0	29,5
Arts, visual and performing	25,0	5,3	2,6	67,1	32,8	3,6	3,1	60,5
Business, commerce and management sciences	36,4	5,8	13,7	44,1	76,7	6,4	2,8	14,2
Communication	58,9	2,7	5,2	33,3	69,5	5,8	4,1	20,6
Computer science and data processing	40,6	5,1	12,0	42,4	65,6	7,6	7,5	19,4
Education	88,1	2,1	1,8	8,1	96,4	1,5	0,4	1,8
Engineering and engineering technology	26,0	3,1	13,3	57,6	68,8	5,1	6,6	19,4
Health care and health sciences	43,6	5,2	13,5	37,7	47,2	7,5	10,7	34,6
Home economics	59,9	2,1	0,7	37,3	57,1	5,8	5,8	31,3
Industrial arts, trades and Technology	8,5	5,8	1,5	84,2	32,4	9,7	6,7	51,2
Language, linguistics, and literature	55,8	6,4	4,6	33,2	76,8	7,9	3,4	11,9
Law	45,2	6,7	9,6	38,6	77,5	7,8	2,9	11,8
Libraries and museums	53,1	3,9	4,4	38,5	77,3	5,9	7,5	9,3
Life sciences and physical sciences	40,9	6,0	8,4	44,7	74,1	7,3	7,4	11,1
Mathematical sciences	46,5	3,3	8,8	41,4	69,4	7,3	4,3	19,0
Military sciences	45,5	0,0	0,0	54,5	0,0	0,0	0,0	0,0
Philosophy, religion and theology	38,4	7,0	5,6	49,0	89,0	5,3	0,8	4,8
Physical education, health education and leisure	34,9	3,0	4,3	57,8	38,0	4,1	1,1	56,9
Psychology	44,5	5,7	7,3	42,5	75,8	8,2	2,7	13,2
Public administration and social services	77,3	6,4	3,2	13,1	80,2	7,6	3,0	9,2
Social sciences and social Studies	56,2	5,1	8,1	30,7	76,8	5,8	2,9	14,5
Total	**193 318**	**17 969**	**31 265**	**128 650**	**145 738**	**12 493**	**8 200**	**33 962**
	52,1	**4,8**	**8,4**	**34,7**	**72,7**	**6,2**	**4,1**	**16,9**

Source: DHET (HEMIS)
Note: *Unspecified population group was excluded from the analysis

4.2 Survey questions

4.2.1 Results

There are currently 7 916 Candidate registrations on the ECSA CRM system:

- Candidate engineers: 2 976
- Candidate Engineering Technologist: 2 292
- Candidate Engineering Technician: 2 648.

The link to the online questionnaire was electronically sent to all Candidates. The response rates as follows:

- Candidate engineers: 45% (1 435 responses)
- Candidate Engineering Technologist: 37% (865 responses)
- Candidate Engineering Technician: 33% (873 responses).

The sectors Candidates are active in are shown in Table 4.3 About 64% of the respondents are in private practice.

Table 4.3: Sectors and responses

In which sector are you currently working?								
Answer Choices:	Engineers		Technologists		Technicians		Totals	
Public	15.12%	217	22.20%	192	30.01%	262	21.15%	671
Private	67.32%	966	64.39%	557	57.27%	500	**63.76%**	2023
Parastatal	15.05%	216	11.56%	100	9.51%	83	12.57%	399
Other	2.51%	36	1.85%	16	3.21%	28	2.52%	80
Answered		**1 435**		**865**		**873**		**3 173**
Skipped		**3**		**1**		**9**		

Table 4.4 shows results from the span of control questions related to Candidates' world of work and responsibilities.

Table 4.4: Span of control

Tell us about your span of control:						
Answer Choices	Engineers		Technologists		Technicians	
There is currently no one directly reporting to me.	53.71%	768	43.06%	369	49.02%	426
I'm responsible for a team of 9 persons or less	31.61%	452	33.14%	284	29.23%	254
I'm responsible for a team of 10-30 persons	7.69%	110	13.42%	115	10.70%	93
I'm responsible for a team of more than 30 persons	6.99%	100	10.39%	89	11.05%	96
Answered	**1 430**		**857**		**869**	
Skipped	**8**		**9**		**13**	

As seen in **Table 4.4**, the span of control across all three categories is relatively homogenous; 29% of Candidates manage small teams of less than 10 persons, and 7% of Candidate engineers and more than 10% of Candidate technologists and technicians manage teams of more than 30 persons. The fact that more than 50% of all Candidates manage teams might be an indication of the seniority and engineering responsibility of the Candidate groups.

Table 4.5 shows response per category for the open-ended questions where Candidates had to respond with information describing their current situation. The results are shown in **Figure 4.2** where Word Clouds, which counts the recurrence of keywords, were used to analyse the responses. The Word Cloud constructed from the Candidate engineers' responses is shown in **Figure 4.2**. The same themes emerged across all categories.

Table 4.5: Responses received for open-ended questions related to key managerial and leadership skills

What are the key managerial and leadership skills required from you in your workplace?				
	Engineers	Technologists	Technicians	Totals
Answered	**1 355**	**814**	**818**	**3 138**
Skipped	**83**	**52**	**64**	

Figure 4.2: Managerial Skills Word Cloud

The main themes that emerged include project management, management skills, engineering management, communication skills, people skills, working in teams, managing teams, technical leadership and decision making, technical communication, technical planning, financial planning.

Table 4.6 shows the response to technical skills e required from the Candidates' workplace. The Word Cloud is constructed from the Candidates' responses. The results for Engineers are shown in **Figure 4.3** and for Technicians in **Figure 4.4**. The same themes emerged across all three categories, particularly related to design, problem-solving, technical reporting, maintenance, testing, technical drawings, and writing of specifications. Design emerged more prominently from

the engineering group and themes such as technical drawings, specifications, and maintenance featured more strongly in the technologist and technician groups.

Table 4.6: Responses received for open-ended questions related to key technical skills

What are the key technical (as opposed to managerial) skills required from you in your workplace?				
	Engineers	Technologists	Technicians	Totals
Answered	**1 351**	**814**	**803**	**3 138**
Skipped	**87**	**52**	**79**	

Figure 4.3: Technical knowledge (engineers)

Figure 4.4: Technical knowledge (Technicians)

The two open-ended multiple-choice questions related to managerial and technical knowledge were asked followed by six questions that focused in more depth on the candidate's world of work and types of activities candidates are involved in. The purpose of these questions was to gauge the potential degree of mismatch between a candidate's world of work and ECSA's expectations for registration.

- **Table 4.7**: Although there are significant overlaps in the complexity of the environments, measured in terms of uncertainty and conflicting constraints among the Candidate categories, 24% of Engineers, 32% of Technologists and 39% of Technicians indicated that they mainly deal with problems related to *project management* and the *management of resources*.
- **Table 4.8:** Most candidates, irrespective of category, indicated that they deal with activities involving diverse resources that interact significantly. The majority experience their environments as highly complex.
- **Table 4.7**: Only 24% of *Candidate engineers* are exposed to the design of *complex* systems, components, and processes, and only 32% are exposed to design problems with some uncertainty and conflicting constraints, where the solution partially falls outside standard codes and procedures (typical technologist type problems).

- **Table 4.9**: On the other hand, 36% of Candidate engineers, 40% of Candidate technologists, and 48% of Candidate technicians stated that their work is more engineering management related and that engineering design is not their primary focus.
- **Table 4.9**: Only 25% of Candidate engineers indicated that their current work requires in-depth theoretical knowledge and analytical skills and to comprehend and apply advanced knowledge of widely applied principles. 35% indicated that in their current situation, they only need sound knowledge of principles and knowledge embodied in widely accepted procedures, processes, systems, or methodologies (typically required of technologists). Across all Candidate categories, more than 20% indicated that their work is more engineering management related and that they need in-depth knowledge related to project management, finances, contracts, tenders, etc.
- **Table 4.10 and Table 4.11**: Approximately 40% of all Candidates indicated that their primary focus is to deliver large engineering projects within budget and on time and that their work is engineering management related.

Table 4.7: Nature of engineering problems

With which type of problems are you mainly dealing within your workplace?								
Answer Choices	Engineers		Technologists		Technicians		Totals	
Concrete problems with few conflicting constraints, which can be solved using standard codes and procedures.	19.90%	283	27.12%	233	29.99%	257	24.63%	773

With which type of problems are you mainly dealing within your workplace?								
Answer Choices	Engineers		Technologists		Technicians		Totals	
Unfamiliar problems with a significant degree of uncertainty and many conflicting constraints with no obvious solution.	23.63%	336	17.23%	148	12.95%	111	18.96%	595
Problems with some uncertainty and conflicting constraints where the solution partially falls outside standard codes and procedures.	**32.35%**	460	23.63%	203	17.15%	147	25.81%	810
I deal mainly with problems related to project management and the management of resources.	24.12%	343	**32.01%**	275	**39.91%**	342	**30.59%**	960
Answered		**1422**		**859**		**857**		**3 138**
Skipped		**16**		**7**		**25**		

Table 4.8: Complexity of environment and resource interaction

What type of engineering activities are you primarily engaged in within your day-to-day work?								
Answer Choices	Engineers		Technologists		Technicians		Totals	
Activities involving diverse resources, interacting significantly and extending beyond the use of existing materials and techniques.	**47.78%**	678	**50.23%**	431	**46.21%**	396	**48.02%**	1 505
Activities involving limited resources, having limited interaction and requiring standard materials and techniques.	33.90%	481	34.73%	298	38.51%	330	35.39%	1 109
Activities involving a variety of resources requiring the use of new materials and techniques in novel ways.	18.32%	260	15.03%	129	15.29%	131	16.59%	520
Answered		**1419**		**858**		**857**		**3 134**
Skipped		**19**		**8**		**25**		

Table 4.9: Engineering design

To what extent does engineering design play a role in your work at present?								
Answer Choices	Engineers		Technologists		Technicians		Totals	
I regularly use sophisticated strategies and tools to design and oversee potentially very complex systems, components, and processes.	24.01%	341	25.49%	219	16.39%	140	22.34%	700
I mostly execute intermediate design functions and contribute to the design of systems, components or processes.	**39.93%**	567	33.53%	288	34.89%	298	36.80%	1153
My work is more engineering management related. Engineering design is not the main focus of my work.	36.06%	512	**40.98%**	352	**48.71%**	416	**40.86%**	1280
Answered		**1420**		**859**		**854**		**3133**
Skipped		**18**		**7**		**28**		

Table 4.10: Engineering knowledge

What type of knowledge is most needed for the kinds of problems you are dealing with in your workplace?								
Answer Choices	Engineers		Technologists		Technicians		Totals	
I need in-depth theoretical knowledge and analytical skills and to comprehend and apply advanced knowledge of widely applied principles.	25.04%	355	**27.62%**	237	23.63%	202	25.36%	794
I need a sound knowledge of principles and knowledge embodied in widely accepted procedures, processes, systems or methodologies.	**34.84%**	494	31.35%	269	25.15%	215	31.24%	978
I need limited theoretical knowledge but need extensive practical knowledge embodied in standardized practices and procedures.	17.42%	247	15.03%	129	16.26%	139	16.45%	515

What type of knowledge is most needed for the kinds of problems you are dealing with in your workplace?								
Answer Choices	Engineers		Technologists		Technicians		Totals	
My work is more engineering management related. I need knowledge related to project management, finances, contracts, tenders, etc.	22.71%	322	25.99%	223	34.97%	299	**26.96%**	844
Answered		**1418**		**858**		**855**		**3131**
Skipped		**20**		**8**		**27**		

Table 4.11: Simulations, tests and experiments

To what extent are simulations, tests, test procedures and experiments part of your work?								
Answer Choices	Engineers		Technologists		Technicians		Totals	
I design and execute standard or routine tests and measurements to arrive at conclusions.	12.69%	180	13.63%	116	12.82%	109	12.98%	405
If needed, I mainly execute standard or routine tests and measurements to arrive at conclusions using standard codes and	30.89%	438	31.49%	268	30.94%	263	31.07%	969

To what extent are simulations, tests, test procedures and experiments part of your work?								
Answer Choices	Engineers		Technologists		Technicians		Totals	
procedures, but this is not the main focus of what I do.								
The design of simulations, tests, and experiments, and the analysis and synthesis of complex information to arrive at conclusions are part of what I do.	18.27%	259	17.74%	151	13.06%	111	16.70%	521
My work is more engineering management related. Simulations, tests and experiments are not a core part of my work.	**38.15%**	541	**37.13%**	316	**43.18%**	367	**39.24%**	1224
Answered		**1418**		**851**		**850**		**3119**
Skipped		**20**		**15**		**32**		

Table 4.12: Engineering Tools

Tell us about the engineering tools you use to execute your work								
Answer Choices	Engineers		Technologists		Technicians		Totals	
I regularly use modern engineering tools to solve engineering problems:	21.46%	303	23.54%	201	20.48%	172	21.76%	676
I need to select and use modern engineering tools, including those involving some modelling and prediction, to solve engineering problems.	24.58%	347	21.66%	185	18.10%	152	22.02%	684
My main function is to create, select and use modern engineering tools, including those involving modelling and prediction, to solve engineering problems.	16.22%	229	15.11%	129	13.33%	112	15.13%	470
The tools I use relate more to engineering and project management than engineering design. My main focus is to	**37.75%**	533	**39.70%**	339	**48.10%**	404	**41.08%**	1276

Tell us about the engineering tools you use to execute your work								
Answer Choices	Engineers		Technologists		Technicians		Totals	
deliver large projects within budget and on time.								
Answered		**1412**		**854**		**840**		**3106**
Skipped		**26**		**12**		**42**		

Table 4.13 shows the responses from the Candidates per category with regards to the perceptions of the contribution and suitability of current work.

From **Table 4.13**, it is clear that less than 50% of candidates were fully convinced that their current work created a strong foundation for Candidates to register and mentor junior Candidates professionally. **Table 4.11** and **Table 4.12** and other open-ended questions, this uncertainty stems from the current workplace placing a premium on project management and the delivery of large engineering projects within budget and on time, as opposed to traditional engineering design.

Table 4.13: Perception of the contribution of current work

Do you think that the skills you acquired in your company created a strong foundation for candidates to register and to mentor junior candidates professionally?								
Answer Choices	Engineers		Technologists		Technicians		Totals	
Yes	44.83%	638	52.44%	451	48.67%	421	**47.97%**	1510
To some extent	37.81%	538	35.12%	302	35.14%	304	36.34%	1144
Not sure	17.36%	247	12.44%	107	16.18%	140	15.69%	494
No	0.00%	0	0.00%	0	0.00%	0	0.00%	0
Answered		**1423**		**860**		**865**		**3148**
Skipped		**15**		**6**		**17**		

Table 4.14 shows results to the questions related to the importance of professional registration and mentoring. The observation made from **Table 4.14**, is that only about 3% of all Candidates

indicated that they did not need mentoring. Between 30% and 32% of all Candidates indicated that they were mentored, and the rest, roughly 30%, indicated that there were potential mentors, but they were not mentored, while *35% indicated that they did not have access to mentors* in their environments. Re-thinking mentorship therefore can potentially impact 65% of the Candidate population.

Table 4.14: Being mentored

Is there a registered person in your environment who is assisting you on your registration journey and formally or informally mentoring you?								
Answer Choices	Engineers		Technologists		Technicians		Totals	
Yes, and the person's guidance is valuable	31.83%	453	30.02%	257	30.89%	266	31.08%	976
Yes, there are such persons in my environment, but I'm not mentored	34.08%	485	26.75%	229	28.69%	247	30.61%	961
No, there are no mentors available in my environment	30.64%	436	39.95%	342	38.21%	329	**35.25%**	1107
No, I know what to do and don't need additional assistance	3.44%	49	3.27%	28	2.21%	19	3.06%	96
Answered		**1423**		**856**		**861**		**3140**
Skipped		**15**		**10**		**21**		

Table 4.15 and **Table 4.16** shows that 83% of all Candidates are convinced that supporting development towards registration can ensure a self-sustaining system of skills transfer and experience within their sectors, and 73.71% felt that the development of engineering graduates to the point of registration should be a national priority, requiring targets, policy, and funding.

Table 4.15: Self-sustaining system of skills transfer

Do you think that supporting development towards registration can ensure that there is a self-sustaining system of skills transfer and experience within your sector?								
Answer Choices	Engineers		Technologists		Technicians		Totals	
Yes	81.98%	1169	86.83%	745	83.31%	719	**83.67%**	2633
Not sure	11.99%	171	10.49%	90	12.28%	106	11.66%	367
No	6.03%	86	2.68%	23	4.40%	38	4.67%	147
Answered		**1426**		**858**		**863**		**3147**
Skipped		**12**		**8**		**19**		

Table 4.16: National priority and targets

Do you think the development of engineering graduates to the point of registration should be a national priority, requiring targets, policy, and funding?								
Answer Choices	Engineers		Technologists		Technicians		Totals	
Yes	65.96%	938	79.44%	684	80.74%	700	**73.71%**	2322
To some extent	26.37%	375	16.96%	146	16.15%	140	20.98%	661
Not sure	7.67%	109	3.60%	31	3.11%	27	5.30%	167
Answered		**1422**		**861**		**867**		**3150**
Skipped		**16**		**5**		**15**		

As shown in **Table 4.17**, 83% of Candidates felt that engineering students should be made aware of the Engineering Council's Code of Conduct during and/or after the completion of their studies. Determining to what extend this is built into the Graduate Attributes and accessed during accreditation visits to universities should be investigated.

Table 4.17: Awareness of Code of Conduct

To what extent should engineering students be made aware of the Engineering Council's Code of Conduct during or after the completion of their studies?								
Answer Choices	Engineers		Technologists		Technicians		Totals	
Detailed awareness	75.04%	1067	88.69%	761	89.86%	771	**82.82%**	2599
Limited/some awareness	21.03%	299	9.79%	84	8.16%	70	14.44%	453
Not necessary	3.94%	56	1.52%	13	1.98%	17	2.74%	86
Answered		**1422**		**858**		**858**		**3138**
Skipped		**16**		**8**		**24**		

The three open-ended questions related to registration hurdles were also asked as listed below:

- What could ECSA do to assist Candidates better that want to register as professionals?
- What challenges have you faced that have prevented you from applying for professional registration?
- How do you think your current role could accommodate competencies that you have not been exposed to?

ECSA needs to give support to the several overlapping themes that emerged from these questions. The themes can be summarised under the following headings:

Process related: There are prevailing perceptions that completing and submitting the documentation is difficult. The lack of good examples of successful submissions and guidelines to report work done in an acceptable way were mentioned. The general sentiment is that the process should be simple, fast and uncomplicated. Many seem to be unaware of the progress ECSA has made in this regard.

Mentor and support related: Creating a mentor network and a process to access to such a network, especially for individuals working in small companies with restricted resources, were highlighted. It was suggested that one way to do this would be for reports to be sent *by ECSA* to mentors to scrutinise and provide feedback on before submission.

Requirements related: Many Candidates expressed that ECSA should re-visit the requirements for registration, especially relating to traditional engineering activities and design. Many expressed the opinion that there should be a recognition that the engineering economy in South Africa has shifted away from *traditional* engineering activities, that a greater premium and emphasis is being placed on the management of engineering projects, and that what is viewed as acceptable work should adapt accordingly.

These sentiments verbally reflect what has been reported in **Table 4.7** to **4.12**: It is clear that fewer than 50% of Candidates were fully convinced that their current work creates a strong foundation for Candidates to register and to mentor junior Candidates professionally. It is not clear to what extent this is rooted in their current *perceptions* of the ECSA requirements or in an accurate assessment of their work experience. It can be inferred that this uncertainty stems from the current workplace placing a premium on project management and the delivery of large engineering projects within budget and on time, as opposed to traditional engineering design.

Registration disciplines: Many reported that the existing disciplines were outdated and not accommodating emerging fields such as Computer Engineering, Automation Engineering, Biomedical Engineering, etc. Recommendations to have an Engineering Management category also emerged. This need seems to be supported by the gathered data.

Legislation related: Many expressed that the engineering profession should be no different from the legal and medical professions. The prevailing sentiments were that as long as registration is optional, getting people to register will be problematic.

4.2.2 Findings of the shortage of engineering practitioners

One question, shown in **Table 4.18**, was included to get a sense of the perceived shortage of engineering professionals. As shown in **Table 4.18**, between 15% and 19% of Candidates felt that there was no shortage currently. Another extremely interesting phenomenon emerged: Candidate engineers felt that there was only a shortage of engineers. Candidate technologists felt that there was only a shortage of engineers and technologists, and Candidate technicians felt that there was a shortage in the engineer, technologist and technician categories. On average, only 6% felt that there was a shortage of artisans.

Table 4.18: Shortage of engineering professionals

Of which types of engineering professionals are there a shortage in your environment?								
Answer Choices	Engineers		Technologists		Technicians		Totals	
Engineers	**60.22%**	857	**30.81%**	265	**30.91%**	268	44.13%	1390
Technologists	6.32%	90	**40.47%**	348	**29.07%**	252	21.90%	690
Technicians	5.97%	85	5.81%	50	**18.80%**	163	9.46%	298
Artisans	7.73%	110	5.81%	50	5.42%	47	6.57%	207
There is no shortage	19.75%	281	17.09%	147	15.80%	137	**17.94%**	565
Answered		**1423**		**860**		**867**		**3150**
Skipped		**15**		**6**		**15**		

4.2.3 Types of complaints recorded in Quality management on the Registration business unit

The themes picked up from the recorded complaints were as listed below:

- Delayed access to information requested.
- Delayed response to an advisory interview request.
- An internal non-conformity was against additional documents not scanned into the paper trail system.

ECSA can easily mitigate these complaints by improving the response time from the registration team.

4.3 Applications in abeyance

4.3.1 Results

The statistics analysed from the database of Candidates in abeyance revealed the following:

- Engineering with regards to registration is still dominated by men (87%).
- The race struggling the most with registration is African males (47%) followed by White males (32%).

- In terms of writing the report, Candidates seem to be struggling with the Engineering Report (55%). With regards to discipline Mechanical leads with 50%, followed by Electrical at 30% and Civil at 28%.
- For Professional Engineering Technologist category, Civil is a red flag leading with 56%.
- For Professional Engineer category, Mechanical is a red flag leading with 62%.
- For Professional Engineering Technician category, Civil is a red flag leading with 67%.

ECSA is should investigate the root cause of the red flags listed above and mitigate them accordingly.

4.4 Declined applications

None were investigated as per the reasons listed in **Section 2.4**.

4.5 Comparison with other countries

The ECSA registration model is robust and comparable with other engineering registration systems globally. It is ECSA's responsibility to ensure sustainability of registering engineering professionals by ensuring that there are enough assessors, moderators and reviewers to handle all the registration categories.

Four IEA members' registration systems were studied and the results are listed below.

New Zealand

New Zealand uses a peer review model in the registration of its engineers. It is argued that peer review is a powerful tool in maintaining and enhancing the quality of engineering work It is an important check in a self-regulating profession like engineering. Further to this, Engineering New Zealand is of the view that a peer review can identify situations where different engineering decisions could have been made. Originating engineers and their engineering firms or organisations have the chance to hear and understand different ways of approaching aspects of the engineering work. Engineering New Zealand currently has over 20 000 registered members and it is arguable that this high number of registrations is due to an effective registration model that New Zealand uses to register its engineers This is the same model that ECSA uses, as such,

it should be noted that the ECSA registration model is not only robust but it is also of global standard[8].

United Kingdom

There are 36 Professional Engineering Institutions (PEIs) in the UK, each covering specific engineering disciplines. A person who wishes to be registered as an engineer joins a PEI which is licensed by the Engineering Council. Once the person has joined a PEI, he/she is required to record his/her professional development. This can be in the form of academic qualification, employer training and development schemes. The candidate can then apply for assessment once he/she is of the view that they have gained the indispensable technical and personal competences (The CEng eBook). Though the titles given to registered engineers may differ from the ones ECSA affords, the model is the same and it has resulted in the UK registering over 222 000 people professionally as Engineering Technicians (EngTech), Incorporated Engineers (IEng), Chartered Engineers (CEng) and Information and Communication Technology Technicians (ICTTech) (CEng eBook)[9].

Netherlands

In the Netherlands, the registration process requires the applicant to show five competencies: (i) Knowledge and understanding of engineering (ii) Design development of processes, systems, services or products (iii) Leadership, responsibility and management (iv) Communication and interpersonal skills (v) Professional commitment. Engineers in the Netherlands can register and be recognised as a Chartered Engineer (CEng) or an Incorporated Engineer (IEng) . The registration process to become a CEng or IEng comprises an interview which lasts for 90 minutes; the interview is conducted by two experienced engineers. The candidate is then required to prepare a 10-minute presentation on one or two projects, after which questions are asked on both the presentation and the portfolio . Looking at this model and the current ECSA registration model, it is arguable that the ECSA model is more rigorous as the policy dictates that 11 people – reviewers, assessors and moderators – are required to assess one application[10].

USA

In the USA, an engineer who requires to register as Professional Engineer (PE) has to undergo the principles and practice of engineering exam. However, the taking of the PE exam differs from state to state. States such as Alabama, Alaska, Florida and Michigan do not allow applicants to take the PE exam without prior experience which includes 4-year Accreditation Board for Engineering and Technology/Engineering Accreditation Commission accredited degree, passing the Fundamentals of Engineering exam and the Principles and Practice of Engineering exam, and 4 years of progressive engineering experience. On the other hand, as stated above, states such as California allow graduates of accredited engineering programmes to take the PE exam after gaining two years of experience. In 2009, Illinois changed its requirements so that engineers could take the PE any time after passing the Fundamentals of Engineering (FE) exam . Furthermore, in October 2013, Kentucky started allowing candidates to apply to take the PE exam without any experience if they had passed the FE exam and met the state's education requirements. Nevada was the first state to allow graduates to take the PE any time after passing the FE exam. The 4-year experience requirement remains, but it can be fulfilled after a candidate takes the PE exam experience[11]

4.6 Observations from the team

This section shares one key observation shared by the team as active mentors in industry. Additionally this observation is drawn from their experience as assessors, moderators and reviewers.

The biggest challenge is the submissions' poor quality. Poor applications are the main reason for the increased abeyance and declines. This results from applicants not fully understanding the requirements outlined in the 11 outcomes. ECSA has provided the policy on registration on its website and this information can be accessed by everyone interested in registering with ECSA. ECSA's responsibility is to provide a platform where applicants can access this information with ease and this has been implemented successfully. ECSA cannot be responsible for the poor applications submitted by applicants due to lack of interest and commitment. Ideally, Candidates

should self-assess their competence against the 11 outcomes before submitting to their referees and ECSA.

It is critical to mention that mentors play an important role in the development and growth of mentees. Mentors must be familiar with the requirements of NRS so they can ensure that the candidate's experience and knowledge address the 11 outcomes adequately.

5. RECOMMENDATIONS

The recommendations made from the different findings are as follows;

1. From Section 2.2.2, the recommendation is for ECSA to increase the number and frequency of the "road to registration" presentations, more specifically because they are currently offered on request.
2. From Section 2.2.2, an interesting aspect to probe is which system were the 19% registered professionals between the age 30 of 39 registered under. Two key guiding questions to investigate are the following:
    - Which system did they register in, legacy or NRS?
    - Which registration system is the pool of assessors, moderators and reviewers registered through?

    The answers to these questions will conclusively inform which mitigation measures ECSA can commission to assist Candidates, e.g. training of mentors in industry.
3. From Section 2.2.2, the general recommendation is for ECSA to increase promotion of the specified categories.
4. From Section 2.3.1, the recommendation is for the ECSA registration team to probe the root cause in the leading three disciplines and mitigate the findings accordingly.

5. From Section 2.3.3, the recommendation is for the ECSA registration team to probe the root cause of the abeyance in Mechanical with 31%, followed by Civil with 30% and then Electrical with 21%. and mitigate the findings accordingly.

6. From Section 2.3.3, the recommendation is for the ECSA registration team to probe the root cause of the abeyance in the following cases and mitigate the findings accordingly.

    - Civil discipline in both the Technologists and Technicians category.
    - Assess the fairness of the additional requirement for the mechanical discipline in the engineers category

7. From Section 2.3.3, the recommendation to ECSA is that during the “road to registration” presentations, the importance of the Candidates reading the outcomes thoroughly and fully understanding them before writing should be emphasised and Candidates should be encouraged to ask any and all questions related to the outcomes they do not fully understand because there is no stupid question.

8. From Section 2.3.4, the recommendation for ECSA, judging from the underlying message from these results, is that ECSA should encourage Candidates to attend technical report writing courses as part of their IDP.

9. From Section 2.3.5, the recommendation for ECSA, using the key leading reason for abeyance, is that ECSA should encourage Candidates to attend technical report writing courses as part of their IDP. A more effective measure would be for ECSA to arrange to present soft skill courses, such as technical report writing, and offer them free to Candidates as they do with “road to registration” presentations where the presenters are paid by ECSA and the target number for attendance is limited by the venue capacity.

10. From Section 4.1, the finding is that engineering as a profession still requires much promotion and marketing at high school. ECSA is recommended to increase participation in school through the Engenius programme.

11. From Section 4.2.1, ECSA should re-think mentorship as it could potentially impact 65% of the Candidate population.

12. From Section 4.2.3, the complaints can easily be mitigated by improving ECSA's registration team's response time.

13. From Section 4.3, ECSA is recommended to investigate the root cause of the red flags listed above and mitigate them accordingly.

14. From Section 4.4, ECSA must probe the mentor-manager relationship to expose engineering Candidates' fundamental and technical aspects.

15. From Section 4.5, it is recommended that ECSA must state that professional development through CPD is vital for development of professionals and it is legal requirement to continue to practice as professional engineer.

16. From Section 4.6, it is recommended that ECSA investigate whether Candidate engineers and technicians have work expertise aimed at investigating engineering problems.

17. From Section 4.14, it is recommended that ECSA establish how a mentoring programme can be applied and institutionalised at a strategic level within the organisation.

18. From Section 4.15, it is recommended that ECSA encourage self-sustaining skills transfer as it could impact on 83% of engineering Candidates during registration.

19. From Section 4.16, it is recommended that ECSA encourage such national priority intervention on the strategic level as it can potentially impact 73.71% of engineering Candidates.

20. From Section 4.17, ECSA should assess the effectiveness of engineering graduates in understanding the Engineering Council's Code of Conduct, as that could impact 82.82% of engineering graduates.

21. The survey clearly showed that the world of work has shifted away from traditional engineering and that a greater emphasis is currently being placed on advanced engineering

management skills. Nearly half of the Candidates indicated that delivering large projects within budget on the time accounts for most of what they do. Yet, it seems that the criteria for registration have not adapted and are out of step with industry. The is little recognition that the engineering economy in South Africa has shifted away from traditional activities, that a greater premium and emphasis is being placed on the management of engineering projects, and that what is viewed as acceptable work should adapt accordingly.

22. To the knowledge of the Working Group, there is no clear process to add new registration disciplines. The discipline names and number of disciplines reflect the situation 25 years ago. Little or no movement to adapt to the industry has happened. Linking the disciplines to Voluntary Associations, such as in UK (Professional Engineering Institutions), to cover specific engineering disciplines, and using these organisations to assess Candidates should be considered.

Other random recommendations to resolve registration challenges made by the team as practising active mentors and engineering registered professionals are:

A. ECSA should sensitise government to consider a setup/programme that will develop engineering graduates to the point of registration by setting national targets, including the regulation of the profession in the EPA, and provide funding.

B. ECSA should sensitise government to implement an intervention to assist with the leaking pipeline.

C. ECSA should look into programmes to attract practising graduates to register as professionals

D. ECSA and government must actively and proactively motivate, stimulate interest in and improve access to engineering to students in high school.

6. CONCLUSION

The purpose of this research was to determine the root causes of why Candidate engineers do not register as Professionals. This study has confirmed the target group of professionals below 39 years and currently registered. 58% of registered professionals are white males who are over 50 years, with 34% retired, who are over the age of 70 years.

The study has confirmed the presence of challenges such as being familiar with the NRS registration system requirements and mentoring as most of the mentors were registered under the legacy system. The NRS system developed should be used as the basis for encouraging mentoring and registration. The study has also confirmed, across all Candidate categories that their work is more engineering management related and that they need more knowledge related to project management, finances, contracts, tenders, etc. It can also be inferred from this study that ECSA should re-visit the requirements, especially related to traditional engineering activities and design. The study also confirmed that there should be recognition that the engineering economy in South Africa has shifted away from the traditional activities and that more premium is being placed on the management of engineering project.

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	Revision Date	Revision Details	Approved By
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Identify challenges for registration from Candidate to Professional registration

Revision 0, dated 18 June 2020, consisting of 62 pages, was reviewed for adequacy by the Business Unit Manager and approved by the Executive: Research, Policy and Standards **(RPS)**.

Business Unit Manager — 2021/10/07 Date

Executive: RPS — 2021/10/11 Date

This definitive version of this research report is available on our website.