

Factors affecting the registration of Black South African civil engineering graduates with the Engineering Council of South Africa

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Management, University of the Witwatersrand, in partial fulfilment of the
requirements for the degree of Master of Business Administration**

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ABSTRACT

The objective of this research was to identify the factors affecting the professional registration of Black South African civil engineering graduates with the Engineering Council of South Africa.

The main research question was, why, despite research hinting that the political and economic climate being in favour of the development of Black graduate civil engineering professionals, and that the processes for registration are clearly defined, only 12% of the registered engineering population are Black South Africans. What are the barriers that prevent civil engineering graduates from registering as professionals? The formulation of the research question was informed by the literature review.

The research method adopted was a qualitative analysis. Data was collected by interviews with individual Black civil engineering graduates from various civil, construction and the built environment sectors. Central constructs were then identified and grouped together to formulate themes that eventually informed the outcomes of the research study.

The research findings concluded that the factors which are barriers to professional registration for Black civil engineering graduates include weaknesses in the professional development programs and initiatives within organisations in both the private and public sectors. This included inefficient supervision, mentoring and coaching. The study also showed that the type and quality of work given to Black graduates is not suitable for the process of professional registration. Language was also found to be an inhibitor in social environments. Learning and knowledge transfer happening equally often in social events and corridor discussions as they do in formal project, business or mentoring meetings.

The study concluded that the overall work experience and civil engineering culture in the work place, was incongruent with the aspirations of Black graduates. The experience was demotivating to the point that some graduates who shared a

passion and purpose for civil engineering as a profession, now feel that they are possibly in the wrong career.

There was also a clear indication that Black graduates need to become more acquainted with the professional registration processes and take charge of their career path in relation to the registration processes, and not rely on the system to direct their personal and professional development, and that the role of the bodies that govern civil engineering should become more prominent and attuned with the needs of the industry and its members.

Various recommendations were presented to partners in the industry. The key recommendations includes the development of a macro, integrated and aligned process of professional registration that required practical and deliberate involvement of the individual, institutions, employers and the public sector with a view to achieve rapid transformation of the civil engineering sector, which is part of the national agenda of South Africa.

DECLARATION

I, Manglin Pillay, declare that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Signed at Midrand on the 11th day of February 2015.

A handwritten signature in black ink, appearing to read 'Manglin Pillay', with a large, stylized loop at the end.

Manglin Pillay PrEng HDE MSAICE

DEDICATION

For my mother, and all mothers who wrestle with Heaven and prevail, for the emancipation of their children through education,

for my sister, and all sisters that rise and rise again until lambs become lions

and for my brother, and all brothers imposed upon to bear the burden of fraternal responsibility.

ACKNOWLEDGEMENTS

I express sincere gratitude to the following individuals –

I thank Dr. Christoph Maier, my supervisor, for his patient guidance and encouragement during this research project.

I thank the South African Institution of Civil Engineering (SAICE) and its members who are associated with the most rewarding, honourable and gratifying profession – Civil Engineering, for their continued support.

I acknowledge my mentor, Mr Peter Kleynhans (SAICE President 2013), in whom I have found a role model – you have my respect.

I also express sincere gratitude to Miss Rebekka Wellmans for assisting with technical research, and Mr Desigan Dever, Miss Nomathamsanqa Mpofana, Miss Nadeena Le'Tang and Mrs Nobothwe Mugeru for their assistance in transcribing the interviews. Mrs Mugeru, my personal assistant, was indomitable in helping with my time management.

Finally, reading for an MBA degree is demanding on filial relationships – for her constant quiet affirmation, I thank my wife Edlyn Natalie Pillay. Edlyn has taught me love, the verb, throughout this MBA journey. She continues to do so every day.

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LIST OF ABBREVIATIONS

ANC	African National Congress
ASCE	American Society of Civil Engineers
BBBEE	Broad Based Black Economic Empowerment
BRICS	Brazil, Russia, India, China and South Africa
CBE	Council for the Built Environment
CESA	Consulting Engineers South Africa
CSCE	Cape Society of Civil Engineers
DHET	Department of Higher Education and Training
DPW	Department of Public Works
ECSA	Engineering Council of South Africa
GDP	Gross Domestic Product
HBCU	Historically Black Colleges and Universities
HR	Human Resources
ICE	Institution of Civil Engineers
IdoEW	Identification of Engineering Work
MTEF	Medium Term Expenditure Framework
NDP	National Development Plan
NGP	New Growth Path
NPC	National Planning Commission
PICC	Presidential Infrastructure Co-ordinating Commission
PrEng	Professional registration
SAFCEC	South African Forum for Civil Engineering Contractors
SAICE	South African Institution of Civil Engineering
SIPs	Strategic Infrastructure Projects
UK	United Kingdom
UNESCO	United Nations Engineering and Science Council
UoT	University of Technology

USA	United States of America
VA	Voluntary Association
WIL	Work Integrated Learning

CHAPTER 1. INTRODUCTION

1.1 Purpose of the study

The purpose of this research is to identify those factors that inhibit Black South African civil engineering graduates from achieving adequate training and development in order to meet the criteria for professional registration with the Engineering Council of South Africa (ECSA).

In order to derive maximum benefit from the opportunities that the built infrastructure environment offers in South Africa, it is imperative the engineering graduates are professionally registered with the ECSA (Lawless, 2005).

1.2 Context of the study

Civil Engineering is the oldest of the engineering professions and its main task is to perform civil works in order to make the properties of matter and the sources of nature useful to people (Horikawa, 2009). This definition is affirmed by the classical definition of Civil Engineering which is the art of directing the great sources of power in nature for the use and convenience of man (ICE, 1828). Horikawa (2009) continues that the advancement of civil engineering has therefore been closely associated with the development of civilization. A Civil Engineer is one who practices this art (Ferguson & Chrimes, 2011).

The work of Civil Engineers has long been associated with the planning, design, construction and operation and maintenance of various facilities and structures to satisfy the need of human activities including military operations (Horikawa, 2009). Historically, this included roads, bridges, railways, aqueducts, canals, river navigation, docks, storehouses, ports, harbours, breakwaters, lighthouses, sea and flood defence, hydropower, water supply, irrigation, urban drainage and sanitation (Booth, 1979). Modern additions to the list include airports, urban

transport, transportation planning, sewerage, sewage treatment and waste management, public and private buildings, dams and reservoirs, power supply and distribution, ground, geotechnical and geospatial engineering, offshore engineering, construction materials, and environmental engineering (Ferguson & Chrimes, 2011).

While Civil Engineers are employed in various sectors in the economy, their main places of employment are in the public sector in tiers of Government involved in infrastructure delivery, operation and maintenance, and in the private sector in construction businesses and consulting engineering services (Horikawa, 2009; Lawless, 2005).

In South Africa, Civil Engineers are regarded as a scarce skill (Rasool, 2014). A scarce skill is a qualification or job for which there are limited people doing that job (Ramutla, 2010). Effective utilisation of scarce skills has been proven to set countries on a winning economic pathway, as evidenced in Singapore, China, and Japan (Pillay, 2014).

South Africa has in recent years experienced a major boom in the construction industry (Thwala, 2008). According to Medium Term Expenditure Framework (MTEF) figures published by the National Department of Treasury, South Africa invested, on average, 7.4% of GDP per year on infrastructure from 2009 to 2013, and will continue spending 7.4% of GDP on infrastructure for the next 3 years (Landman, 2014). The comparative average infrastructure spend for other BRICS countries over the same period is 4.5% (Pillay, 2014). It has become evident that Government has adopted an infrastructure development strategy as its overall economic development strategy for South Africa (Zuma, 2014).

A comparison of general engineering capacity with other developing and developed countries, however, suggests that South Africa has a shortage of engineering skills. South Africa has only one tenth the number of the engineers of the BRICS nations (Watermeyer & Pillay, 2013). The need for engineering skills is

most dire in the public sector in national, provincial and local Government, where infrastructure is administrated, planned, delivered and managed (Lawless, 2005).

Transformation in the Civil Engineering and built infrastructure environment is a further challenge as indicated by the ECSA database. Transformation in terms of gender, race balance and diversity has been a worldwide challenge, but is a particularly sensitive issue in South Africa, in all sectors of the economy, including the engineering sector (Gale & Davidson, 2006; Hooper, 2012; Ketcham, Frehill, & Jeser-Cannavale, 2005; Lawless, 2005). Race representation of engineering professionals on the ECSA database indicates an imbalance with less than 12% of the 34 000 registered professionals being Black (ECSA, 2013). About 90% of the population of South Africa are Black African, Coloured and Indian (Tamara et al., 2010).

The political and economic climate is evidently in favour of the development of Black professionals in South Africa, including Civil Engineers (Emuze & Adlam, 2013). The number of Black professionals actually registering with the ECSA and becoming active members of the South African Institution of Civil Engineering (SAICE) however, needs to be improved (ECSA, 2013).

Against this canvas, the business problem that this research investigates is the challenges affecting the development of candidate Black South African civil engineers into professionals.

1.3 Problem statement

1.3.1 *Main problem*

The main research problem is that Black South African civil engineering graduates experience challenges in gaining work experience and registering with the ECSA. A direct result of this situation is the constricted production of Black South African Civil Engineering capacity into the infrastructure engineering and construction industry.

1.3.2 Sub-problem 1

The first sub problem is that Black civil engineers are not registering fast enough to achieve the transformation imperatives of the country and to alleviate the shortage of civil engineering capacity. This problem exists despite civil engineering is a scarce skill and is critically needed for the planning, design, delivery and management of infrastructure (Reddy, 2010; UNESCO, 2010).

1.3.3 Sub-problem 2

The second sub problem is that graduate Black engineering graduates seem to be stifled in the work place with regard to work place training and development. There seems to be insufficient training and a disjoint between the actual experience of Black graduate civil engineering professionals in the work environment in comparison to the documented expectations and requirements for registration as professional civil engineering practitioners with ECSA.

1.3.4 Sub-problem 3

The third sub problem is that it is perceived that Black engineering graduates advance in organisations without accumulating sufficient knowledge, wisdom and experience, which then stifles their professional advancement in terms of professional registration and flexibility to make progressive career moves within the industry.

1.4 Significance of the study

This study is significant because the civil engineering and built infrastructure industry in South Africa, has been experiencing challenges in attracting, recruiting and retaining skills in civil engineering to deliver infrastructure to the nation (Lawless, 2005).

A comparison with other developing and developed countries suggests that South Africa is far behind in terms of engineering capacity (Watermeyer & Pillay, 2013). The comparison is discussed further in the literature review under Section 2.6.

The study is important because a nation's socio-economic development and quality of life of its citizens depend heavily on the supply, efficient operation and maintenance of civil engineering infrastructure (Lawless, 2005). The sustainability of the civil infrastructure and engineering industry is driven by GDP, interest rates, inflation rates, access to investment funding and public sector spending (Reddy, 2010). Behind the agriculture and mining sectors, the civil engineering infrastructure and construction sector is the 3rd highest employer of all sectors in South Africa (Watermeyer, 2012).

A third reason for this study being significant is that it has become evident that Government has adopted an infrastructure development strategy as its overall economic development strategy for South Africa (Zuma, 2014). The process of structurally aligning Government's budget with the NDP and the SIPs was started during 2013 (South African Reserve Bank, 2013). South Africa will continue to spend 7.5% of its annual GDP on infrastructure

The NDP, together with the Department of Economic Development's New Growth Path, have informed the establishment of the Presidential Infrastructure Coordination Commission (PICC) within the office of the Presidency (The Presidency: Republic of South Africa, 2013). At a macro level, the PICC has developed a National Infrastructure Plan with 18 identified Strategic Integrated Projects (SIPs) that have been approved for implementation by cabinet. These projects include more than 645 infrastructure projects across the country (Presidential Infrastructure Coordinating Commission, 2012).

Finally, this study is important because in attempting to resolve the challenge of civil engineering capacity in South Africa, therein exists an opportunity to address transformation imperatives required to eradicate all forms of discrimination and obstacles against equal opportunity in the civil engineering sector.

Based on South Africa's apartheid legacy, there is an urgent need to improve the racial diversity imbalance in the economy of South Africa (Nkuhlu, 1993; Sithole, 2010; Tladi, 2001). While South Africa has made great strides in transformation since 1992, the need for tangible equal opportunities in relation to economic and professional development remains a disquieting concern (Leadership, 2014; Richards, 2013).

Although the number of Black graduate engineers increased twofold from 1996 to 2005 (Renette Du Toit & Joan Roodt, 2009), Lawless (2005) asserts that Black graduates have been slower to register professionally than their White male counterparts. ECSA has indicated that transformation challenges continue to plague the profession by announcing that ECSA's Implementation and Transformation Committee have been charged to address the low conversion rate from candidate engineer to professional engineer status, for Black graduates (ECSA, 2013).

1.4.1 *Symptoms of the lack of engineering capacity*

Lawless (2007), discovered, when assessing projects that had been initiated in the 72 municipalities, only about 50% were completed with minor niggles. The remaining projects required major reworking or were abandoned (refer to Figure 1-1).

The various failures were attributed to a lack of professional skills in civil engineering and its allied disciplines (Mkhacane, 2014a). Civil engineering skills are regarded as scarce skills in light of South Africa's adoption of an infrastructure development strategy for the overall socio-economic development plan for the country (Rasool, 2014).

Figure 1-1 Project assessments in responding municipalities

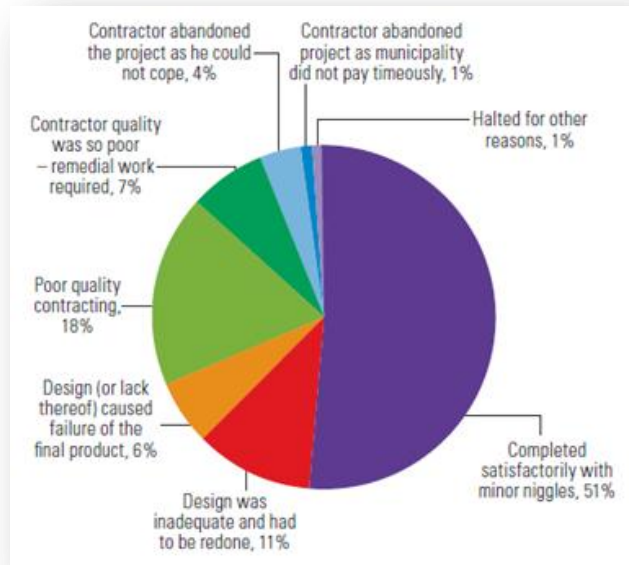


Figure 1-1 courtesy of Lawless (2007)

1.5 Research objectives

The objectives of the research report are to:

- Gain an overall understanding on the factors that cause Black engineering graduates to experience challenges in registering as professionals with ECSA, despite the registration process being clear and well-advertised in the industry.
- Achieve understanding on why the civil engineering industry is not transforming fast enough to address proportional racial representation with the national population statistics, despite a shortage of civil engineering practitioners in the industry and a national, government driven focus on achieving transformation in all sectors of the economy.

- Improve understanding of prevalent workplace training challenges that Black graduate civil engineering professionals experience and that stifles their prospective registration with ECSA.
- Gain an understanding on the expectations and reasons for Black graduates advancing in organisations without achieving sufficient engineering training, experience and professional registration.
- After the research, the author surmises to be in a position to put forward thoughts on how to address the challenges that might emanate from the investigation. This will feature in a recommendations section.

1.6 Research contribution

This research report is intended to be of value to:

- Employers and HR Managers of civil engineers, including the public sector and national government, who will be able to use the findings of the study to inform their strategies, planning and execution models to increase their technical and professional civil engineering capacity.
- Senior civil engineering practitioners, who are involved in mentoring, coaching and managing graduates, may also find this study useful in informing their approach to guiding their mentees towards professional registration.
- University staff and academics involved in civil engineering could utilise the outcomes of this research to review and enhance their curricula in order to address weakness and shortfalls rooted in university level but that are manifest in the work place. Awareness of registration is one such example.
- Organised civil society like the institutions mentioned above, play a critical role as advocates for social change in South Africa (Camay & Gordon, 2002). Institutions like the South African Institution of Civil Engineering (SAICE), South African Forum of Civil Engineering Contractors (SAFCEC), Consulting Engineers South Africa (CESA), and others, to use the findings

of the study to assist them in establishing relevant and sustainable programs for Black candidate engineering practitioners to register as professionals.

1.7 Delimitations of the study

The following delimitations are applicable:

- Civil engineering graduates are employed in various components of the engineering project cycle and infrastructure delivery pipeline including contracting, consulting, public & parastatal sector administration, banking and finance, manufacturing, education and others.

This study focusses on Black civil engineering graduates from the traditional academic universities that produce graduate engineers and universities of technology (UOTs) that produce engineering technicians and technologists.

- ‘Civil engineering professionals’ or ‘civil engineering graduates’ are used interchangeably, but refer to the combined population of engineering technicians, engineering technologists and engineers. For the difference between these categories, see Table 2-1 in Section 2.4.

While each category of engineering practitioner follows different career paths in terms of undergraduate academic course content, expected performance in the workplace and process for professional registration, the process of registration requires assessment in line with the same competency areas of development shown in Table 2-2 in Section 2.4.

- Women are generally underrepresented in the engineering profession (Gale & Cartright 1995; Lawless 2005, 2007). The lack of gender diversity

is of international concern. While the study will aim to attract participation equally from both genders, it is expected that the dominant gender participating will be male because the industry is a male dominated one (Power, 2014).

Due to time constraints, I have excluded gender diversity from the scope of this research report. Being acutely aware of the gravity and significance of the lack of gender diversity in engineering, I advocate for an independent study on the subject in order gain insight into the topic.

1.8 Definition of terms

The following definitions are applicable to this research – see Table 1-1.

Table 1-1 Definition of terms

Term	Definition
Civil Engineering	Classically defined as the art of directing the great sources of power in nature for the use and convenience of man (ICE, 1828)
Black	Is a generic term which means Africans, Coloureds and Indians (BBBEE Act, 2003)
Registration	The administrative process undertaken in order to receive recognition from the ECSA's committees that one meets the minimum requirements expected of a professional person. This recognition extends to colleagues, as well as all other practitioners in the

Term	Definition
	profession (ECSA, 2014).
ECSA	For the engineering profession, the Engineering Council of South Africa (ECSA) was established to provide for the registration of professionals, candidates, and specified categories in the engineering profession (Engineering Professions Act 46 of 2000). The core mandate of ECSA is to accredit engineering education programs and to register engineering professionals thereby ensuring that engineering professionals conduct themselves as professionals and adhere to an engineer's code of conduct (Steyn & Daniels, 2003).
SAICE	The South African Institution of Civil Engineering (SAICE) is the official voluntary association for the civil engineering profession in South Africa offering learned society, technical leadership for the profession (SAICE, 2010).
Professional	For the context of this study, a professional is an individual with a post high school qualification in civil engineering, from a recognised tertiary institution.
Registered Professional	For the context of this study, a registered professional is an individual with a post high school

Term	Definition
	qualification in civil engineering, from a recognised tertiary institution, and accredited by a peer review system via the Engineering Council of South Africa, to take responsibility for work as per the Engineers Professions Act (2000).

1.9 Assumptions

The following assumptions are applicable:

- The sample in the research is a reasonable reflection of the population of Black graduate and registered engineering professionals in the field of civil engineering.
- Achieving professional engineering status is an aspiration for all civil engineering graduates. Professional status is viewed as a key asset for promotion, improved salary and exposure to greater responsibility in the work place.
- The factors that affect the development of Black South African civil engineering practitioners will be similar before, during and after the study is complete. Any variation will be negligible.
- The participants for the interviews will be Black graduate civil engineering professionals who work in South Africa. While there may be similarities in the outcomes that might resonate in other professions or countries, the research outcomes is aimed to address the need of the South African civil engineering environment alone. See also, Section 1.6.

CHAPTER 2. LITERATURE REVIEW

2.1 Introduction

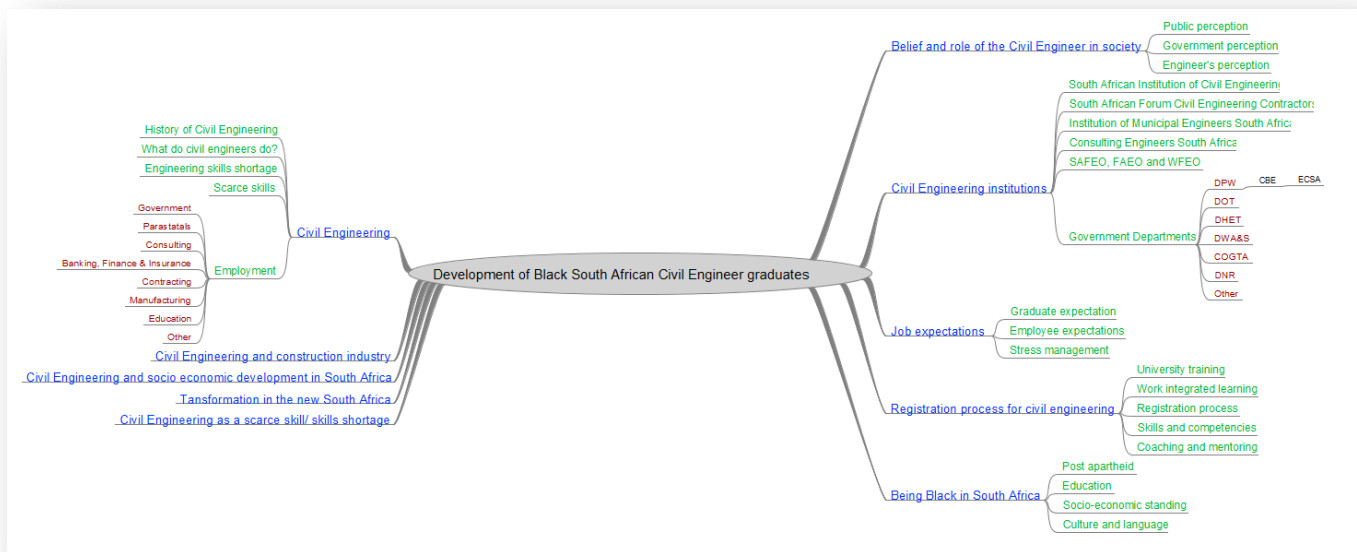
The literature review is intended to paint the landscape against which all civil engineers are attracted to the profession, undergo academic training at universities, register as professionals and finally operate in.

Initially, it will take a broad view of the civil engineering and construction environment as well as to briefly discuss current challenges and opportunities in the sector. The study will then focus on the issues pertaining to the development of Black South African Civil Engineers which includes academic training, work integrated training, professional registration requirements and the process of professional registration before the individual is recognised as professional Civil Engineer by ECSA and SAICE.

This chapter then, explores the literature base associated with civil engineering as a profession which includes the type of work that civil engineers do and where they are employed. It follows on with the institutions that govern civil engineers and the opportunities arising in the South African construction industry. Finally the research focusses on transformation and diversity in South Africa as a national socio-economic imperative, the engineering skills shortage issue, the registration process for civil engineers and job expectations of graduate engineers.

The subheadings of these categories may be viewed graphically in the form of a mind map shown in Figure 2-1. Mind mapping of ideas in visual drawing form helps create new insights and show multidirectional connections as opposed to being isolated and abstract when present in linear words alone (Brown, 2014). The mind map used in this document was created by FreeMind 1.0.1 2014 software, which is freely downloadable from the internet.

Figure 2-1 Literature review topics – Mind Map



2.2 Civil engineering as a profession

Civil Engineers and civil engineering existed long before the term was coined and dates as far back as 5000 years to the construction of the Great Pyramids (Wood, 2012). The word Civil Engineer was used formally in Italy and France around the 17th century, to distinguish engineering services provided to civil society from that of military engineering services (Ferguson & Chrimes, 2011). John Smeaton, known as the founder of modern civil engineering, around 1750, was the first to create the notion of Civil Engineering as a profession (Horikawa, 2009).

In more recent times, the London based Institute of Civil Engineers (ICE) expanded the definition of Civil Engineering to the great art on which the wealth and well-being of the whole of society, is totally dependent upon (Adama Science & Technology University, 2011). A unique feature of Civil Engineering is the exercise of the imagination to create business processes, products and the overall built environment necessary for a sustainable future, by applying scientific

principles, knowledge of materials and the art of analysis and synthesis. It also requires great business, leadership and team working skills.

Civil Engineers, as a professionals engage in organised civil engineering projects, where they is involved in technical design and supervision of construction (Consulting Engineer), as well as building the infrastructure (Contractor) (Ferguson & Chrimes, 2011). The work of civil engineering is manifest in the development of civil infrastructure associated with transport, supply of water, water and wastewater treatment, supply of power and in general, the facilitation and management of nature's forces for the benefit of man (Charles, 2012).

Civil engineers are involved in the planning, design, construction, operation and maintenance of infrastructure (ASCE, 2006). Traditionally civil engineers are employed in contracting engineering services, spheres of Government related to infrastructure planning, delivery and management, consulting engineering services and in manufacturing (Lawless, 2005). In general, civil engineers are involved in innovation and integration of ideas and technology across the public, private and academic sectors (ASCE, 2006).

Due to their intensive academic engineering training and resulting ability to apply strategic process and problem solving principles to challenges, civil engineers are sought after by the banking, finance and insurance sectors, other corporate businesses and public sector institutions and other non-engineering related industries (Renette Du Toit & Joan Roodt, 2009).

2.3 Institutions that govern civil engineering in South Africa

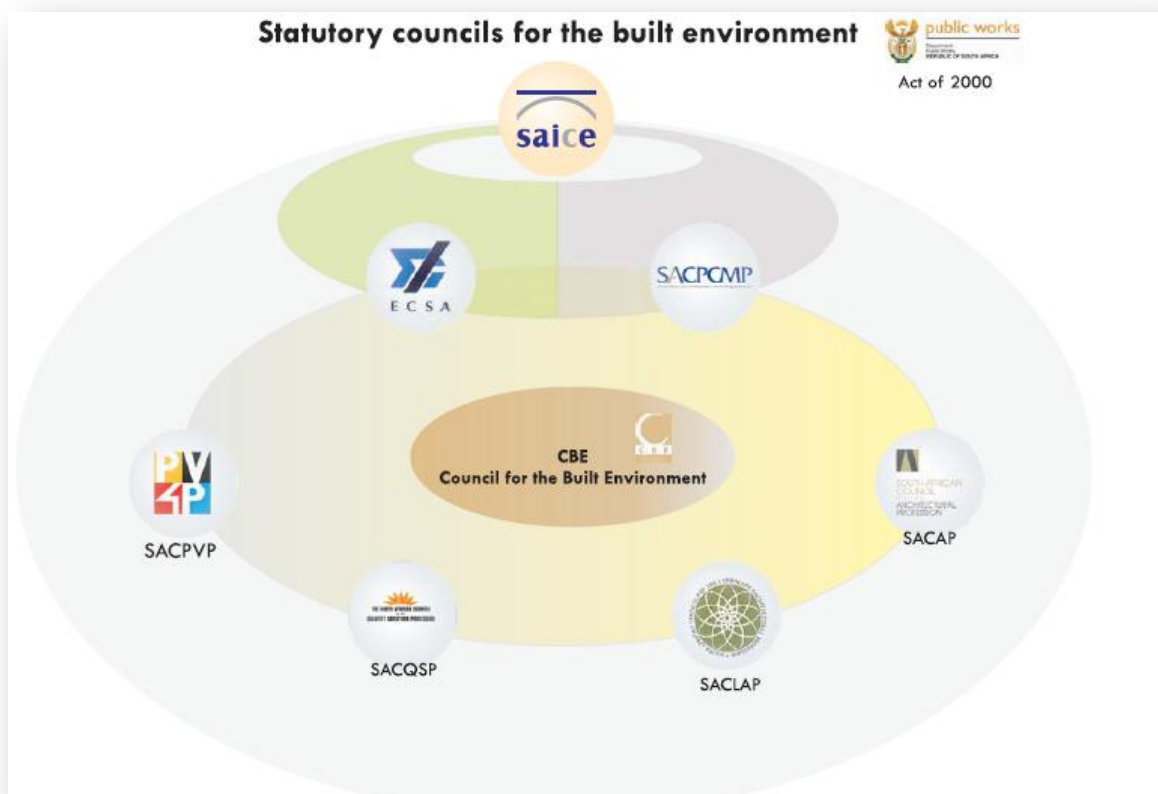
In South Africa, professional engineering practice is regulated and administrated by acts of law, under the auspices of the Ministry of the Department of Public Works (DPW). Each Act regulating the professions provides for the establishment of a statutory council for that specific profession (Republic of South Africa, 2000a).

For the engineering profession, the Engineering Council of South Africa (ECSA) was established to provide for the registration of professionals in specified

categories in the engineering profession (Republic of South Africa, 2000b). The core mandate of ECSA is to accredit university engineering programs and to register engineering professionals thereby ensuring that engineering professionals conduct themselves as professionals and adhere to an engineer's code of conduct (Steyn & Daniels, 2003).

The scope of the engineering statutory bodies is shown in Figure 2-2.

Figure 2-2 Institutions that govern civil engineering in South Africa



The South African Institution of Civil Engineering (SAICE), is a Voluntary Association (VA) recognised by the ECSA (Republic of South Africa, 2000b). Not unlike the London based Institution of Civil Engineer (ICE), which was established in January 1818 as a self-help learning society for British based Civil Engineers (Ferguson & Chrimes, 2011), SAICE was established to promote social interaction

amongst Civil Engineers and to serve as a learned society and technical leadership institution for civil engineering (Cape Society of Civil Engineers, 1904).

SAICE was initially founded as the Cape Society of Civil Engineers (CSCE) in Cape Town in 1903 (Botha, 2003). SAICE is governed by a Constitution and a set of by-laws which guides the manner in which it achieves its objectives and continues to be the voice of civil engineering with close to 18 000 members on its database (SAICE, 2014) some 111 years later.

Externally, the bodies that SAICE engages with includes a vast network and includes statutory bodies, discipline-specific bodies, international bodies, tertiary institutions and interested and associated structures (DeKoker, 2013). The network where Civil Engineers feature prominently as professionals also includes civil engineering specific VAs like Consulting Engineers South Africa (CESA), the South African Forum for Civil Engineering Contractors (SAFCEC) and the Institution of Municipal Engineers South Africa (Lawless, 2007).

2.4 Professional engineering registration process

Society places great faith in the engineering profession, trusting them to deliver infrastructure that is reliable, safe, and cost effective to build, operate and maintain (Pillay, 2011b). This trust can only be delivered through significant individual commitment that is publicly demonstrated by the attainment of professional competencies and behaviour that are described in a standard (Bourn & Neal, 2008).

Competence is the possession of knowledge, skills and attitudes necessary to perform to a certain standard, activities related to a professional category or discipline of engineering (ECSA, 2012). The ECSA guide explains further that knowledge is acquired from the engineering education process and subsequent processes, and skills and attitudes are defined by a set of assessable outcomes.

In relation to engineering education, the current qualification offerings at South African Universities and Universities of Technology are shown in Table 2-1.

One indicator of competence in engineering knowledge, evidenced both in one's own engineering self-efficacy as well as through external audit is professional licensure or registration after reading for an engineering degree (Hughes & Hurtado, 2013). Professional registration with the Engineering Council is based on competence and commitment (Bourn & Neal, 2008; Crawley, Malmqvist, Östlund, Brodeur, & Edström, 2014). ECSA has defined the requirements for registration under the categories for Engineer, Engineering Technologist, Certified Engineer and Engineering Technician (Case, 2006).

After graduating at an academic institution, and following a minimum of 3 years of work experience in civil engineering areas of project management, technical engineering design and construction, a candidate may apply for professional registration with ECSA (ECSA, 2012).

A summary of the registration categories is shown also in Table 2-1.

Table 2-1 Engineering qualifications and registration categories in South Africa

Institution	Qualification in Engineering			
Traditional Academic University	Bachelor's Degree (BSc, BEng)	Honours (BSc Hons, BEng Hons)	Masters (MSc)	Doctorate (PhD)
ECSA Registration	Professional Engineer (PrEng)			
University of Technology	National Diploma (ND)	Bachelor of Technology	Masters in Technology	Doctorate in Technology

Institution	Qualification in Engineering			
(Old Technikons)		(BTech)	(MTech)	(DTech)
ECSA Registration	Professional Engineering Technician (Pr Techni Eng)	Professional Engineering Technologist (Pr Tech Eng)	Professional Engineering Technologist (Pr Tech Eng). Registration as Pr Eng is possible via Alternative Routes.	

Table 2-1 courtesy of Lawless (2005)

After graduation, candidates should be mentored while they gain training and experience, under an immediate supervisor who is a registered professional, in the work environment, on real projects (Pillay, 2011a). The role of the mentor is to serve as an experienced and trusted advisor guiding the graduate engineer through their training period, checking that the training requirements are fulfilled (Hammack & High, 2014).

During the training experience, the graduate is required to demonstrate 11 competency outcomes within 5 competency groups (ECSA, 2012). These are summarised in Table 2-2.

Table 2-2 Competency areas of development required for professional registration with ECSA

Group	Summary of group	Expected outcomes
A	Knowledge based engineering problem solving	1. Define, investigate and analyse problems
		2. Design or develop solutions
		3. Comprehend and apply knowledge

Group	Summary of group	Expected outcomes
B	Manage engineering activities	4. Manage part or all of one or more engineering activities
		5. Communicate clearly with all stakeholders related to the engineering activities
C	Impacts of engineering activity	6. Recognise and address foreseeable social, cultural and environmental impacts
		7. Meet regulatory requirements and protect health and safety of people
D	Exercise judgement, take responsibility and act ethically	8. Conduct engineering activities ethically
		9. Exercise sound judgement
		10. Be responsible for decision making
E	Continuous professional development	11. Undertake professional development

Table 2-2 courtesy of ECSA (2012)

2.4.1 Desirability of professional registration

At the time of compiling this document, professional engineering registration with ECSA was optional. As a result only about 30-40% of civil engineering graduates register with the ECSA (Lawless, 2014). ECSA and the CBE, however, have begun the process of promulgating identification of engineering work legislation,

which will enforce registration for individuals who wish to pursue careers in engineering (Sabelo, 2014).

Through the introduction of policy to make registration compulsory, coupled with the low numbers of professionally registered Black candidates, government appears to portray the sentiment amongst Black engineering graduates to register with ECSA, as being weak. It also indicates that government wishes to increase the desirability of graduate engineering practitioners to professionalise (ECSA, 2013). To achieve this aspiration, Government appears to have turned to policy rather than rely on the private sector only to encourage registration with ECSA (Pillay, 2012b).

After professional registration ECSA considers the individual to be a professional that is able to achieve the 11 expected outcomes discussed in the 5 competency areas, as set out in Table 2-2, with little or no supervision (ECSA, 2012). A registered professional may sign off on engineering work that usually manifests in drawings, reports and other documentation (Rènette du Toit & Joan Roodt, 2009). Signing off is an indication that registered individuals absorb more responsibility and accountability for their work, and they therefore are deemed more valuable to employers. An expected consequence of registration then is an increased responsibility in the workplace, which also solicits a commensurate increase in commercial and corporate rewards (Lawless, 2014). This process of professional development is described to students at undergraduate level studies at universities by their lecturers, SAICE and ECSA (Pautz, 2015).

Based on this historic status quo, and the Engineer Professions Act (2000) which advocates professional registration, it is expected that the desirability of graduates to want to register is prevalent – refer to Section 1.9 where this assumption is put forward.

2.5 Civil engineering and construction sector opportunities in South Africa

In the global economy, the state of a nation's physical infrastructure provides one of the best indicators of its likely prosperity (SAICE, 2011). The quadrennial Infrastructure Report Card also states that there exists a positive relationship between infrastructure and human well-being. Former US President John F. Kennedy has been quoted saying, "It is not the wealth of the nation that build roads, but the roads that build the wealth of a nation" (UNESCO, 2010, p. 319). A nation's economy and the quality of life of its citizens depend heavily on the supply, efficient operation and maintenance of infrastructure (Lawless, 2005).

South Africa has in recent years experienced a major boom in the construction industry (Thwala, 2008). Prior to hosting the soccer world cup in 2010, the country embarked on a massive expansion in infrastructure which included investments in the upgrading of power stations, building roads, airports, harbours and improving municipal services and public transportation (Renette Du Toit & Joan Roodt, 2009). The Government of South Africa used the advent of the world cup as a catalyst to fast track many of these infrastructure projects and invested R30 billion on transportation and telecommunications infrastructure as well as building and upgrading 10 stadiums in 9 cities across the country (Department: Sport and Recreation South Africa, 2010).

The South African infrastructure engineering and construction industry had total revenues of R102 billion in 2012. The civil engineering segment was the industry's most lucrative in 2012, with total revenues of R80 billion. The performance of the industry is forecast to accelerate to R118 billion by the end of 2017 (Datamonitor, 2014). The 2013 national budget, however, magnified the commitment to infrastructure spending in the medium term, announcing a substantial R827 billion budget for various infrastructure projects over the next 3 years (South African Reserve Bank, 2013).

The South African National Planning Commission (NPC), under the auspices of the office of the Presidency, being charged to develop a long term vision and strategy for the nation, put forward a National Development Plan (NDP) (National Planning Commission, 2010). During 2012, the NDP was adopted by Cabinet and by the ruling political party, the African National Congress, to guide economic policy over the period to 2030 (South African Reserve Bank, 2013).

The NDP identifies 10 key development focus areas (National Planning Commission, 2013). While infrastructure engineering cut across all 10 focus areas, 6 are directly impacted upon by civil engineering, viz. Transformation of Urban Spaces, Expansion of Infrastructure, Job Creation, Fighting Corruption, Building a Capable State and Education and Training (Pillay, 2012c).

2.6 Civil engineering skills shortage

Shortage of engineering skills is a global phenomenon that affects the built infrastructure and civil engineering industry in South Africa (Pillay, 2012b). The industry in South Africa has been experiencing challenges in attracting, recruiting and retaining skills in civil engineering in order to deliver infrastructure to the nation (Lawless, 2005).

The South African National Department of Higher Education and Training (DHET) indicated the perennial nature of this predicament when it announced its South Africa's National Scarce Skills List: Top 100 occupations in demand. Engineering skills dominate the top 20; Civil engineers features second most in demand on the list (Rasool, 2014).

A comparison with other developing and developed countries suggests that South Africa is far behind in terms of general engineering capacity. Western Europe and North America have an average of between 150 and 300 people per engineer (Watermeyer & Pillay, 2013). It is discomfoting to note that both China and India, who are part of the 5 major emerging national economies together with Brazil, Russia, and South Africa (BRICS), have similar statistics (Lawless, 2005;

Watermeyer & Pillay, 2013). Watermeyer and Pillay continue to state that South Africa has only one tenth of the engineers of those nations. The need for engineering skills and capacity in South Africa is therefore far greater.

This view is acknowledged by the Engineering Council of South Africa (ECSA). The international benchmark of average population per engineer shows that South Africa lags behind other developing countries (ECSA, 2013). According to the ECSA, in South Africa, one engineer services 3166 citizens, compared to Brazil's 227 and Malaysia's 543 (ALSTOM, 2012). The discrepancy in the benchmark points out that South Africa "is severely under-engineered" (Watermeyer & Pillay, 2013, p. 4).

The need for engineering skills is most dire in the public sector – national provincial and local Government, where infrastructure is administrated, planned, delivered and managed (Lawless, 2005). Due to the lack of civil engineering and related skills in the public sector, the National Departments of Water and Environmental Affairs, for example, reported a R7.2 billion loss emanated from inefficient water infrastructure (Buthulezi, 2014). The article states that of the 821 municipal water treatment facilities around the country, only 40 plants were functioning optimally and 460 facilities were in a critical or very poor state. On average, South Africa's existing infrastructure most of which are in the care of the public sector has been deemed to be stressed, not coping to meet current demand and is poorly maintained (SAICE, 2011). Owing to the lack proficient systems, structures and appropriate technical capacity within the sector, Government institutions are inefficient at rolling out civil engineering projects effectively (National Planning Commission, 2013).

2.7 Apartheid, transformation and diversity

In order to provide creative and optimal engineering solutions, it is advantageous to have a diverse engineering team that fosters the bringing together of various socio-economic and engineering perspectives to inform the process of finding

ideal engineering solutions to engineering problems (Andrew, 2012; Hooper, 2012; Layne & Arenberg, 2002).

The civil engineering industry lacks diversity and balance in terms of race and gender (Lawless, 2007). According to the ECSA database, race representation of engineering professionals is imbalanced with less than 12% of the 34 000 registered professionals being Black (ECSA, 2013). While this is a particularly sensitive issue in South Africa, the lack of gender and race balance and diversity in the engineering sector has been a worldwide challenge (Gale & Davidson, 2006; Hooper, 2012; Ketcham et al., 2005; Lawless, 2005).

Racial diversity in the engineering workplace immediately after 1994 was a result of the history of racial segregation and job reservation which previously saw career development in engineering reserved for White graduates only, most of which were male (Jawitz, Case, & Ahmed, 2005). Government's equity targets and enforcement of affirmative posts in the public sector have resulted in appointments of young inexperienced Black graduates accepting key senior engineering jobs which they are not equipped for. This results in the graduates not coping and leaving the profession (Lawless, 2005)¹.

In the USA, for example, underrepresentation of Black graduates in engineering is partly due to the unique barriers students face such as inequitable academic preparation, the gradual dismantling of affirmative action policy in college admissions, and a lack of racial minority engineering roles models in the popular media (Hughes & Hurtado, 2013).

Apartheid, racial segregation and the resulting social, economic and educational impacts in South Africa have been researched and documented extensively (Chisholm, 2012; Clark & Worger, 2014; Deegan, 2014; Worden, 2011). In the

¹ Allyson Lawless's study is a comprehensive assessment of the number of engineering practitioners in South Africa and the infrastructure engineering needs in both the public and private sectors. For further appreciation of Lawless's views in relation to equity targets and the impact on individual practitioners, the reader is encouraged to study Lawless's work.

pre-apartheid era, racial categories were used as a tool for status, class privilege and political rights that translated into socio-economic standards and quality of living (James & Lever, 2001). During apartheid, the Black population of South Africa suffered tremendous atrocities that limited their socio-economic, educational and political opportunities and benefits (Davenport & Saunders, 2000). Until 1994, for example, racial segregation was the norm within South African public school structure and schools serving Black African student populations were measurably inferior to those serving White students (Clark & Worger, 2014). The situation was similar in the USA up until 1951 when gradual change in racial diversity in school was accepted (Jackson, 2007).

Despite race being a declining factor in popular calculus in post 1994 South Africa, racial classification has been sustained in order to measure the progress of people, especially the progress of the previously disadvantaged and disenfranchised Black people (James & Lever, 2001).

Furthermore, in addition to the ethical reasons and the business case for encouraging diversity, there are legal requirements that employers should comply with to ensure that employees are not subject to discrimination (Hooper, 2012). Various pieces of South African legislation endorses that this is especially true for the South African context. The ANC Government has installed legislation, systems and structures to create economic, education & training, small business opportunities as well as support mechanisms and long term strategies that favour the development of African people, who were the most disadvantaged people during apartheid (Davenport & Saunders, 2000; James, 2013).

The Government of South African having acknowledged that under apartheid, race population groups was used to control access to education, resources, advancement of skills, and productive resources and assets (Republic of South Africa, 2004). With a view to redress the past socio-economic injustices the Government, since 1994, has embarked on a string of empowerment aligned legislation. These include the Restitution of Land Rights Act of 1994, the National

Empowerment Fund Act of 1998, the Employment Equity Act of 1998, the Competition Act of 1998, The Employment Equity Act of 1998, the Skills Development Act of 1998, the Skills Development Levies Act of 1999, the Preferential Procurement Policy Framework Act of 2000 and the Promotion of Equality and Prevention of Unfair Discrimination Act of 2000, together with other acts, policies, strategies and programmes, all of which had a direct impact on the economy (Emuze & Adlam, 2013).

Hatch (2008) makes a convincing business case argument for the need for diversity in the civil engineering workforce. The South African government by establishing policy to achieve transformation to redress the past, the consequence of these policies will be the achievement of diversity in the workplace, which has an overall positive impact on the success of business (Lounsbury, Boxenbaum, Vican, & Pernell-Gallagher, 2013).

Since the advent of democracy in 1994, and the legislative interventions, there has been various signs of progress in Black communities, nevertheless, social and economic inequality continue to plague and differentiate the experiences of Black and White South Africans (Kaus, 2013). In relation to the job market in the USA, resumes of job applicants with typically European names, are 50% more likely than those displaying African names, to progress to an interview (Jackson, 2007). Jackson (2007) asserts that the socio-economic experience of the South African Black people is similar.

With a Gini-coefficient of 0.7, South Africa has one of the highest rates of inequality in the world (Tregenna & Tsela, 2012). A Price Waterhouse Coopers Report (2010) on executive pay in South Africa showed that more than half of executives in large Johannesburg Stock Exchange listed companies (the overwhelming majority of whom are still White men) earned more than \$1 million per annum. The lowest paid workers on the other hand, have monthly salaries of around \$350, which means a pay gap in the order of 250-300 times (Cock, 2014). Cock reveals further that some 40% of South African (Black) households continue to live on less than \$40 per month.

2.8 Job expectations of engineering employers and engineering graduates

2.8.1 *Graduates' expectations*

The aspirations of the modern Black engineering graduate are captured in Cock's (2014) inequality and consumption study in modern South Africa. Cock (2014) asserts that the new Black elites demonstrate an ostentatious display of wealth, designer clothes, expensive cars, sumptuous houses and hosting costly parties. This is in line with the expectations of young Black people in post 1994 South Africa (Davenport & Saunders, 2000).

Significant differences have been found between the expectations and aspirations of engineering students and the experiences of engineering graduates (Riordan & Goodman, 2007). Following the experiences of other graduates in the UK in the late 1980's and in South Africa in the early 1990's, the situation has not changed over the past 30 years (Adams, 1994; Riordan & Goodman, 2007).

Formal university education is considered the single most important equaliser of social and economic opportunity (Anyon, 2014). As a result, engineering graduates from all universities expect to be employed after graduation (Pillay, 2011b).

Graduates also expect a job market that will assess their performance on their preparation and ability and not their race or school (Jackson, 2007). In the United States of America (USA), Historically Black Colleges and Universities (HBCU) graduates are perceived to have read for a high quality qualification, are intelligent, and deemed to possess the necessary skills to excel in the workplace. Upon entering into the workforce HBCU graduates expect the same career opportunities as graduates from non HBCU institutions. The job market in reality, however, does not reflect equity and equal opportunity for all (Jackson, 2007).

Engineering graduates anticipate being immersed and accepted into an identity and culture of engineering, which will have been developed during their undergraduate academic degree program (Hughes & Hurtado, 2013). Most Black engineering graduates from predominantly White Institutions (PWIs), complained about a lack of identity in the workplace, which was traced back to sentiments of isolation and absence of sense of belonging experienced in the social environment of their alma maters (Allie et al., 2009).

In order to endorse their sense of engineering identity and culture, graduates also expect to participate in internships and social activity related to engineering. This would include engaging in engineering clubs and institutions as part of their work (Hughes & Hurtado, 2013).

Generation Y graduates place heavy significance on corporate philanthropy and social awareness, seeing themselves as being accountable to make a difference in the world (Vieira, 2012). This is reflected in the new breed of graduate engineer as observed in the SAICE network of student chapters and young members that have greater attraction to a career in civil engineering that brings about social change (Mkhacane, 2014b; Pillay, 2014). This experience is similar in the USA where graduates seek opportunities to demonstrate, in their engineering careers, their passion for bringing about social change (Hughes & Hurtado, 2013).

This view contradicts Cock's (2014) claim that most young Black graduate professionals appear to be preoccupied with salary, high living and material gain. The opinion of the author is that Cock's view appears to be radical and it borders on typical stereotyping. This study does not include consumer patterns and practices according to race. Refer to Section 6.4 which addresses opportunities for further research.

Graduate engineers also expect to be managed, supervised and mentored by a senior registered engineering professional, who would guide them to professional registration with the relevant engineering registration bodies (Vieira, 2012). They anticipate working in a structured environment doing clearly defined and

worthwhile work that is intellectually stimulating and that adds value to the organisation (Hughes & Hurtado, 2013; Jawitz et al., 2005; Vieira, 2012).

In her study on early career expectations and retention factors for Generation Y engineers, Vieira (2012) discovered that salary featured third on the career expectation importance list, preceded by doing stimulating and challenging work and career advancement opportunities. The need to travel and achieving work-life balance also featured in the study.

2.8.2 *Employers' expectations*

Most literature on engineering employer expectations from graduates suggest that graduates do not have adequate practical preparation needed to ensure viable entry and sustainability in the present day workforce (Fauzi, Abidin, & Awang, 2013).

The expectation of current employers of graduate engineers, in terms of confidence, communication skills and technical ability, supersede the expectation that the industry held for their predecessors (Yuzainee, Zaharim, & Omar, 2011; Zaharim, Omar, Basri, Muhamad, & Isa, 2008). Again, most literature show that beyond these general expectations, most employers do not possess a full appreciation of what graduates pre-entry career expectations are (Adams, 1994; Hughes & Hurtado, 2013; Jackson, 2007; Vieira, 2012).

Due to technological advancements, organisational structures of many engineering companies have 'flattened,' allowing for greater decision making at the point of service delivery. Consequently the expectation is that workers are expected to function efficiently in teams and with clients in both written and spoken communication and to exhibit minimal reliance on senior supervision and guidance (Jackson, 2007). As result graduates are expected to possess excellent interpersonal skills, good leadership skills, high self-esteem and strong self-development skills (Jackson, 2007).

In addition, employees expect graduate engineers to immediately engage in problem solving, to possess superior knowledge of science and engineering principles and to be proficient in self-learning (Yuzainee et al., 2011). Employees also indicated that current engineering graduates struggle with knowledge retention and the ability to synthesize and make connections between courses and application of knowledge (Zaharim et al., 2008).

2.9 Summary of literature review

The review showed that civil engineering is an honourable profession with a proud tradition of serving society through the design, construction, operation and maintenance of civil infrastructure. Civil Engineers historically, were a vital component of the public sector working closely with government, providing independent technical solutions in an honest, ethical and unbiased fashion.

South Africa has a structured and systematic approach for engineering professionals to be recognised and registered. Professional engineering practice is regulated and administrated by Acts of law, under the auspices of the Ministry of the Department of Public Works. ECSA is the council that is responsible for registering engineering professionals and to ensure that professionals conduct themselves under a code that protects the health and safety of the public.

Considering the boom in the construction industry, and the various plans related to infrastructure like the National Development Plan and the Presidential Infrastructure Coordination Commission led by the State President, and the budgets projected for spending on infrastructure, it has become evident that South Africa has adopted an infrastructure development strategy for its overall economic development strategy.

The government regards engineering skills as scarce. In comparison to developed Scandinavian and BRICS countries, South Africa has one tenth of the engineering capacity of those nations. Literature also suggests that the skills gap is most

prevalent in the public sector, where infrastructure is administrated, planned, delivered and managed. The lack of capacity has impacted the state of South African infrastructure in that existing infrastructure is poorly maintained or not at all and are therefore stressed, and new infrastructure projects are stifled from being rolled out.

A further challenge evidenced in literature, and that is central to this research, is that race representation in engineering is imbalanced with only 12% of South Africa's 34 000 registered engineering professionals being Black. With a view to urgently address this imbalance, the South African Government has embarked on a string of empowerment aligned legislation. A contributor to the lack of development of Black South African civil engineering professionals is the inherited Apartheid system that saw Black people deprived of educational, social, economic and political development. Most Black graduates still feel the impact of social segregation in the work place.

Literature suggests that Black graduates expect to be immersed into a culture of engineering in their university environment, and to enjoy similar culture in the work place. They also expect to be managed, supervised and mentored by a senior registered engineering professional, who would guide them to professional registration with the relevant engineering registration bodies. Employers, however, expect graduate engineering professionals to be adequately prepared in terms of communication skills, technical ability, and to be ready to function in the work place immediately after graduation.

A final outcome of the literature survey indicates that the political and economic climate is in favour of the development of Black civil engineering professionals in South Africa (Emuze & Adlam, 2013). The number of Black professionals actually registering with the ECSA and advancing in the civil engineering profession, however, needs to be improved (ECSA, 2013).

2.9.1 Main research question

Despite research hinting that the political and economic climate is in favour of the development of Black graduate civil engineering professionals, and that the processes for registration are clearly defined, only 12% of the registered engineering population are Black South Africans. Where are the barriers that prevent Black civil engineering graduates from registering as professionals with ECSA?

2.9.2 Research question 1

Whilst literature gave evidence that the platforms for transformation have been created by a focussed effort by government and policy, what are the reasons for civil engineering graduates not registering fast enough, which then affect transformation of the industry in order to address proportional racial representation?

2.9.3 Research question 2

What are the explanations for Black engineering graduates being stifled in the work place and for the disjoint between actual workplace experiences in comparison to the documented expectations and requirements for registration with ECSA?

2.9.4 Research question 3

What are the motivations and reasons for Black engineering graduates risking their civil engineering careers by accepting promotions and advancements early in their careers without accumulating sufficient knowledge for technical growth and thereby inhibiting their professional registration with ECSA?

CHAPTER 3. RESEARCH METHODOLOGY

This chapter discusses the methodology adopted to analyse the propositions discussed in the literature review. It includes a description and explanation for the choice of research model and explains the repercussions of the chosen method on the research. The research design will also be discussed, followed by considerations of the research population, sample sizes and sampling methods. The research instruments and analysis methodology used to determine the authenticity of the stated propositions will also be explored. This chapter is concluded with a discussion on the validity and reliability of the research.

3.1 Research paradigm

Research can be done using qualitative, quantitative or mixed method approaches (Venkatesh, Brown, & Bala, 2013). In essence, quantitative research tends to aim for objectivity while qualitative research tends to aim for subjectivity (Bernard & Bernard, 2013). The mixed method approach is best used where an alternative method that bridges the qualitative-quantitative divide is required (Venkatesh et al., 2013).

Quantitative research options are predetermined and a large number of respondents are required in order to produce data to be statistically analysed for the outcome (Bernard & Bernard, 2013). Qualitative research options on the other hand is collecting, analysing and interpreting data by observing what people do and say (Ritchie, Lewis, Nicholls, & Ormston, 2013).

Based on the interviewees' diverse experiences emanating from their individual work environments, type of engineering work done and different supervision structures, the nature of the research topic is subjective, exploratory and open ended and required interpretation (see Section 3.4 for research instrument to be used). As a result, the interview was open ended and it was most appropriate to

host in-depth interviews with participants where probing and exploring responses were possible.

For these reasons, a qualitative approach was deemed most suitable for the study and was therefore adopted for the research.

3.2 Research design

The interview is the most widely employed method in qualitative research (Creswell, 2013). The research design took the interview approach which allowed for participants to be asked general questions and for the interviewer to probe and explore responses. This approach was most conducive to identifying and defining perceptions, opinions and feelings about factors that affect individual development as civil engineers with a view to register with ECSA.

The disadvantage of the interview was that they were time consuming and resource intensive. Another disadvantage was that the author is involved in the institution of civil engineering in South Africa and it will require effort to remain unbiased during the interview. Added effort was made to minimise bias (Creswell, 2013). This was accomplished by not asking leading questions. Questions were open ended. Furthermore, the writer considered the answers provided by interviewees, beyond the default interpretation which would have been influenced by the writer's bias.

Taking into consideration that the research topic is racially sensitive, the interview option in the form of a one-on-one conversations allows for body language and voice quality interpretation. The interview method is advantageous in this regard since the main purpose of the research design is to ascertain opinions, perceptions and sentiment which are generally subjective in nature.

3.3 Population and sample

3.3.1 *Population*

The population for the research was Black graduate civil engineers with a qualification from traditional academic universities that are registered with ECSA or are potential registrants with ECSA. The selected population were from the public sector, parastatal institutions, consulting engineering and construction engineering sectors.

A summary of the respondents interviewed for the research interview, expanded into sector employed, race and gender diversity, is shown in to Table 3-1. It was envisaged to interview at least 14 participants for the research. This aspiration was successfully accomplished. Refer to Table 3-1 for the actual sample.

3.3.2 *Sample and sampling method*

The selected population was extracted from the public sector, parastatal institutions, consulting engineering and construction.

This approach may be regarded as convenience sampling. Criticisms against this convenience sampling is sampling bias and the limitation or inability to make general inferences about the entire population, which consequently creates low external validity of the study (Creswell, 2013).

In order to counter bias, a list of open ended questions was compiled, and interviews were carried out with individual interviewees on a one to one basis. To prepare interviewees, the questions were emailed a week in advance to the participants. The interviews were done in a neutral environment with effort made to make the participants comfortable.

3.4 The research instrument

An interview guide, together with a semi structured interview was prepared and scheduled. See Appendix A for interview questions. Post interview reflection notes were also captured. The cover letter used to invite participants to the interview is shown in Appendix C.

The questions were structured in a format that aimed to optimise opportunity for respondents to share information in a comfortable and familiar manner (Marshall, 1996). The advantage of the semi structured interview allowed for adaptive probing of concerns and for side tracking to explore other interesting insights and perceptions, but participants were guided back to the factors that affected their progressive development to register as professional engineers (Creswell, 2013).

The disadvantage of this approach was that it was time consuming, and respondents concerns varied depending on the sensitivity to confidentiality and inhibitions related to institutional procedures for sharing delicate information (Ritchie et al., 2013).

3.5 Procedure for data collection

The interviews were prearranged interviews with participants. Interview meetings were held at the interviewee's place of employment in a neutral common room, e.g. a tea room or meeting room. A professional atmosphere, environment and language of engineering professionals were maintained throughout.

The location also presented an opportunity to observe the working situation of the respondent. Interviews were recorded, as well as hand written notes transcribed. Observations on the physical surroundings of the office were noted, including office setup, atmosphere and any staff interactions that arose on the day. Data was collected on body language and gestures of respondents.

3.6 Data analysis and interpretation

The data analysis procedure adopted for this research is constant comparative analysis, which was originally developed by Glaser and Strauss (Thorne, 2014). This comprises data reduction, data display, conclusion derivation and verification (Charmaz, 2014). As part of a thematic content analysis, the data was reduced according to data sections with central themes. Similarities of key terms and terms that featured across the discussions were recorded using a code book and colour coding (Thorne, 2014). Variations and irregularities were also be highlighted.

The extracted themes and contradictions are described and discussed in relation to the data (Creswell, 2013) in Chapter 5. The outcome of this process is a reduced data set that is set into a text-based matrix which guided further interpretation (Charmaz, 2014) as discussed in Chapter 4. .

By comparing and contrasting the refined data, conclusions were drawn and then verified by re-contacting a smaller selection of the respondents. Further triangulation with other data sources, further discussions, internal documents and media articles, provided verification for the resulting outcomes (Thorne, 2014) presented Chapter 5. Of the 14 participants, 4 were contacted for points of clarification.

3.7 Limitations of study

In addition to the traditional limitations associated with qualitative studies, limitations related to race relations and work experiences needed to be dealt with. While race issues are liberally discussed in the context of modern South Africa, conducting research on a sensitive topic like race perceptions in the civil engineering industry incurs limitations on individuals and organisations. For this specific study, the following limitations were applicable:

- The study was reliant upon individuals being available to participate in the study.
- Every effort was made to ensure the interviews and discussions occur in person where participants are physically present. Participation for the follow up activities was done via telephone and email. Some participants were not available for the triangulation interviews; telephonic conversations had to suffice.
- Some interviews were held in the offices of the offices of the participant's employers. This created discomfort and constant checking on who was watching and listening to the conversations. To deal with this, where possible, doors were closed and confidentiality of the exercise was affirmed.
- Time limitations needed to be adhered to strictly. As discussions were had and issues were unravelled, however, scheduled conversations surpassed their time limitations. On the other hand, some experiences did not allow for detailed probing due to the time constraints and the need for individuals to return to work.
- Very often, it was revealed that some participants were emotionally affected by their experience in relation to the topic. A result would have been crying in the interview, an experience that the interviewer did not adequately prepare for. This was dealt with by allowing the process to adopt a natural progress. Interviews were temporarily stopped and time out was taken before resuming the discussion.

3.8 Validity and reliability

3.8.1 *External validity*

The sample selected for this research may be regarded as convenience sampling. Criticisms against this approach is sampling bias resulting in the inability to make

general inferences about the entire population, which consequently creates low external validity of the study (Creswell, 2013).

The requirements for professional registration for civil engineers however, are consistent irrespective of where a graduate professional is employed (ECSA, 2012). Based on this common requirement, it is suggested that despite convenience sampling, the outcomes and learnings from the study, are a true reflection of the interviewees' experiences in relation to the object of the enquiry. The learnings may circumspectly, be applied to the general population of graduate civil engineering practitioners.

3.8.2 *Internal validity*

To ensure internal validity and consistency throughout the data collection process, the interview guide and the semi-structured interview was replicated and applied uniformly to all interviewees. While maximum benefit was derived from the adaptive nature of the research method, internal validity was not sacrificed. Furthermore, the author confirms internal validity by ensuring by triangulation with other sources of documentation as noted by Thorne (2014).

3.8.3 *Reliability*

Due to the interpretative and subjective nature of qualitative research, reliability is paramount for the authenticity of the study outcomes (Thorne, 2014). Reliability is the extent to which outcomes of the study are consistent and similar results are achieved on repeated trials (Charmaz, 2014). To achieve reliability, the actual research instrument was tested on a trial respondent. Refinements in terms of ambiguities, time management, social sensitivities and clarifications were made and improvements incorporated to achieve appropriate data from the respondents as described in Section 3.3.2.

3.9 Demographic profile of respondents

In this section, the demographics of the population interviewed are presented. A brief description of the demographics planned initially is also presented. A summary of the actual demographics of the respondents interviewed, expanded into sector employed, race and gender diversity, is shown in Table 3-1.

Table 3-1 Actual demographic profile of sample in the research study

Sector	Ethnic group	Male	Female
Government	Indian		
	African	1	2
	Coloured		
Parastatal	Indian		
	African		1
	Coloured		
Consulting	Indian	1	
	African	3	3
	Coloured		1
Construction	Indian	1	
	African		
	Coloured		
Total sample (by gender)		6	8
TOTAL SAMPLE		14	

In comparison with the initial planning as documented in Section 3.3, it was anticipated that the population for the research would include Black graduate civil engineers with a qualification from traditional academic universities that are registered with ECSA or are potential registrants with ECSA. Furthermore, it was planned that the selected population would be from the public sector, parastatal institutions, consulting engineering and construction engineering sectors.

This was achieved in the actual interview process.

While it was planned to interview 8 respondents, 14 were actually interviewed. The reason for the increase was to test the possible consistency in negative work experiences, which was forthcoming in the first 8 interviews, across the sectors.

Table 3-2 Ethnic group distribution of sample

Ethnic group	Frequency	% of sample
Black African	11	79
Coloured	2	14
Indian	1	7
Total	14	100

An ethnic group distribution is shown in Table 3-2. 79% of the sample was Black Africans. An attempt was made to align the sample to the overall South African population as discussed in Section 1.2.

Table 3-3 Professional status of sample

Professional status	Frequency	% of sample
PrEng	1	7
PrTechEng	1	7
PrTechniEng	0	0
Total	2	14

As shown in Table 3-3, of the 14 participants, only 2 (14%) are professionally registered civil engineering practitioners.

Table 3-4 Age profile of sample

Age profile	Frequency	% of sample
20-25	1	7
26-30	7	50

Age profile	Frequency	% of sample
31-35	4	29
36-40	2	14
>41	0	0
Total	14	100

The age profile of the sample is shown in Table 3-4. The oldest participant was 38 years and the youngest was 24. 50% of the participants were between the ages of 26 and 30.

Table 3-5 Gender distribution of sample

Gender	Frequency	% of sample
Male	6	43
Female	8	57
Total	14	100

A gender distribution of the sample is shown in Table 3-5. The female participant contribution was 57%.

Table 3-6 Experience distribution measured in years

Experience (years)	Frequency	% of sample
0-5	2	14
6-10	9	64
11-15	3	21
16-20	0	0
>20	0	0
Total	14	100

Table 3-6 shows the number of years of work experience of the participants. The least experience was 3 years, which is the minimum time required in practice before an individual may register as a professional. The maximum experience in

the sample is 14 years. The number of years working excludes years spent in full time academic training.

Table 3-7 Final civil engineering qualification of sample

Civil Engineering Qualification (Final)	Frequency	% of sample
MSc		0
BSc (Hons)	3	21
BSc	6	43
BEng	2	14
BTech	3	21
ND	0	0
Total	14	100

Table 3-7 shows the qualifications of the participants. Of the 14 interviewed, 7 participants have stand-alone undergraduate qualifications. The remaining 7 participants have multiple qualifications. Shown in the table are the last qualifications read for.

One participant has BSc degree qualifications in civil engineering, electrical engineering and is currently studying mechanical engineering.

CHAPTER 4. PRESENTATION OF RESULTS

4.1 Introduction

In this section, the research data from 14 interviews is presented in tabular format. The questions asked in the interview were derived from the research questions shown in Section 2.9. In keeping with this, the answers to the questions have been segmented, grouped and presented to respond to each research question.

In order to present the data in tabular form, the interview content was analysed for themes and frequency of those themes. All interviews were transcribed and each response analysed. Constructs with the same meaning or themes were then grouped together and presented in tables. The frequency of appearance of each construct was also counted, documented and presented as percentages.

The questions used for each research question are answered through the data presented in each table. The Main Research Question is answered in the conclusion of the overall report in Section 6.2 and not in this section. The reason for adopting this approach is that the sub questions, i.e. research questions 1, 2 and 3 related directly to the main research question and have been created to address the main research question, each in part. The summary of the conclusions for each sub question then, is a presentation of the conclusion for the main question.

4.2 Results pertaining to the Research Question 1

The questions that were used for research questions (refer to Section 2.9.), are answered through the data presented in this section.

Research Question 1 Whilst literature gives evidence that the platforms for transformation have been created by a focussed effort by government and policy,

what are the reasons for civil engineering graduates not registering fast enough, which then affect transformation of the industry in order to address proportional racial representation?

To explore this issue, the following questions were asked: Why did you choose to study civil engineering? Are you familiar with the NDP, the NGP, the PICC and the SIPs? Do you feel that you are contributing the success of these initiatives? Describe your involvement in the projects you are currently working on? Do you feel that you are doing worthwhile work? Are you familiar with the professional registration process for engineering practitioners? Do you feel that it is necessary to register as a professional with ECSA? What are your concerns about professional registration process?

The common themes that featured in the interviews are shown in Table 4-1. The theme that featured the most, at 100%, is that the professional institutions associated with civil engineering in South Africa are ineffective at raising the awareness of civil engineering career opportunities, and facilitating the professional engineering registration process for the current share of black graduates within the profession.

The theme of senior civil engineering professionals not sharing the workload fairly, based on race, because they are working to maximise their own utilisation to attract higher economic benefit for themselves features the least, at 21%.

Table 4-1 Results pertaining to Research Question 1

Common theme/ construct	Frequency	% of sample
ECSA together with SAICE and CESA are ineffective in raising awareness of the profession, influencing the public or organisations and facilitating processes to assist graduate civil	14	100

Common theme/ construct	Frequency	% of sample
engineering practitioners to register.		
I am not engaged with professional institution (SAICE) where I know I can get help.	12	86
I don't feel I am contributing to the success of Governments infrastructure development strategy - the NDP, NGP, PICC and the SIPs.	9	64
Lack of development prospects and clearly defined career path in the workplace.	8	57
My overall work experience has left me demotivated. I do not feel immersed in a culture of civil engineering.	8	57
There is no glamour, government or societal recognition in being affirmed as a professional engineer.	7	50
I don't trust the registration system and process.	6	43
The models of professionalism I am exposed to are unattractive and uninspirational.	6	43
The ECSA requirements are arduous and too rigid.	6	43

Common theme/ construct	Frequency	% of sample
Lack of awareness of what civil engineers do and about a career in civil engineering career at basic education level.	5	36
Not familiar with the infrastructure development strategy of the Government, the NDP, NGP, PICC and SIPs, and the career opportunities associated with them.	5	36
Limited project roll out from national government that restricts the variety of projects in the consulting engineering workplace.	3	21
Graduates not feeling that they contribute to the success of their organisation.	3	21
Senior, qualified, skilled and registered professionals don't share the workload fairly (based on race) because they are working to show utilisation which attract higher bonuses for themselves.	3	21

Following from the commonly featured themes shown in Table 4-1, it may be concluded that the reason the industry is not transforming rapidly enough in terms of race, are diverse, integrated and are complex. Furthermore, civil engineering graduates expect the civil engineering institutions (ECSA, SAICE, CESA and others) to actively engage in and resolve.

4.3 Results pertaining to the Research Question 2

The questions that were used for research questions (refer to Section 2.9.), are answered through the data presented in this section.

Research Question 2 What are the explanations for Black engineering graduates being stifled in the work place and for the disjoint between actual workplace experiences in comparison to the documented expectations and requirements for registration with ECSA?

To explore this issue, the following questions were asked: As a student, what were your perceptions and expectations from the work place? Did those expectations materialise? Do you feel you are inhibited by language given that English/ Afrikaans is not your mother tongue/ first language? Explain those activities that make you feel immersed into a culture of Civil Engineering in the workplace. Are you receiving design/ construction/ project management and engineering experience? Do you have a mentor and a coach? How often do you meet, and what do you talk about? Describe your relationship with your immediate supervisor? How often do you sit with your seniors to discuss your professional development? Do you feel that you are treated differently because of your race/ language barriers/ inabilities? Do you feel that you are on a career path? Where to from here?

The common themes that featured in the interviews are shown in Table 4-2.

There are 2 themes that featured consistently by all respondents giving it a frequency of 100%. These are (1) Ignorance of the value of registration and the perceived lack of benefits and incentives associated with professional registration and (2) Ineffective and poor coaching, mentoring, training and supervision in the workplace with a view to guide graduates to a point where they may register successfully with ECSA.

Followed very closely with 93% frequency is the uncertainty of project work available in the working environment, together with the adhoc allocation of project work to graduates on a day to day basis, with little thought to experience required for professional registration.

The themes that featured the least are related to distractions that prevent a focussed effort on compiling the application for professional registration. These are “I am side-tracked with other areas of interest like hobbies, voluntary work, studies, social, etc.” at 21% and ‘I am too busy with project (billable) work to focus on writing the reports needed to register’ at 14%.

Table 4-2 Results pertaining to Research Question 2

Common theme/ construct	Frequency	% of sample
Unfamiliar with why one should register as a professional. I don't understand or see the value in registering - there are no benefits or incentives associated with registering.	14	100
Poor coaching, mentoring and supervision - the structure for monitoring of workplace training so that individuals are on a path to register is ineffective.	14	100
Work allocation is adhoc and dependent on what projects are available. This affects the experience I need to receive in order to register.	13	93
The person I report to does not assist or	12	86

Common theme/ construct	Frequency	% of sample
motivate me to register. I do not have an appropriate mentor that meaningfully contributes to my professional development.		
I have learned that I need to focus to get it done myself. Self-motivation is weak. I need to take a greater interest in my professional development and take personal responsibility for my professional registration with ECSA.	12	86
Company corporate structure promotes business sections to be insular. Reciprocal operation and project load sharing is not promoted - this limits me from gaining a diverse, rounded experience that will enable me to register.	11	79
The environment I work in is unstructured in relation to professional development and growth. The career development path is unclear or non-existent.	11	79
Language is an inhibitor. Language used in socials is inhibitive. I feel restricted in the social activity and interaction. Social discussions including informal discussions are where a lot of learning happens.	11	79

Common theme/ construct	Frequency	% of sample
I feel uninspired and demotivated because I don't get to do what I imagined I would do when I started studying civil engineering - plan, design, build infrastructure that would improve the quality of life of people. I don't feel my work improves the quality of life of people. The focus is about making money for the company.	11	79
I am timid and shy to ask questions or to challenge the status quo so I avoid confronting the issues around my professional and personal development.	11	79
Unfamiliar with the registration process.	10	71
I am not receiving the full array of design, construction and project management experience so that I can register professionally.	10	71
I do not feel I am doing worthwhile work. As a graduate I am not given meaningful work that will enable me to register. Very often I feel I am doing menial work not commensurate to my qualification.	9	64

Common theme/ construct	Frequency	% of sample
As a Black graduate, I am not given challenging work. I am doing menial work repeatedly - I want more challenging work that would give me good experience that would make me viable to register. This makes me feel my degree and capability is not respected or maximised.	9	64
I feel White graduates are given more challenging projects. They seem to receive more attention socially and professionally (in relation to mentoring, coaching and supervision) with a view to register with ECSA.	8	57
There are subtle differences in the way seniors treat graduate engineers with regard to race. When questions are answered, White graduates get a full explanation and in a social and informal tone, while black graduates receive concise answers in a formal tone.	7	50
I feel personally judged and belittled when my inabilities are highlighted and not my strengths	5	36
I feel that as a Black graduate, I am put onto the team to win tenders, make up the number to show transformation, and to influence clients in project meetings, but I am not engaged on the	4	29

Common theme/ construct	Frequency	% of sample
meat (design, project management) of those projects.		
I have family responsibilities - I do not have time to give the application process the attention it requires. My bosses will not allow me to do the work required to register during working hours.	4	29
I am side-tracked with other areas of interest like hobbies, voluntary work, studies, social, etc.	3	21
I am too busy with project (billable) work to focus on writing the reports needed to register.	2	14

Following from the commonly featured themes shown in Table 4-2, it may be concluded that the dominant reasons for graduates not enjoying appropriate experience that leads to professional registration, are related to company structure and poor mentoring, coaching and supervision. In addition to these a high proportion of the respondents agreed that they need to confidently give more attention to their personal development and prioritise professional registration.

4.4 Results pertaining to the Research Question 3

The questions that were used for research questions (refer to Section 2.9.), are answered through the data presented in this section.

Research Question 3 What are the motivations and reasons for Black engineering graduates risking their civil engineering careers by accepting

promotions and advancements early in their careers without accumulating sufficient knowledge for technical growth and thereby inhibiting their professional registration with ECSA?

To explore this issue, the following questions were asked: Explain those activities that make you feel immersed into a culture of Civil Engineering in the workplace? Do you feel that you are on a career path? Do you feel that you are treated differently because of your race/ language barriers/ inabilities? What do you talk about? What, in your opinion, are the major drawbacks in relation to registration and professional development, as a Black Engineer in the work place?

The common themes that featured in the interviews are shown in Table 4-3.

The most mentioned theme with regard to this research question is that the companies are focussed on making money but sacrifice professional development of staff. Furthermore this encourages Black graduates to take the view that is an opportune time to enjoy economic benefit from this environment. 86% of respondents felt this way.

The least featured theme is again related to economic benefit. 36% of respondents said that they are earning a good salary without being professional registered, and that they are currently satisfied with their salary arrangement.

Table 4-3 Results pertaining to Research Question 3

Common theme/ construct	Frequency	% of sample
The company focusses more on the bottom line (making money), than the development of its people in terms of professional registration. The environment is favourable for economic benefit.	12	86

Common theme/ construct	Frequency	% of sample
My overall work experience has left me demotivated. I do not feel immersed in a culture of civil engineering.	8	57
My early promotion and taking on of responsibility without professional registration, doesn't create an urgency to register.	7	50
I feel cornered in that I am in a senior position without professional registration, but my supervisors will limit my participation in big projects because I am not registered. I prefer to retain the position and salary.	7	50
Having been promoted without my PrEng into management. I do more project management, administration, supervision, and little technical design.	5	36
I am earning a good salary, without being professional registered. My salary level will not change should I register. I am happy with that for now.	5	36

Following from the commonly featured themes shown in Table 4-3, it may be concluded that the dominant reasons for graduates risking their careers in civil engineering by accepting senior posts without relevant experience and

professional registration, is related to economic benefit, and the present enjoyment of comfort that higher salaries bring with senior posts.

CHAPTER 5. DISCUSSION OF RESULTS

5.1 Introduction

It must be noted that the main research question is discussed in the conclusion of the report in Section 6.2.

To gain insight into the research topic and research questions fourteen Black engineering practitioners were interviewed individually. In this section, the research findings will be discussed in relation to research questions (see Section 2.9). This will be compared and contrasted to the literature study that was presented in Chapter 2 to show contradiction and/or confirmation of the findings.

It is important to appreciate that the research data obtained from the respondents, are outcomes of the research questions only. While the literature guided the formulation of the questions, the literature study did not influence the responses obtained from those interviewed.

The data was converted into information and presented in tabular format with a view to understand the themes that featured dominantly in the interviews. The themes are summarised in Chapter 4. While themes are ranked according to the frequency in which they appeared in the interviews, it must be noted that the highest ranked themes do not necessarily contribute in isolation, to the challenges raised by the research questions.

It is imperative to recognise that the themes that emerge are diverse and interconnected. This is an indication of the complex and integrated nature of the challenges of diversity and transformation in the built environment and construction sector in South Africa. This is clearly in line with the literature survey which covers topics related to diversity and transformation.

Actual comments made by respondents are documented in this section. In order to keep the identity of interviewees confidential a coding system has been created and is explained in the following example.

“I initially wasn’t sure about what to study. I thought I wanted to do something in chemistry. I tried it and hated it. I tried civil engineering next and loved it” (9BFC1)

In the code 9BFC1, the meaning of each component is explained as:

Component in code	Meaning	Alternatives
9	Interview Number	0 – 14
B	Race group	B lack African, Indian, C olored
F	Gender	M ale or F emale
C	Sector of employment	C onsultant, C ontractor, P arastatal, G overnment
1	This quote appears on page number 1	As per page number or T elephonic conversation

5.2 Research Question 1

The results pertaining to Research Question 1 are shown in Table 4-1 in Section 4.2. A general perusal of the results shows that all themes that arose are interlinked and will require an integrated discussion.

Research Question 1 Whilst literature gives evidence that the platforms for transformation have been created by a focussed effort by government and legislation, what are the reasons for the civil engineering industry not transforming fast enough to address proportional racial representation?

5.2.1 The role of ECSA, CESA and SAICE

The theme of ECSA, together with SAICE and CESA, being ineffective in raising awareness of the profession, influencing the public sector or private sector employers and facilitating processes, to assist graduate civil engineering practitioners to register was mentioned by all participants.

In relation to influencing the public and raising the awareness of the value that civil engineering adds to a countries socio-economic development and inadvertently raising the profile of the individual civil engineering practitioner, 50% of the participants complained about the lack of recognition, glamour and government or societal recognition of civil engineering. They felt that the professional bodies should be responsible for the public relations of the profession.

One respondent stated:

“A lot of Black people leave the profession because they want to be affirmed as people. We are not celebrated – despite our hard work and our contribution to society. We are just impotent tools, and not something that shines. SAICE needs to do something about it.” (4BFC15)

While literature is silent on this latter theme, the respondents seem clear of their expectations.

“I am not clear what the difference between SAICE and ECSA is and I am not sure what SAICE actually does for me – I think that SAICE should be responsible to help me with professional registration. I don’t feel that SAICE or ECSA does enough for me to register. They should take the message of our profession out there” (4BFC5)

Another respondent stated:

“I think that companies and mentors need to be held accountable by ECSA and SAICE, in a measurable and documented way. I don’t believe ECSA or SAICE are doing this on our behalf” (10CFC10)

There appears to be a recurring view of wanting more service in terms of guidance towards professional registration and raising the importance of professional registration with their employers. This expectation is in alignment with

literature on professional bodies, which by definition claim to be the voice and home of the profession and that claim to have vast networks with which to influence the value placed on professional registration (SAICE, 2014). All participants are members of the SAICE.

Furthermore, SAICE has embarked on a movement called 'Civilution' (Pillay, 2012a) that seeks to raise awareness of the value of the civil engineering profession in the public sector, the general public and to restore confidence to its members in relation to their purpose as civil engineering professionals (Kleynhans, 2013; Mkhacane, 2014b). This includes taking civil engineering to marginalised areas as well as offering relevant service to its members (Mkhacane, 2014b).

A respondent appreciated the movement of Civilution and asked about the impact and future of the Civilution movement:

"I like Civilution – but where to with Civilution? It gives us young people a new focus regarding our professional future. I feel (through) Civilution, us young people...we can start leading ourselves to a better future in the profession" (4BFCTel).

5.2.2 Disengaged

While 100% of the respondents expressed disappointment on the role that civil engineering institutions play on raising awareness of the profession and the institutions' lack of initiatives that directly impact the increase in Black graduate registrations, 86% of the respondents also admitted to not engaging with the institutions.

In this theme, the respondents also mentioned that they were aware that the institutions, particularly SAICE could assist in relation to their personal professional development, one aspect of which is professional registration. There appears to be apathy towards engaging with CESA or SAICE.

One respondent articulated his indifference:

"I don't engage with SAICE or CESA – they don't do anything for me – the perception is that it is a waste of time – that there is a lot of talk and no action. You are the first person I am meeting (from SAICE)." (14BMC2)

Yet another respondent said:

"I don't know much about SAICE really. When I was studying the lecturers asked us to register and I did. It was free (shrugs). They haven't done anything for me, so I don't participate...I think they help with registration" (8BFG6)

5.2.1 Perceived lack of value of registration

Another theme that featured prominently; 100% of the participants do not see value in registering as professionals. Their views are related to the lack of incentives, related to tangible economic benefit from their employers, associated with professional registration. Behaviour and attitude towards work that leads to professional registration appears to be influenced by the perceived lack of value in professional registration.

In reference to Table 3-6, it must be noted that 85% of respondents have more than 6 years of work experience, which is double the minimum time required to undertake the professional registration process.

Some of the views expressed:

"I am a senior engineer. When you register, you can call yourself better. I'm not sure what other value there is if you are registered. Nothing is here for registered people." (12BFC8)

"I never really saw the need to put effort into it – we don't get anything for it. Why should I register?" (4BFC8)

"The company doesn't pay for ECSA – they don't see it as important. It doesn't make a difference whether you are registered or not." (6BFP21)

"In government, professional registration is not recognised. We don't get anything if you are registered. It's not like you get a car or something. Now that I think about it, I don't know why I want to do it." (8BFG12)

The perceived lack of value of professional registration appeared in all respondents from the public sector, including parastatal organisations.

Furthermore, it was interesting to note that 71% of the respondents also alluded to their lack of knowledge of the process of registration. This theme is discussed in Section 5.2.1.

5.2.2 Disdain towards the system

It is clear that some respondents felt a disdain towards the system of professional registration and the actual process undertaken. 43% of the respondents articulated this construct which was in keeping with the contemptuous view that some participants held of ECSA and SAICE as described in Section 5.2.1. A separate 43% of the respondents also felt that the ECSA requirements are arduous and too rigid. There is limited literature on views of engineering registration bodies or the processes associated with registration. The registration process, however, has usually been perceived to be established, accepted and followed by all who wish to register in the history of the ECSA and the profession.

The actual constructs featured:

"I am not confident in ECSA's registration system. I think they want to keep us (Black graduates) out." (3BMC6)

"I don't like ECSA's system of registration – anyone can sign your reports and that person doesn't know a thing about you. You can just get a professional to sign for work they don't know." (13BFG3)

When queried on what the process was, 71% of the respondents fumbled for a clear understanding of what the professional registration process actually entailed (refer to Table 4-2).

Some views expressed by respondents:

"I think you need design experience." (12BFC20)

"I know you need to get design...which I've tried to get, but here we get nothing – we don't do design here". (13BFG5).

"I don't know what the new registration process is. There is a new process in ECSA. But the old one – you needed 3 years of work experience to register. I need to find out." (6BFP16).

It appears then, that the disdain towards the registration process is associated with a lack of knowledge of the process and requirements for professional registration, rather than the actual system in place for registration.

5.2.3 Demotivating work experience

Another outcome that featured prominently was the lack of work place training in relation to professional development. 57% of the respondents mentioned the lack of development prospects and the lack of clear career paths in the workplace. Similarly, 57% of the respondents also described that their overall work experience left them demotivated to register and that they did not feel immersed in a culture of civil engineering. Some 43% revealed that the models of professionalism they are exposed to are unattractive and uninspirational from role model and professional development perspectives.

These featured themes arose in the literature study relating to job expectations of engineering graduates (see Section 2.8). The work done by Hughes and Hurtado (2013) clearly state that engineering graduates expect to be immersed in a culture of civil engineering which will have developed during their academic training. The work done by Vieira (2012) validates these outcomes in that graduates look to their seniors, company structures and human resource systems to guide them through professional development and registration. They expect to be managed, supervised and mentored upon entering the work environment.

One respondent stated:

"I don't do any engineering work – we appoint consultants to do the work. I do the administration to appoint them." (8BFG7)

Another dismaying comment – in reference to her work environment and how she is being managed:

“I don’t feel like I am on a career path – I don’t know what I want to do or where I want to go – right now I even question myself and my ability. This place has clouded my focus (crying).” (9BFC9)

Another respondent after 6 years in the industry said:

“I have learnt that I can’t rely on the system. After 5 years of struggle, with limited help, I had to take control of my own career. But that time, I almost gave up” (11BFC5)

While it may be argued that these views may be applicable to most engineering graduates, it is particularly applicable to Black graduates because they have not had examples and role models in the civil engineering profession, within their immediate circle of influence (family and friends) when growing up. As a result their entrance into the workplace is probably their initiating exposure into the working environment, firstly as professionals, and secondly as graduate civil engineering practitioners. This view is supported by Sithole (2010).

5.2.4 Opportunities missed in the national infrastructure development agenda

The literature study clearly showed that there is a shortage of professional civil engineering capacity in the country. Furthermore, it showed that the country has adopted an infrastructure development strategy for the overall socio-economic development of the country.

However 64% of the participants were affected by the theme of not feeling they are contributing to the success of the Governments infrastructure development strategy. Upon testing participants’ awareness of Governments programs aimed at achieving infrastructure development in relation to the NDP, NGP, PICC and SIPs (refer to Section 2.5), 36% of the respondents had limited exposure and

understanding of the plans and the career development opportunities associated with these national mega infrastructure projects.

A respondent said:

"I've heard about the NDP but I am not familiar with its content in any detail – honestly I don't anything about it...or the SIPs...and the others." (7BMC2)

The same respondent said in reference to contributing to the success of the NDP, NGP, PICC and SIPs:

"I don't know if I am contributing to (the success of) these things. I don't feel like I make a difference there...I don't know." (7BMC3)

Another respondent summarised her knowledge of the plans:

"I am not as familiar as I should be with the NDP – I am ashamed." (10CFC4)

When queried upon why she felt ashamed, she said:

"...well because I am a civil engineer, and I think these plans are about civil engineering development projects – I should know about them and how they affect the country...and what role my company plays in that. And me...what role I play." (10CFC4)

Furthermore 21% had a broader view that the Government sector was inefficient, lacked skilled capacity and were unable to coordinate, administrate or release projects effectively for the private sector consulting and contracting engineering firms to be kept busy so that they are graduates could also be kept busy within their firms.

A parastatal employee that works in the rail infrastructure sector had this to say on the roll out of projects:

"We have all these big plans and announcements of big projects, but we don't see them coming out. I don't know which projects are there that I can be involved in to get experience in. Even if it was out, the work would be with consultants...but I don't know." (12BFC6)

Another respondent in the private sector said:

“As a graduate engineer, I get work as and when it comes...I don’t think we have all the different kinds of projects that can allow the different projects the registration process wants. It depends on tenders – it’s hard these days (to win work from tendering). The managers say that tendering is killing us.” (14BMC3)

Literature supports the notion of efficient roll out of projects so that graduate engineering practitioner may progress in terms of professional development. The roll out of projects from the public sector is a critical concern for companies who wish to promote their values associated with development of young engineers and professional registration (Pillay, 2011b). In order to register, graduate engineers are required to work on real projects. This process is commonly referred to as Work Integrated Learning (WIL). WIL experience needs to be gained under the supervision of a professionally registered engineering practitioner (Lawless, 2005, 2007, 2014).

Given that most civil engineering work comes from the public sector, it is imperative that the public sector releases work so that the private sector economy related to civil engineering is consistently kept healthy and active. When this occurs, graduates are guaranteed to receive the range and diversity of WIL successfully required for registration.

Literature on the topic is in alignment with this outcome. An inefficient public sector, in relation to infrastructure service delivery, negatively affects the role out of civil engineering projects for the private sector to work on (Datamonitor, 2014; National Planning Commission, 2010; Pillay, 2014). This has a resulting negative effect on the variety of project work that consulting and construction companies are able to offer their graduates which then affects negatively on the graduates gaining appropriate experience for registration (Lawless, 2014).

Drawing from the aspirations of the NDP, ironically, the inefficiency and lack of professionalism in the public sector infrastructure delivery departments, then, appears to be an impediment in the national transformation agenda.

5.2.5 Conclusion pertaining to Research Question 1

The reasons for civil engineering graduates not registering fast enough and for the industry not transforming rapidly, in order to address proportional racial representation appears to be related to:

- 1) A lack of a coordinated transformation effort by the institutions (ECSA, SAICE, SAFCEC and CESA) that govern civil engineering.
- 2) Graduates not engaging with the professional voluntary associations (SAICE, CESA and SAFCEC) where they can receive guidance on participating effectively in the world of civil engineering, with a view to register as professionals.
- 3) Graduates have a pessimistic view towards the registration process which they feel is long and arduous. This sentiment exists because of a lack of knowledge of the actual registration process.
- 4) There is a lack of project roll out due to technical incapacity in the public sector. This limits graduates from gaining comprehensive and diverse WIL that meets the requirements for professional registration with ECSA. The national transformation agenda is thus impeded by the lack of technical capacity in the public sector.
- 5) There is limited awareness of the Governments infrastructure development strategy, the role of civil engineers in that strategy and the opportunities for professional career development associated with the NDP, NGP, PICC and the SIPs.

5.3 Research Question 2

The results pertaining to Research Question 1 are shown in Table 4-2 in Section 4.3. A general perusal of the results shows that all themes that arose are interlinked and will require an integrated discussion.

Research Question 2 What are the explanations for Black engineering graduates being stifled in the work place and for the disjoint between actual workplace experiences in comparison to the documented expectations and requirements for registration with ECSA?

5.3.1 Lack of mentoring, coaching and effective supervision

The theme of a lack of ineffective coaching, mentoring and supervision was raised by 100% of the respondents. When quizzed about the role of mentors, coaches and supervisors, all graduates commented about inefficient relationships with their seniors. They were also clear about what they expected and what was undesirable from their seniors.

86% of respondents felt that their seniors do not motivate or inspire them to register as professionals. A further 79% of participants discussed their supervisors not collaborating with them, to determine together, a channelled and structured career development path. In many cases, a career path was absent. Sadly, 36% of the respondents felt they were constantly criticised, judged and compared, to their peers, in relation to their inabilities or lack of understanding on certain project activities. Of the 36%, 2 respondents said that they felt doubtful about their career, despite working hard, achieving good marks and enjoying the academic program prior to entering the working world.

One respondent when asked about her expectation regarding mentoring said:

I was not expecting to be spoon fed but to find someone who was willing to take me under their wing and help me with the steps. I am a hard worker, and I still work hard (crying). I simply wanted them to expose me to some experience and to teach me skills to become a civil engineer. I didn't get that...even now." (11BFC1)

She continues:

"My concerns are around the development plans in the work place for skills transfer and sharing of knowledge. We are not paired with mentors. What we get now is the odd and occasional question '...how's your registration going?' That's not mentoring." (11BFC6)

Another respondent said in relation to how serious mentors take their role:

"I mean sometimes my mentor meetings with my boss - it's in the car. That's all he has time for. And that's really difficult. I'm sure we can do better. The problem is there isn't focussed and structured attention. There is also no commonality between him and me. There is no relationship - a White man who speaks Afrikaans (and is) 60 something. No!" (4BFC6)

Another respondent that worked in the public sector had this to say:

"I only moved this year (2014) to the BRT. But for as long as I have been here I don't have a mentor. But there is a guy now that mentors me – he is on my case. Before him, there wasn't anyone that was registered – not here (in the Metro). (5BMG9)

Yet another respondent said:

"In 'name of company,' they were under a commitment and undertaking, but there was no mentoring. There was a training plan, but nobody did anything about. We were just lost. Not only me. And we were not getting some of the training experience so we were lost." (12BFC10).

There were 2 particular cases that were very critical of the mentoring they received from their immediate supervisors. The first said:

"ECSA turned me down because I couldn't show my mentors. I told them I didn't have mentors. There was nobody in 'name of parastatal'. But I worked hard and did it myself (crying). And the people that were here – there was this White guy, and he refused to sign off my reports because he was new. He wasn't here before when I did the work. Even he now – he doesn't help me. He told me in a one on one meeting that he will approve my request for post graduate studies, but when they interviewed me for the bursary, he said he cannot approve it, even though we talked about it. ECSA said that if I did my Masters – that would count for the time I lost." (6BFP13)

The second said:

"I don't feel like they are helping me to become professional. All they tell me '...you cannot do this, you cannot do that...' There is no support or motivation anymore. Sometimes I question myself. I used to be smart at school – I can show you my marks at 'name of university.' I know I am not stupid, but to her (supervisor) I am stupid. I just want to start again – I want someone to tell me where to start, what to do...what am I expected to do (crying). I don't have someone to guide me. My boss – she doesn't have any faith in me. She says I am

not capable of doing that work, and I know I am. Just having a difficult time at the moment (sobs and leaves interview room).” (9BFC6)

In general, all respondents felt the broader mentoring role was lacking. They felt that their seniors did not contribute meaningfully, in a direct and involved fashion to provide guidance for professional or personal development.

Literature on the job expectations of graduates and their employers, show the conflicting aspirations of employers and employees (refer to Section 2.8). The experience of the graduates is in line with this conflict. The work done by Yuzainee et al (2011) states that the expectation of current employers of graduate engineers, in terms of confidence, communication skills and technical ability, supersede the expectation that the industry held for their predecessors. In addition, employees expect graduate engineers to immediately engage in problem solving, to possess superior knowledge of science and engineering principles and to be proficient in self-learning (Zaharim et al., 2008). Graduates however, have a very different expectation in that they are expecting focused and intentional mentoring and to have a friendly and positive relationship with their supervisors.

There appears to be yet another contradiction in the article written by Pillay (2014). Pillay states that senior civil engineers have an inherent value system of training young engineers based on the nature of civil engineering projects. Senior engineers are compelled to work with graduate engineers because the cost of time for graduates is cheaper. In his article, Pillay quotes a senior civil engineer to have said: “In the time I have here (in this job), I want to be able to leave a legacy in my work and develop the young people.”

5.3.2 *Work allocation and department structure not geared towards professional development of graduates*

A central theme featured around unsuitable work allocation that was not credible for professional development and professional registration. When asked specifically on design, construction and project management experience, 71% of

respondents said they were not receiving adequate experience in each activity area of experience required for registration. 64% of the participants stated that they felt they were not doing meaningful or worthwhile work. Some went to the extent of labelling their responsibilities 'menial.' Another 64% stated they were looking for more challenging projects because they feel their qualifications and capabilities were disrespected given the type of work they are currently doing. In terms of allocation of work along racial lines, 57% felt that White graduates are given the challenging projects.

Some of the comments:

A frustrated respondent said:

"I have been doing this bloody job – the same thing for 4 years now. Traffic impact studies and research - that's all I do. And my boss won't move me. I know this thing – I haven't learnt anything new." (9BFC4)

Another respondent said:

"I have been doing maintenance, and here you don't get to do anything or even interact with people. You go, you see the tracks and you fill in a report. I don't even know if someone checks or reads those reports. It feels like so useless. But what happens here is that most of exciting work gets taken to consultants." (6BFP4)

Yet another respondent said:

"I am not doing worthwhile work – it makes my bosses happy, but I am not happy. It doesn't contribute to my personal or professional goals. I didn't study to do administration – writing minutes and sending emails. I want to design things and build things." (7BMC4)

Finally, the point is made eloquently:

"At university I sweated for 4 years, and then I come here, and all I do is go to site, look black so that the government client is happy about BEE. I am tired of site supervision. A friend told me about registration. We talked and I am so far behind. I can drive the bakkie and yes – I can do filing." (14BMC3)

This is in keeping with the literature study. Graduate engineers expect to be managed, supervised and mentored by a senior registered engineering professional, who would guide them to professional registration with the relevant engineering registration bodies. They anticipate working in a structured environment doing clearly defined and worthwhile work that is intellectually stimulating and that adds value to the organisation (Hughes & Hurtado, 2013; Jawitz et al., 2005; Vieira, 2012).

It may be proposed that the experience of limited work experience could be resolved by moving graduates around in the company. Another theme that exacerbates the challenge of impeding individual professional development, however, is company structure. 79% of respondents mentioned that the company structure promotes insular business sections that limit reciprocal operations and project load sharing. This inhibits the diversity in project work that graduates wish to engage in, in pursuit of professional registration.

One respondent articulated this:

“They don’t put me on the right type of projects – I mean I do site visits for maintenance – there is no design experience there. I travel all over the place looking at stuff alone. At that time, I didn’t even know what to look for. Now, my boss says it is the priority of our department – maintenance. But the other guys in capital projects, they get to do design.” (6BFP6)

Another respondent said:

“When they bought us out, my eyes opened. They don’t want us to move to get experience. The international bosses say there is opportunity to develop and travel – we can’t even go from this department to down the corridor. You know we like to build silos and focus on your section’s profits and bonuses. That’s how it is.” (12BFC19)

Related to this theme, another 79% felt that their companies were focussed more on making profits rather than the development of their graduates. They complained that their overall work experience in civil engineering left them feeling uninspired and demotivated. They felt they are not doing what they initially aspired to do in the civil engineering profession which was to plan, design and build

infrastructure that improved the quality of lives of people. In their current situation they do not feel like they are achieving this goal.

Some comments that made the point:

“I don’t feel my work improves the lives of people – that was what I signed up for. During our studies we heard of water projects – I got excited about that – to do something important like that you know. But I haven’t come close to a water project in 3 years.” (5BMG4)

“At ‘name of university’ I thought: I want to build a school and a shopping mall. But we don’t have those types of projects. I don’t think it will happen – at least not if I stayed in this company. It does mess with me job satisfaction and fulfilment. But I’ll get there.” (11BFC1)

This is in keeping with literature. The work done by Vieira (2012) states that graduate engineers place heavy significance on corporate philanthropy and social awareness, seeing themselves as being accountable to make a difference in the world. Considering the role of civil engineering in society and the definitions of civil engineer discussed in Section 2.2, the attitude of the graduate engineering professional, in relation to wanting to make a difference, is ideally suited to the profession. They are appropriate candidates to play a role in the ‘...redemption strategy to restore fairness, order and balance in society, and to being servant of the people, custodian of the natural environment and collaborator with its processes...’ (Pillay, 2012a).

5.3.3 Language is an inhibitor

While most formal civil engineering business is known to be carried out in the English language and all race groups participate in English, 79% of the respondents said that language was an inhibitor even though the effect was felt informally. These interviewees described that learning in the work place is not limited in the formal engagements only. On the contrary, most of the passing on of the culture, attitudes and knowledge of civil engineering happens informally in social activities, in corridor discussions and in general interaction. The complaint

was that the language used in social events and corridor discussions were often in Afrikaans, a language that they struggled to comprehend.

This is in line with literature. Language is directly associated with culture, group habits, ethnic behaviour and social circles (Nkuhlu, 1993). Individuals tend to conglomerate amongst people of common concern and language. In order to establish a new *modus operandi*, a deliberate effort needs to be made, from a point of understanding of why that effort is required.

It is fair for graduates to expect a job market that will assess their performance on their preparation and ability and not their race, language or school (Jackson, 2007). According to Pillay (2011a), a new culture for the graduate engineer must emerge based on the fact that all graduates are equal in the work place. Pillay states that the engineering qualification, combined with a common fight for the development of our people, provides a platform and equal footing in the professional environment.

The language factor was not limited to Afrikaans only. In one instance a respondent felt marginalised because the Black staff spoke in Zulu on a construction site, a language that she couldn't understand. This respondent started Zulu lessons in order to:

"...be and feel included on my construction sites. Now I converse with the staff in my office as well. I mess up more often than not, but everyone appreciates my effort. And we have a good laugh too." (10CFC6)

5.3.4 Personal responsibility for my professional development

Personal responsibility to professional development clearly featured as one of the key factors preventing transformation in the civil engineering sector. 86% of respondents felt they have learned to focus to get professional registration and defining a career path by themselves and not to depend on seniors alone or the system. They articulated that even though self-motivation was weak, they needed to take a greater interest in their progress.

Some of the responses on this issue:

"I have no clue as to how to do it – but really it's a lack of interest from my side. I am lazy about it and my peers do nothing to influence me otherwise." (9BFC6)

"I have a mentor and he asks about it. But I'm relaxed about it. I haven't given it the urgency it requires – I keep saying next week for the past 3 years. I take the blame – at some stage I just didn't see the relevance. But still - it's me." (4BFC8)

"I need to get out of this easy comfort zone. I've been avoiding it for 10 years now, at some point you get used to it. I've been taking it easy." (5BMG12)

Literature is very limited with regard to individual motivation to become professionally registered with engineering councils. However the role of civil engineering professional is one of taking responsibility for ones decisions, not limited to civil engineering alone. To attain this level of recognition from one's peers requires vast effort for self-discipline for continuous professional development which is the responsibility of the individual. However, the path to professionalism and the need to self-manage that process must be taught by academic institutions in partnership with the institutions that govern civil engineering.

5.3.5 Conclusion pertaining to Research Question 1

The explanations for Black engineering graduates being stifled in the work place and for the disjoint between actual workplace experiences in comparison to the documented expectations and requirements for registration with ECSA are:

- A lack effective mentoring, coaching and supervising of graduate engineering professionals. Senior staff is not trained to be effective mentors – they simply apply the system that were applied to them when they were graduate engineers. Little consideration is given to the needs of the new generation of graduate engineers.

- Black graduates are given menial work that they do not find challenging or that develops their engineering skills to the point where they are eligible to embark on the registration process.
- The company structure prevents personal and professional development, in that the structure is not conducive for individuals to participate in projects from other departments. It appears that the structure will work for those graduates who are confident to challenge the status quo.
- Language is a subtle barrier that prevents transfer of knowledge and introducing a culture that all can subscribe to.
- Black graduate engineering practitioners, after waiting for the system, companies or seniors to take charge of them receiving appropriate work experience to register; they have come to realise that transference of this responsibility has left them demotivated and lazy. They therefore need to take charge of their own personal and professional development.

5.4 Research Question 3

The results pertaining to Research Question 1 are shown in Table 4-3 in Section 4.4. A general perusal of the results shows that all themes that arose are interlinked and will require an integrated discussion.

Research Question 3 What are the motivations and reasons for Black engineering graduates risking their civil engineering careers by accepting promotions and advancements early in their careers without accumulating sufficient knowledge for technical growth and thereby inhibiting their professional registration with ECSA?

5.4.1 *Promoted without professional registration*

This theme is related to being promoted early in their careers, without being professionally registered. 50% of the respondents said that they were promoted

early in their careers and in line with those promotions, took on greater responsibility and larger salary packages. This was achieved without professional registration.

As a result, attaining professional registration seemed a futile exercise. While professional registration was still perceived to be valuable, there appeared to be no urgency to register. 36% stated that they were earning a good salary, without being professional registered, and that their salary levels will not change should they register. This view was prevalent in the public sector respondents. All 4 participants from the public sector were included in the 7 respondents subscribed to this view.

One of the respondents working in a consulting environment said:

"I have 7 years of the right experience and I am a senior civil engineer...I will register. I think it is important to register. But right now it's not a priority. I am not going anywhere even if I do register. There won't be any changes. My salary won't change. But I will register." (10CFC6)

Views from the public sector:

From a respondent with 14 years of work experience but not registered:

"I know I jumped the gun. I couldn't take a cut in my salary. To go there (reference to consulting), I was offered less. So I decided to stay – I have been around. The money is fine – no one will match it. So I am trying now for the PR. It's the long way (laughs)." (5BMG10)

Another respondent's view:

"I'm a senior technologist here, and I won't get that in consulting. I tried but it's tough (to get in). When I wanted to get some design, the people we worked with, they said they will look at a secondment on another project. That was some years ago and so I decided to register from here." (13BFG5)

It appears that the private sector places more value on professional registration than the public sector. Not all private companies give professional registration attention, but professional registration is a valued prerogative in the private sector,

particularly in the established consulting firms, as was evident from the respondents.

The public sector, however, seeks to address transformation challenges within their structures and may appoint Black staff without professional accreditations while the private sector place greater emphasis on employ and promote professionals that are registered with the relevant engineering authority.

Lawless (2014), in reference to her 'Numbers and Needs in Local Government' discusses the lack of value placement of professional registration in the public sector departments as a trade-off for achieving the transformation agenda. In this research she suggests attracting retired professionals into the public sector to assist with mentoring and training Black staff in order to assist graduates with professional registration.

5.4.2 *High salaries without professional registration stifled movement*

36% of the respondents said they were unable to move jobs due to the fact that they were promoted, without professional registration, into management. The respondents wished to move to consulting organisations but due to work experience limited to project management and contracts administration and no technical design experience, together with disproportionate salary aspirations, the private sector turned their applications away.

The promotion appointments came with commensurate increases in salary. Due to the lack of experience, however, they are given limited involvement in bigger projects. 50% of respondents felt that even though they are seniors in terms of position and rank albeit without professional registration, they felt restricted from participating in bigger and more challenging projects. They preferred however to retain the position and salary, rather than to take a cut in salary to accumulate more experience with a view to register.

When queried on why then they wished to move to private consulting firms, a regular answer was that the packages offered were more competitive. At first glance, there appeared to be resonance with the work done by Cock (2014) who said that the new Black elites wished to demonstrate an ostentatious display of wealth. While there might be some level of truth to this, one needs to consider that the socio-economic circumstances of the individuals interviewed. 100% of the participants have the responsibility of families or siblings or parents or external family members. It is therefore not necessarily true that designer clothes, expensive cars, sumptuous houses and hosting costly parties, as Davenport and Saunders (2000) may suggest.

One of the public sector employees had this to say:

"We are only allowed to do the appointing and to monitor consultants. And that's what the department wants from us. The consultant does the designs. I would like to be in one of those teams. We are not allowed to go beyond project administration. That's why I want my PR." (5BMG11)

Another respondent from the private consulting sector said:

"When they make up the teams, some of us do the small work. We don't do the detail designs. Only the PRs get to be on the design teams. We go to site and manage the drawing office sometimes." (12BFC10)

Yet another public sector respondent, when asked if she would consider going to the private sector to get the appropriate work experience to register:

"I can't change now. I am living in a lifestyle I can't change. I also have a family." (8BFG5)

Lawless, in 2007 states that graduates in the public sector are stifled in the work place in the public sector due to their bursary commitments, lack of proper supervision by registered professionals because the professionals are not employed in the public sector, and the high salaries. Pillay (2012) discusses a possible solution in relation to this challenge, requesting government to employ professionals into full time positions into the fabric of the public sector infrastructure departments but to position the registered professionals in posts

where they are allowed to make technical decisions, oversee projects and mentor the Black graduate engineers within a stipulated time frame.

For this to happen with immediate effect, (Lawless, 2007) called upon Government to consider temporarily relaxing employment equity targets. Lawless's call was echoed by Pillay (2011). The then Minister of the Department of Public Works responded by requesting registered engineering professionals of all race groups, to submit their CVs to the department (Specifier, 2011). No further information was forthcoming since the Minister's departure in 2011.

5.4.1 *Conclusion pertaining to Research Question 1*

The motivations and reasons for Black engineering graduates risking their civil engineering careers by accepting promotions and advancements early in their careers without accumulating sufficient knowledge for technical growth and thereby inhibiting their professional registration with ECSA are:

- The public sector prioritising the transformation agenda over reprofessionalising the public sector with technical and professional skills. While this approach is prevalent in the public sector, it is uncommon to be promoted in the private sector without appropriate qualifications together with experience and professional registration with ECSA. There appears to be a distinct impression that professional registration and transformation are dealt with differently at the private and public sectors.
- Position and title are perceived to be of greater value than work experience. Commensurate comparably higher levels of authority and responsibility are also attaché to promotions which satisfies the need to be doing valuable work in terms of supervising consultants who are the skilled service providers.
- Higher salaries associated with promotions have been entrenched in setting up lifestyles that are difficult to change. Temporarily downscaling in

order to source personal technical development opportunities is not an option.

- Black graduates seem to take on filial responsibilities that extend further than their immediate individual needs. Very often they are caring for siblings, parents and other family members. This socio-economic responsibility prevents them from taking temporary salary cuts in pursuit of professional registration. This is exacerbated when there seems to be no perceived value in terms of monetary benefit.
- The value proposition decision making and the long term impacts of accepting promotions too early and without professional registration, are not clearly understood. The repercussions of taking long decisions with short term gratification are negatives, and have not been exposed to graduate engineering practitioners.

CHAPTER 6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This section summarises the findings of the research exercise, suggests recommendations to employers, employees and institutions that govern civil engineering, on how to encourage graduates to embark successfully on the process of professional registration and to eventually be recognised as civil engineering professional in the industry.

6.2 Conclusions

This research was undertaken in order to identify the factors that affect the registration of Black South African civil engineering graduates with the Engineering Council of South Africa. While this study is by no means an exhaustive exercise to deal with the issues related to professional registration,. After presenting the data, it was envisaged to share some recommendations and suggestions on how to improve the status quo.

Main Research Question: Despite research hinting that the political and economic climate is in favour of the development of Black graduate civil engineering professionals, and that the processes for registration are clearly defined, only 12% of the registered engineering population are Black South Africans. Where are the barriers that prevent Black civil engineering graduates from registering as professionals with ECSA?

The literature review described civil engineering as an honourable profession, and the value that the profession adds to socio-economic development through the development of infrastructure. It went further to assess the current opportunities in the construction, infrastructure and built environment, given national Government's adoption of an infrastructure development strategy for the country's

overall development strategy. The shortage of civil engineering skills was also discussed. Finally the expectations of both graduate engineering practitioners and their employees were also considered.

Against this backdrop, it was highlighted that there is a discrepancy in the proportionate number of black civil engineering professionals that were registering with ECSA, against the proportion of the national population of Black South Africans. The main purpose of this study proposition was to understand why Black graduates do not embark on the registration process exercise.

The outcome of the research study showed diverse conclusions. The study showed that the main reasons for the industry not transforming fast enough are interlinked and integrated. This was anticipated as the process of registration requires an integrated network of activities that are controlled at independent nodes of the engineering career path, by different authorities and participants, and at different times. The flow of these activities, too are left entirely to the graduate to determine and to achieve, with superficial guidance from senior engineers. As a result the average time for a graduate to register is 7 – 10 years, while the minimum stipulated time is 3 years after graduation.

The study found weaknesses in the professional development programs and initiatives within organisations in both the private and public sectors. This included inefficient supervision, mentoring and coaching of Black graduates. The study also showed that the type and quality of work given to Black graduates is not suitable for the process of professional registration. At times, the work seems menial. Inappropriate work is extended over long periods of time, with little intervention from seniors to monitor or rectify the situation. Often this is perceived by the graduates as not being valued and being sacrificed for the company's economic benefit and financial success agenda.

Language was also found to be an inhibitor to professional development, albeit in social environments. A case may be made, however, for learning and knowledge transfer happening equally often in social events and corridor discussions as they

do in formal project, business or mentoring meetings. Black graduate civil engineering practitioners develop a sense of civil engineering culture and aspirations of doing worthwhile work in conceptualising, planning, designing and constructing infrastructure projects that improve the quality of life of society. It was distressing to acknowledge the outcome of the study that showed the work experience and civil engineering culture in the work place, was incongruent with these aspirations. As such their overall work experience was demotivating to the point that some graduates who shared a passion and purpose for civil engineering as a profession, now feel that they are possibly in the wrong career.

There was also clear indication that Black graduates need to become more acquainted with the professional registration processes and take charge of their career path in relation to the registration processes, and not rely on the system to direct their personal and professional development. Black engineering graduates are being promoted into positions of authority without professional registration in the public sector more than in the private sector. Commensurate with the promotions, are work responsibility and higher salaries which become career traps for graduates in that they lack experience to engage with a very skilled private sector. They are then limited to project management and contract administration work and stifle their mobility in the human resource market.

This study might also suggest that the assumption, that professional registration is an expected desire of the engineering graduate, could be flawed. The interviewees' answers indicate that the mindset to achieve professional registration is not prevalent. The value and benefits of registration with ECSA appeared to be unclear to the interviewees. Furthermore there appears to be a distinct difference in perception and desirability of professional registration in the public sector and the private sector. Interviewees from the public sector indicated that their employers do not value professional registration, which has consequently developed their sense of apathy towards registration.

The study also showed that the national infrastructure plans for South Africa present an opportunity to integrate programs for professional registration of Black graduates and thereby achieve rapid transformation of the industry. This opportunity is currently not be optimised.

Finally, the study shows that the bodies that govern civil engineering needs to be relevant to the needs of the profession and the industry in relation to professional registration.

6.3 Recommendations

Emanating from the outcomes of the study, the following section discusses recommendations that organisations, institutions and employers could employ to assist with encouraging their graduates to register as professionals:

- 1) The value of the professional registration accreditation needs to be given priority and recognition by both the public and private sectors, clients and services providers alike. The only way for this to happen is through legislation. At this stage, as per the Engineers Professions Act, professional registration is compulsory on identified work. Without specific work being identified, renders the Act useless. It is imperative that the identification of engineering work is promulgated in order to promote professional registration and safeguarding the profession.
- 2) In relation to (1), the private sector seems to place more value on professional registration. It may take decades for the public sector to deal with the HR issues associated with "...professionalising the public sector..." and take the professional registration process seriously. The public sector is immersed in the transformation agenda and political interference to achieve the professionalising aspiration of the NDP.

This therefore presents an opportunity for the private engineering institutions to govern themselves. This may be the opportune time to start the process that will allow the institutions, which are also known as learned societies for civil engineering; to set up peer reviewed standards, to guard the civil engineering profession from entrants who may embark on government granted diluted forms of professional registration.

This route is similar to the self-governing of the profession in the accounting and medical fields.

- 3) There is a need for a combined and integrated effort, from all institutions that govern civil engineering, the private civil engineer business sector and the public sector, to establish a structured and coordinated program aimed at ensuring graduates have an understanding of the:
 - a. Value of professional registration
 - b. Requirements of the process to be professional registered
 - c. Hands on role of their employers
 - d. Role of the individual
 - e. Career path for professional registration
- 4) The concept of Civilution has been deemed a new era to raise awareness of the value that civil engineering brings to social and economic development in a country (Engineering News, 2014). It is recommended that SAICE and its partnering organisations in this endeavour continue to aggressively fund and promote the concept and embark on public relations exercises to achieve the aspirations of the movement.
- 5) Furthermore, the SAICE membership database comprises 55% unregistered members in total. 35% of the total membership is unregistered black members. In order to offer appropriate and relevant service to its members SAICE should consider a direct approach to individuals and companies (via SAFCEC and CESA) that will enable non registered black

civil engineering professionals to register. The current flagship course Road to Registration which is intended to assist engineering graduates with registration (Theron, 2006), may require expansion to accommodate the new generation of graduates while maintaining the same level of professionalism on accomplishing the 11 outcomes (See Table 2-2) required for professional registration.

- 6) Employers of civil engineering practitioners and the graduates themselves need to become aware of SAICE, SAFCEC, CESA and ECSA and the roles each institution plays in the governing of the profession. Having clearly understood these roles, employers should encourage active participation in the appropriate institutions. Employers should support by releasing graduates during work time occasionally and making appropriate budgetary provision for participation in voluntary activities. In like manner, the respective institutions need to engage employers to share the benefits and value that their companies and employees will derive from participation in the various associated institutions.
- 7) In relation to the awareness of Governments national strategy for infrastructure development:
 - a. There is a need for urgent collaboration between government and interested and affected parties in the infrastructure delivery value chain, particularly the civil engineering community who are custodians of infrastructure in the country. This is critical to achieve support and buy in from the local civil engineering capacity.
 - b. The lack of awareness among the professionals, of the projects and initiatives in this regard, will also need to be dealt with. Strategic and regular public relations engagements, that target the associated professional bodies, should be embarked upon. This will raise the awareness of professional development opportunities within the infrastructure frameworks established by Government while at the

same time reduce sentiments of mistrust between Black graduate engineering professionals towards the public sector and towards the profession.

- 8) Companies need to place greater emphasis on mentoring, coaching and supervising. Mentorship programs need to be deliberate and purposeful - not incidental. Companies need to allow for time, in their professional billable hours, to be used for mentoring. Supervisors need special training on how to formally mentor graduate engineers. The topics included in the training of mentors should be diversity management, psychology, and leadership.
- 9) Professional development, including professional registration and career pathing, should form part of the Performance Management System and HR policies of the company.
- 10) Company structures should function in an integrated and partnering fashion. The new graduate engineer is a team operator and finds diversity attractive. The need to be appropriately managed while getting involved in projects across departments should not be stifled, but encouraged.
- 11) Diversity management and training programs is crucial to the social and professional camaraderie of South African engineering teams. Ignoring the effects of different cultures, languages and behaviours and blaming "...people like to associate with whom they feel comfortable..." is perpetuating old regime thinking that does not make for the goals of diversity by design.
- 12) The effort for deliberate socialising outside of racial and social comfort zones from a point of understanding should be made. Special effort needs to be made by senior staff members and team managers, particularly at office socials and informal events.

- 13) It is critical that the public sector Ministers and Directors General, make concerted efforts to recognise the need for technical professionals to lead the infrastructure ministries in South Africa. Government needs to make strides in attracting qualified, experienced and registered professionals back into the public sector. A re-professionalization program should be embarked upon that should seek to:
- a. Attract professionals back into the public sector
 - b. Afford them control of technical decision making
 - c. Limit political involvement in technocratic work
 - d. Ensure proper supervision, mentoring and coaching of graduate engineering staff with a view to register with ECSA. A stipulated time frame with strict performance assessment should be part of the plan in order to achieve the nation's transformation agenda

6.4 Suggestions for further research

When the author initially embarked on this study, the scope was broad and ambitiously attempted to resolve the issue of transformation in the civil engineering profession. Having been through the research exercise, transformation in any context has emerged as a complex and integrated challenge. In true engineering problem solving fashion it is necessary to segregate the challenges and consider each sub challenge one piece at a time, and then to integrate the solutions as they are independently resolved.

This particular research topic is by no means an exhaustive study on the subject. The following section discusses other possible research topics which will help on holistically understanding and resolving the transformation imperatives and challenges associated with skills development for Black graduates in civil engineering in South Africa.

- 1) This study has alluded to differences between the work experiences between Black graduates and White graduates in the workplace in relation to professional registration. It will be interesting to compare and contrast the actual work experiences of White graduates in this regard. A study of this nature will inform the establishment of a comprehensive and integrated program for professional registration and one that will include diversity related issues.
- 2) The need for the institutions that govern the civil engineering profession to be more relevant and attuned to the needs of their members is critical. In relation to professional registration, a study that instigates collaboration between graduates, their employers, and the public sector infrastructure ministries should be embarked upon. The study should explore the potential of establishing an integrated program for engineering graduates to register in the minimum timeframes allocated by the ECSA. This requires a new mind set and a revolution against the current system of participants and the level at which they are engaged in the current registration process.
- 3) An outcome of the current study and research was that graduates find no meeting place for their expectations in terms of job satisfaction and anticipated civil engineering culture and their actual experience in the work place. The author advocates for a study that compares the aspirations developed prior to and during academic studies and the actual experiences with a view to inform the changes that need to occur.
- 4) Informed by the definition of civil engineering, the largest employer of civil engineering professional should be the public sector. As such the issue of transformation, which is a national agenda, should be accomplished first in the public without losing the technical, professional and functional role of the civil engineering professional. A study should be done, with the support and under the custodianship of the national presidency on an infrastructure

ministerial office that determines what factors prevent professionally registered civil engineering practitioners from taking up posts in the public sector. This study must have the intention of attracting professionals into the public sector.

- 5) In relation to consumer patterns and spending habits, Cock's (2014) claim that most young Black graduate professionals appear to be preoccupied with salary, high living and material gain (refer to Section 2.7), appears to be unfounded. Further research on consumer patterns and practices according to race should be conducted.

6.5 Consistency matrix

Table 6-1 Consistency matrix

Research problem Analysis the factors affecting the development of Black South African Civil Engineers with a view to register as professionals with the Engineering Council of South Africa.					
Main research problem	Literature review	Research questions	Source data	Type of data	Analysis
Examine the reasons why Black South African Civil Engineering graduates experience challenges in gaining work experience that enables registration with the Engineering Council of South Africa	Lawless (2007) Watermeyer and Pillay (2013) Zaharim et al. (2008) Reddy (2010) UNESCO (2010) Sithole (2010) Tladi (2001) Richards (2013) Kaus (2013) ECSA (2013) Rasool (2014)	Despite research hinting that the political and economic climate is in favour of the development of Black graduate civil engineering professionals, and that the processes for registration are clearly defined, only 12% of the registered engineering population are Black South Africans. Where are the barriers that prevent Black civil engineering graduates from registering as professionals with ECSA?	Respondents to provide the data through semi structured group interviews. Data to be verified by other documents (e.g. annual reports, press articles, and brochures) and re-approaching respondents.	Qualitative data	Data reduction Data display Conclusion drawing/ verification (Thorne, 2014).

Research problem Analysis the factors affecting the development of Black South African Civil Engineers with a view to register as professionals with the Engineering Council of South Africa.					
Main research problem	Literature review	Research questions	Source data	Type of data	Analysis
		What are the explanations for Black engineering graduates being stifled in the work place and for the disjoint between actual workplace experiences in comparison to the documented expectations and requirements for registration with ECSA?	Respondents to provide the data through semi structured group interviews. Data to be verified by other documents (e.g. annual reports, press articles, and brochures) and re-approaching respondents.	Qualitative data	Data reduction Data display Conclusion drawing/ verification (Thorne, 2014).

REFERENCES

- Adama Science & Technology University. (2011). Civil Engineering Infrastructure Retrieved 24 September 2014, 2014, from <http://www.astu.edu.et/index.php/schools/schools/school-of-engineering-and-it/departments/civil-engineering-a-architecture>
- Adams, R. (1994). *Job expectations of civil engineering graduates*. (MBA MBA Research Report), University of the Witwatersrand, Johannesburg.
- Allie, S., Armien, M. N., Burgoyne, N., Case, J. M., Collier-Reed, B. I., Craig, T. S., . . . Jacobs, C. (2009). Learning as acquiring a discursive identity through participation in a community: Improving student learning in engineering education. *European Journal of Engineering Education*, 34(4), 359-367.
- ALSTOM. (2012). Registration Document Annual Financial Report 2011/12. Levallois-Perret, France: Alstom.
- Andrew, R. M. (2012). 'With'and not 'to'–the key to unlocking communities. *Proceedings of the ICE-Municipal Engineer*, 165(3), 149-156.
- Anyon, J. (2014). *Radical possibilities: Public policy, urban education, and a new social movement*. London: Routledge.
- ASCE. (2006). *The vision for civil engineering in 2025*. Virginia, USA: ASCE.
- Bernard, H. R., & Bernard, H. R. (2013). *Social research methods: Qualitative and quantitative approaches*. Thousand Oaks, CA: Sage.
- Booth, L. (1979). Thomas Tredgold (1788-1829): Some Aspects of his Work: Part 1: His Life. *Transactions of the Newcomen Society*, 51(1), 57-94.
- Botha, D. B. (2003). *Foundation for the future*. Johannesburg: Chris Van Rensburg Publications.
- Bourn, D., & Neal, I. (2008). The Global Engineer: Incorporating global skills within UK higher education of engineers.
- Brown, T. (2014). *Change by design*. London: HarperCollins e-books.
- Buthulezi, L. (2014, 18 May). SA needs to respect water, *Business Report*, p. 4.
- Cape Society of Civil Engineers. (1904). Minutes of Proceedings of the CSCE (1 ed., Vol. 1). Cape Town: CSCE

- Case, J. (2006). *Issues facing engineering education in South Africa*. Paper presented at the 3rd African Regional Conference on Engineering Education, Pretoria.
- Charles, H. P. (2012). *Working in harmony with nature: the key to sustainability*. Paper presented at the Proceedings of the Institution of Civil Engineers. Civil engineering.
- Charmaz, K. (2014). *Constructing grounded theory*. Thousand Oaks, CA: Sage.
- Chisholm, L. (2012). Apartheid education legacies and new directions in post-apartheid South Africa. *Storia delle donne*, 8(1), 81-103.
- Clark, N. L., & Worger, W. H. (2014). *South Africa: The rise and fall of apartheid*. London: Routledge.
- Cock, J. (2014). Inequality, Consumption and Some Damaging Conceptions of the 'Modern' in Contemporary South Africa. *Rethinking Development and Inequality*, 3.
- Crawley, E. F., Malmqvist, J., Östlund, S., Brodeur, D. R., & Edström, K. (2014). The CDIO Syllabus: Learning Outcomes for Engineering Education *Rethinking Engineering Education* (pp. 47-83). Berlin: Springer.
- Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed methods approaches*. Thousand Oaks CA: Sage.
- Datamonitor. (2014). Construction and Engineering Industry Profile: South Africa. Retrieved 12 June 2014, 2014, from http://www.datamonitor.com/store/Product/south_africa_construction_engineering?productid=MLIP0735-0023
- Davenport, R., & Saunders, C. (2000). *South Africa: A modern history by T* (5 ed.). London: Palgrave Macmillan.
- Deegan, H. (2014). *Politics South Africa*. London: Routledge.
- DeKoker, V. (2013, November 2013). The world according to SAICE. *Civil Engineering*, 21, 88.
- Department: Sport and Recreation South Africa. (2010). 2010 FIFA World Cup Report. Pretoria: Department: Sport and Recreation South Africa.
- du Toit, R., & Roodt, J. (2009). Engineering professionals. *List of tables iv List of figures vi Acronyms and abbreviations viii*, 75.

- Du Toit, R., & Roodt, J. (2009). *Engineers in a Developing Country: The profession and education of engineering professionals in South Africa*. Pretoria: HSRC Press.
- ECSA. (2012). Guide to the competency standards for registration as a professional engineer. Johannesburg: ECSA.
- ECSA. (2013). ECSA Transformation Committee. Johannesburg: ECSA.
- Emuze, F., & Adlam, R. (2013). Implementation of Broad-Based Black Economic Empowerment in construction: A South African metropolitan area study. *Acta Structilia*, 20(1), 126-154.
- Engineering News. (2014). Civilution: looking at building South Africa's water security. from <http://www.engineeringnews.co.za/article/civilution-looking-at-building-south-africas-water-security-2014-02-20>
- Fauzi, S. N. F. M., Abidin, N. Z., & Awang, H. (2013). Improving Graduates' Employability Skills through Industrial Training: Suggestions from Employers. *Journal of Education and Practice*, 4(4), 23-29.
- Ferguson, H., & Chrimes, M. (2011). *The Civil Engineers*. London: ICE Publishing
- Gale, A. W., & Davidson, M. J. (2006). *Managing diversity and equality in construction: Initiatives and practice*. London: Routledge.
- Hammack, R., & High, K. (2014). EFFECTS OF AN AFTER SCHOOL ENGINEERING MENTORING PROGRAM ON MIDDLE SCHOOL GIRLS' PERCEPTIONS OF ENGINEERS. *Journal of Women and Minorities in Science and Engineering*, 20(1).
- Hatch, S. (2008). *Diversity by Design: Guide to fostering diversity in the Civil Engineering Workforce*. Virginia: ASCE.
- Hooper, D. (2012). Briefing: The Equality and Diversity Panel, Institution of Civil Engineers. *Proceedings of the ICE-Municipal Engineer*, 165(3), 125-126.
- Horikawa, K. (2009). *Civil Engineering Encyclopaedia on Life Support Systems* (Vol. 1). Qizhong Guo: ELOSS.
- Hughes, B. E., & Hurtado, S. (2013). *Investing in the future: Testing the Efficacy of Socialization within Undergraduate Engineering Degree Programs*. St. Louis, MO: UCLA.
- Jackson, T. (2007). *Employer Perceptions of Technology Graduates from Historically Black Colleges and Universities: AQ Methodological Study*. Ann Arbor: Walden University.

- James, W. (2013). The meaning of race in modern South Africa.
- James, W., & Lever, J. (2001). *The second republic: Race, inequality, and democracy in South Africa*. Colorado: Lynne Rienner.
- Jawitz, J., Case, J., & Ahmed, N. (2005). *Smile Nicely, Make The Tea But Will I Ever Be Taken Seriously? Engineering Students' Experiences of Vacation Work*. Cape Town: University of Cape Town.
- Kaus, W. (2013). Conspicuous consumption and “race”: Evidence from South Africa. *Journal of Development Economics*, 100(1), 63-73.
- Ketcham, L. N., Frehill, L. M., & Jeser-Cannavale, C. (2005). Women in engineering: A review of the 2004 literature. *Women in Engineering ProActive Network*.
- Kleynhans, P. (2013). Civilisation gains momentum. *Civil Engineering= Siviele Ingenieurswese*, 21(1), 5-5.
- Landman, J. (2014). *The Long View*. Midrand: Jacana.
- Lawless, A. (2005). *Numbers & needs - Addressing imbalance in the civil engineering profession* Midrand: SAICE.
- Lawless, A. (2007). *Numbers and needs in local government*. Midrand: SAICE.
- Lawless, A. (2014). *Graduate to registration*. Midrand: SAICE.
- Layne, P., & Arenberg, C. (2002). Diversity in engineering: managing the workforce of the future. Washington DC: National Academy of Sciences.
- Leadership. (2014, 14 May 2014). 20 Years of Democracy - An objective look at transformation as a partnership between government and the private sector. *Leadership*.
- Lounsbury, M., Boxenbaum, E., Vican, S., & Pernell-Gallagher, K. (2013). Instantiation of Institutional Logics: The “Business Case” for Diversity and the Prevalence of Diversity Mentoring Practices *Institutional Logics in Action, Part B* (pp. 233-273): Emerald Group Publishing Limited.
- Marshall, M. N. (1996). Sampling for qualitative research. *Family practice*, 13(6), 522-526.
- Mkhacane, S. (2014a). Comment on the national infrastructure policy. Cape Town: SAICE.

- Mkhacane, S. (2014b). Taking civil engineering to the remote and marginalised areas of South Africa and beyond-forward with Civilution: Presidential Address. *Civil Engineering= Siviele Ingenieurswese*, 22(2), 19-23.
- National Planning Commission. (2010). *About the National Development Plan* (Vol. 2014). Cape Town: National Planning Commission.
- National Planning Commission. (2013). *National Development Plan Vision 2030*. Pretoria: Republic of South Africa.
- Nkuhlu, W. (1993). *Affirmative action for South Africa in transition: From theory to practice*. Paper presented at the Affirmative Action, Kenwyn.
- Pautz, M. (2015). *Transitional generations and the need for the young engineer to be counted: presidential address as delivered on 12 February 2015* (Vol. 23). Johannesburg: SAICE.
- Pillay, M. (2011a). I have a dream. *Civil Engineering*, 19.
- Pillay, M. (2011b). Right down the middle. *Civil Engineering*, 19.
- Pillay, M. (2012a). Civilution. *Civil Engineering*, 20, 1-1.
- Pillay, M. (2012b). Let there be Jobs. *Civil Engineering*, 20, 1-1.
- Pillay, M. (2012c, February 2012). Let there be Jobs. *Civil Engineering*, 20, 88.
- Pillay, M. (2014). Code SA. *Civil Engineering*, 22(8), 88.
- Power, M. (2014). Challenging Knowledge, Sex and Power: Gender, Work and Engineering. *Feminist Economics*(ahead-of-print), 1-4.
- Presidential Infrastructure Coordinating Commission. (2012). *A summary of the South African National Infrastructure Plan*. Pretoria: Government Printers.
- Ramutla, L. (2010). Scarce Skills. In Department of Labour (Ed.). Pretoria: The Department.
- Rasool, H. (2014). Top 100 occupations in high demand list. Pretoria: Department of Higher Education and Training.
- Reddy, P. (2010). Factors influencing the development of management skills in South African civil engineers. Johannesburg: University of the Witwatersrand.
- Republic of South Africa. (2000a). *Council for the Built Environment Act*. Cape Town: Government Printer.

- Republic of South Africa. (2000b). *Engineering Professions Act*. Cape Town: Government Printer.
- Republic of South Africa. (2004). *Broad Based Black Economic Empowerment Act*. Cape Town: Government Printer.
- Richards, M. (2013). Transforming Graduates at an Institution of Higher Learning in Cape Town, South Africa. *ICERI2013 Proceedings*, 7185-7185.
- Riordan, S., & Goodman, S. (2007). Managing reality shock: expectations versus experiences of graduate engineers. *SA Journal of Industrial Psychology*, 33(1), 67-73.
- Ritchie, J., Lewis, J., Nicholls, C. M., & Ormston, R. (2013). *Qualitative research practice: A guide for social science students and researchers*. Thousand Oaks, CA: Sage.
- Sabelo, E. (2014, 26 February 2014). *Draft Identification of Engineering Work Regulations*. Email. Engineering Council of South Africa, Johannesburg.
- SAICE. (2011). SAICE's report card on the state of infrastructure. Johannesburg: South African Institution of Civil Engineering.
- SAICE. (2014). SAICE Membership Committee - Meeting Minutes, Special Report. Johannesburg: South African Institution of Civil Engineering.
- Sithole, J. J. (2010). *Career Cognitions of Black Engineers in South Africa*. Pretoria.
- South African Reserve Bank. (2013). *Annual Economic Report of the South African Reserve Bank 2013*. Pretoria: South African Reserve Bank.
- Specifier. (2011). Jobs for engineers. from <http://www.specifile.co.za/specifier/news-now/609-saice-a-dpw-on-jobs-for-engineers>
- Steyn, G., & Daniels, R. C. (2003). *Engineers and Technicians*. Cape Town: HSRC.
- Tamara, D., Gail, E., Lucy, H., Kerwin, L., Nachi, M., & Marius, R. (2010). *South Africa Survey 2011*. Johannesburg: South African Institution of Race Relations.
- The Presidency: Republic of South Africa. (2013). *The Presidency Annual Report 2012/ 2013*. Pretoria: The Presidency.
- Theron, M. (2006). Negotiating the road to ECSA registration. *Civil Engineering= Siviele Ingenieurswese*, 14(1), p. 24-25.

- Thorne, S. E. (2014). Applied Interpretive Approaches 6. *The Oxford Handbook of Qualitative Research*, 99.
- Thwala, W. D. (2008). Skills development in South Africa: Group Five's social investment project. *Development in Practice*, 18(3), 446-449.
- Tladi, T. M. (2001). *Affirmative action and the employment equity act of South Africa*. Rand Afrikaans University, Johannesburg.
- Tregenna, F., & Tsela, M. (2012). Inequality in South Africa: The distribution of income, expenditure and earnings. *Development Southern Africa*, 29(1), 35-61.
- UNESCO. (2010). Engineering: Issues, Challenges and Opportunities for Development. Paris, France: UNESCO.
- Venkatesh, V., Brown, S. A., & Bala, H. (2013). Bridging the qualitative-quantitative divide: Guidelines for conducting mixed methods research in information systems. *Mis Quarterly*, 37(1), 21-54.
- Vieira, J.-A. (2012). *Early-career expectations and retention factors of generation Y engineers*. Johannesburg: University of Johannesburg.
- Watermeyer, R. (2012). *The critical role of consulting firms in the acceleration of infrastructure delivery and the improvement of the quality of life*. Randburg: Infrastructure Options.
- Watermeyer, R., & Pillay, M. (2013). Strategies to address the skills shortage in the delivery and maintenance of infrastructure in South Africa: a civil engineering perspective: infrastructure delivery. *Civil Engineering= Siviele Ingenieurswese*, 20(5), 46-56.
- Wood, D. M. (2012). *Civil Engineering: A Very Short Introduction* (Vol. 331). Oxford: Oxford University Press.
- Worden, N. (2011). *The making of modern South Africa: conquest, apartheid, democracy*. New York: John Wiley & Sons.
- Yuzainee, M., Zaharim, A., & Omar, M. (2011). *Employability skills for an entry-level engineer as seen by Malaysian employers*. Paper presented at the Global Engineering Education Conference (EDUCON), 2011 IEEE.
- Zaharim, A., Omar, M. Z., Basri, H., Muhamad, N., & Isa, F. L. M. (2008). A gap study between employers' perception and expectation of engineering graduates in Malaysia. *Education*, 39, 9.2.

Zuma, J. (2014). Address by His Excellency Mr. Jacob Zuma on the occasion of his inauguration as fifth President of the Republic of South Africa, 2014. Pretoria: The Presidency.

APPENDIX

Appendix A Interview Guide and Semi-structured questionnaire for research interview

1	Name	3	Name	
	Gender		Gender	
	Job description		Job description	
	Ethnic Group		Ethnic Group	
	Age		Age	
2	Name	4	Name	
	Gender		Gender	
	Job description		Job description	
	Ethnic Group		Ethnic Group	
	Age		Age	
1 - Registration	1 - Registration		4 - Work	
	Are you familiar with the registration process?		What is your position at the institution?	
	Do you feel that it is necessary to register as a professional with the Engineering Council?		Describe a normal day at the office for you?	
2 - Institutional	What are your concerns about professional registration as an educator/ government?		Who are your colleagues/ seniors/ managers/ directors/ etc. and how do they influence your work?	
	2 - Institutional		Describe your involvement in the projects you are currently working on?	
	What do you know about ECSA and SAICE? Any differences that stand out?		Do you feel that you are doing worthwhile work - (as you described when discussed why you became a civil engineer)?	
	What in your view is the role of a Civil Engineer?		Are you receiving design/ construction/ project management and engineering experience?	
	Are you familiar with work identification for engineers?		Do you feel you are inhibited by language given that English/ Afrikaans is not your mother tongue/ first language?	
	Do you actively engage with SAICE activities? If not why not? Are you aware that SAICE has a Branch in your area?		Explain those activities that make you feel immersed into a culture of Civil Engineering in the workplace.	
	Are you familiar with the NDP, the NGP, the PICC and the SIPs?		If not, please explain why you feel you are not receiving design/ construction/ project management and engineering experience?	
	Do you feel that you are contributing the success of these initiatives?			
	Are your opinions taken into account in decision		5 - Mentoring and Coaching	
	How important is technical decision making to your seniors?		Do you have a mentor and a coach - if not, why? How often do you meet, and what do you talk about?	
3 - Graduation	3 - Graduation		Describe your relationship with your immediate supervisor?	
	Where do you come from?		Do you feel that your seniors give you adequate attention in terms of experience? How often do you sit with your seniors to discuss your professional development?	
	Why did you choose to study Civil Engineering?		Do you feel that you are treated differently because of your race/ language barriers/ inabilities?	
	Where did you study? Why did you choose this university?		What do you talk about - are the communication doors open at all times?	
	What was the student culture? Did you get to socialise often - what did you do?		What, in your opinion, are the major drawbacks in relation to registration and professional development, as a Black Engineer in the work place?	
	When did you graduate? How did it feel to graduate?		How do you feel we could repair the shortcomings?	
	As a student, what were your perceptions and expectations from the work place?		Do you feel that you are on a career path? Where to from here?	

Appendix B Post interview notes

Perception of success of the interview
View of the interviewee: Talkative/ twitching/ looking around/ co-operative/ nervous/ dress smart/ scruffy
Did the interview open up other avenues of interest?
What was the setting of the interview? Busy/ quiet/ office layout/ new or old building/ people interrupting/ etc?
Body language/ atmosphere

Appendix C Letter to respondents

Dear Respondent,

I am completing an MBA at The University of Witwatersrand, Johannesburg (Wits). My MBA thesis is on the FACTORS AFFECTING THE PROFESSIONAL REGISTRATION OF BLACK SOUTH AFRICAN CIVIL ENGINEERING GRADUATES WITH THE ENGINEERING COUNCIL OF SOUTH AFRICA.

Towards gathering data on this subject, I would be grateful if I could arrange a 1 hour interview with you to understand the process undertaken for the development of graduate professional engineers at the "Name of Company." I understand you are extremely busy and your agreement to contribute to my research is greatly appreciated.

The interview and its outcomes shall be private and confidential interview. The interview will not involve questions on your detailed strategic plans for the future, but will focus on the general manner in which professional development is conducted in your institution. I attach to this cover letter the line of questioning I shall take.

Confidentiality will be observed throughout the thesis compilation process and the final report will be for academic purposes only.

Thank you for your kind assistance.

Yours sincerely,

Manglin Pillay PrEng HDE MSAICE

Appendix D Logistics of interviews

Interview Number	Individual Code	Sector	Date	Times
1	CM	Construction	Wednesday, 3 December 2014	11h00 - 12h30
2	IM	Consulting	Monday, 1 December 2014	11h00 - 12h30
3	BM	Consulting	Friday, 9 January 2015	11h30 - 13h00
4	BF	Consulting	Friday, 28 November 2014	15h00 - 16h30
5	BM	Government	Wednesday, 3 December 2014	07h30 - 09h00
6	BF	Parastatal	Tuesday, 2 December 2014	17h00 - 19h00

Interview Number	Individual Code	Sector	Date	Times
7	BM	Consulting	Friday, 9 January 2015	08h15 - 09h30
8	BF	Government	Wednesday, 3 December 2014	14h15 - 15h15
9	BF	Consulting	Friday, 9 January 2015	15h30 - 17h00
10	CF	Consulting	Saturday, 10 January 2015	08h00 - 09h30
11	BF	Consulting	Tuesday, 2 December 2014	14h00 - 15h30
12	BF	Consulting	Thursday, 4 December 2014	08h00 - 09h30
13	BF	Government	Wednesday, 3 December 2014	15h30 - 16h30
14	BM	Consulting	Thursday, 4 December 2014	10h30 - 11h50

Interview Number	Individual Code	Sector	Date	Times
KEY FOR "Individual"	B	Black African		
	I	Indian		
	C	Colored		

