# Sources of motivation for engineers in South Africa

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# DECLARATION

I, Siyanda Ncwane, declare that this research article 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 Graduate School of Business Administration, University of the Witwatersrand, Johannesburg. It has not been submitted before, for any degree or examination in this or any other university.

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Signed at ……

On the …….. day of …… 20…..

# DEDICATION

This research is dedicated to my fiancée, Christina Duma, my son, Nsika Ncwane and my mother, Jabu Kunene. Without your support and assistance, my journey would have been much tougher.

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# ABSTRACT

**Orientation:** The exodus of engineers from the engineering profession in South Africa is an ongoing phenomenon that continues to be a national challenge. In addition, the engineering industry needs to retain engineers because the profession plays a vital role in the development of infrastructure, the economy and the provision of services to society. Organisations are focusing on instrumental motivations to motivate engineers, the wrong approach, resulting in a disconnect between engineers and their employers. This leads to high levels of dissatisfaction and high levels of attrition of engineers in the engineering industry.

**Research purpose:** The purpose of the research was to identify the sources of motivation of licensed and unlicensed engineers, and of female and male engineers in South Africa. Furthermore, the research aimed to determine whether the sources of motivation differ based these two variables.

**Motivation for the study:** South Africa has a shortage of licensed engineers. The shortage is further exacerbated by the exodus of engineers from the engineering profession to non-engineering disciplines and to other countries. The engineering industry needs to identify what motivates engineers so they can be retained, developed and groomed into global leaders in their profession.

**Research approach, design and method:** The population used in the study consists of engineers who have an undergraduate BSc or BEng qualification in an engineering discipline, and who were working in the engineering industry in South Africa. Subjects were located using non-probabilistic snowball sampling. The sample of engineers comprised 30 male licensed engineers, seven female licensed engineers, 43 male unlicensed engineers and 18 female unlicensed engineers.

The research performed was a cross-sectional study that used a quantitative research method. A self-administered online survey was used to collect data on sources of motivation. In the study, descriptive and inferential statistics (independent sample t-test) were used to analyse the data and answer the research questions.

**Main findings:** The results of the study identified the dominant sources of motivation amongst engineers in South Africa were internal self-concept motivation followed by goal internalisation motivation. These findings mean engineers in South Africa are motivated by their expertise and competence and the achievement of goals. The study results also indicated there was no significant difference between sources of motivation of licensed and unlicensed engineers and between sources of motivation of male and female licensed and unlicensed engineers.

**Practical and managerial implications:** Sources of motivation can be used to identify what motivates licensed and unlicensed engineers in South Africa. Managers can use the sources of motivation to develop employee incentives that will motivate engineers in the engineering industry.

**Contribution or value added:** The study was unique as it investigated sources of motivation of licensed and unlicensed engineers in South Africa, while other studies treated engineers as homogenous. The study also contributed to increasing knowledge on what motivates engineers in South Africa.

Keywords: *sources of motivation, licensed engineers, unlicensed engineers, South Africa, gender, quantitative research*

# Introduction

A wide-ranging review of literature has identified a limited body of knowledge pertaining to the application of Leonard, Beauvais, and Scholl (1999) metatheory of integrated sources of motivation. In addition, there is a gap in the identification of sources of motivation of engineers working in South Africa.

Previous research has focused on engineers working in the United States of America (USA) (Browne, 2013; Gomersall, 1971) and other professions, including research scientists (Ryan 2014), nurses (Bodur & İnfal, 2015), middle managers (Chipunza & Matsumunyane, 2018), teachers (Latta & Fait, 2016) and farm managers (Barbuto , Trout, & Brown, 2004). Given the importance of engineers in South Africa, and problems engendered by their shortage, the findings of this study will be important to employers who want to motivate and retain their engineering workforce.

## Orientation

Engineering as a profession is essential for the development of society (Kirillov & Fadeeva, 2015). Engineers play a vital role in the development of a country's infrastructure, economic development and the provision of services. They design, develop, test, construct, operate and maintain systems and subsystems that solve problems faced by industry and society (Nguyen, 1998).

In benchmarking the average population per licensed engineer, South Africa lags behind Brazil and Malaysia (ECSA, 2017b). In South Africa a licensed engineer services 3,166 people, while in Brazil and Malaysia a licensed engineer services 227 people and 534 people respectively (ECSA, 2017b). These figures indicate there is a severe shortage of licensed engineers in the country. This exemplifies the need for the engineering industry to attempt to retain more engineers to address the shortage.

The shortage of engineers in South Africa is further exacerbated by engineers exiting the engineering profession to work in non-engineering disciplines e.g. Management Consulting and Banking. Other engineers are immigrating to countries such as Australia that have a high demand for South African engineers (Businesstech, 2017).

To reduce the exodus of engineers from the engineering industry in South Africa, enhancing employee motivation is an effective tool available to employers as it has been shown to reduce employee turnover (França, Sharp, & Da Silva, 2014).

## Research purpose and objectives

The purpose of the study was to identify the dominant sources of motivation of licensed and unlicensed engineers in South Africa. The study also aimed to determine whether the sources of motivation of licensed engineers significantly differed from those of unlicensed engineers. In addition, the study further aimed to determine whether the sources of motivation between male and female licensed engineers and between male and female unlicensed engineers significantly differed.

## Problem statement

The main problem of the study was to identify what motivates engineers in South Africa. In order to present the main problem in detail, it was divided into four sub-problems.

### First sub-problem

The first sub-problem of the study was to identify the dominant sources of motivation of licensed and unlicensed engineers in South Africa.

### Second sub-problem

The second sub-problem of the study was to identify the dominant sources of motivation of male and female licensed and unlicensed engineers in South Africa.

### Third sub-problem

The third sub-problem of the study was to identify whether there was a significant difference in sources of motivation between licensed and unlicensed engineers in South Africa.

### Fourth sub-problem

The fourth sub-problem of the study was to identify whether there was a significant difference in sources of motivation between male and female licensed engineers and between male and female unlicensed engineers in South Africa.

## Delimitations of the study

This study has specifically focused on engineers in South Africa and hence did not include other professionals. The study has excluded engineering technologists and technicians, because their work output significantly differs to the work output of engineers in industry, and their skills developed at tertiary level and in industry are not similar to engineers. In addition, the study has excluded engineers who are not working in South Africa, or who are not working in an engineering field as they did not form part of the South African engineering workforce.

## Assumptions

The assumptions made in the study were, the sample of engineers was accurately identified for the research. In addition, it was assumed participants in the survey answered the questionnaire honestly and they aptly referred other licensed and unlicensed engineers to participate in the survey.

# Literature review

## Engineers in South Africa

An engineer is any person possessing an accredited engineering degree whose occupation involves the development, design or implementation of projects and processes (Nguyen, 1998). Work performed by engineers can adversely affect society, the environment, and animals. To mitigate these risks, governments license engineering work within their jurisdiction (Freeman, 1951; Kleiner & Vorotnikov, 2017).

Practising in a licenced occupation without first being licensed is a criminal offence (Chi, Kleiner, & Qian, 2017). As a result engineering work is permissible by law to be performed only by licenced engineers in South Africa. Engineering work is regulated by the Engineering Profession Act 46, of 2000 (Republic of South Africa, 2000).

### Licensed engineers

The Engineering Profession Act 46, of 2000 empowers ECSA to licence engineers as professional engineers. Professional engineers are engineers who after acquiring an engineering degree, acquire the relevant experience to be licensed to practise as an engineer (Khulief, 2002). Licensed engineers assume responsibility for any work they have perfromed and signed off. In the 2016/2017 financial year, ECSA had 16,733 licensed engineers in South Africa (ECSA, 2017a). There were 15,868 male and 865 female engineers licensed

with ECSA (ECSA, 2017a). Amongst licensed engineers, 95% were males and 5% were females.

### Unlicensed engineers

The Engineering Profession Act 46, of 2000 empowers ECSA to register engineers as candidate engineers (Republic of South Africa, 2000). However, engineers can choose to either register with ECSA as candidate engineers or remain unregistered. In the 2016/2017 financial year, ECSA had 8,896 candidate engineers in South Africa (ECSA, 2017a). There were 7072 male and 1,824 female candidate engineers registered with ECSA (ECSA, 2017a). Amongst candidate engineers in the country, 80% were males and 20% were females.

Engineers who are unlicensed in South Africa are required to work under the supervision of a licensed professional engineer for a minimum duration of three years before they can apply to ECSA to be licensed as a professional engineer (Republic of South Africa, 2000). Therefore licensed engineers operate at a senior level compared to unlicensed engineers in the engineering industry.

## Employee motivation

Motivation entails the choice of activity pursued and the intensity and persistence with which an activity is pursued (Sadri & Bowen, 2011). Motivation plays an important role in increasing employee performance and reducing employee turnover (França et al., 2014).

In the workplace, management is responsible for achieving the goals of the organisation through directing and managing resources. According to Sadri and Bowen (2011), employees need motivation to remain engaged at work. Therefore, employers face a mammoth task of keeping employees motivated in order to accomplish organisational goals. It is important employers take into consideration all employee motivation factors when designing motivational strategies (Najjar & Fares, 2017).

## Factors motivating engineers

Studies on the motivation of engineers have been done by researchers previously. In a study performed by Gomersall (1971) on engineers working at Texas Instruments using Herzberg (1968) two factor theory, the study found engineers were motivated in the order of decreasing importance: by having responsibility, the type of work performed, recognition, advancement and achievement.

In a qualitative study performed by Sach, Sharp, and Petre (2011) on software engineers it was found they were motivated by performing technically challenging work, and the people they worked with.

In a study by Browne (2013) using Leonard et al. (1999) metatheory of integrated sources of motivation, it emerged that the dominant sources of motivation for engineers was internal self-concept motivation, followed by goal internalisation motivation. This indicates engineers are motivated by their expertise and competencies as well as the achievement of goals (Leonard et al., 1999).

The findings by Sach et al. (2011) agree with those of Gomersall (1971) as both found engineers were motivated by the work they performed. In addition the findings of Sach et al. (2011) and Gomersall (1971) agree with the findings of Browne (2013) because to perform their work, engineers rely on their engineering expertise and competencies. It is therefore expected that in South Africa engineers are motivated by performing technically challenging work where they take responsibility for work outputs. In addition, the literature reviewed treats engineers as being a homogeneous group, and does not differentiate between licensed and unlicensed engineers. Therefore it is expected that the sources of motivation of licensed and unlicensed engineers in South Africa may not be significantly different.

## Effects of motivated engineers on productivity

The motivation of employees is seen as a means to increase productivity and reduce employee turnover (França et al., 2014). A study by Gomersall (1971) on engineers working at Texas Instruments found the productivity of motivated engineers was greater compared to unmotivated engineers. In a study conducted by Kakepoto, Hadina, Omar, and Said (2012) on engineers in Pakistan it was found that engineers had low levels of motivation that resulted in low productivity and high employee turnover. Based on the findings of these studies, it is expected that organisations with motivated engineers are more productive and have less employee turnover compared to those with engineers who lack motivation.

## Gender based differences in motivation

Differences in sources of motivation based on employee gender have been studied previously. In a study by Ryan (2014) on research scientists in the United Kingdom using Leonard et al. (1999) metatheory of integrated sources of motivation, the study concluded there was no statistically significant difference in the sources of motivation by gender. These findings by Ryan (2014) agree with the findings of a study performed by Browne (2013) on engineers and knowledge workers also using Leonard et al. (1999) metatheory. Similar findings were also reported by Hitka, Vetráková, and Balážová (2015) using goal setting theory on employees working in Slovenia. Based on the literature reviewed, it is expected the sources of motivation are not significantly different based on the gender of engineers in South Africa.

## Needs-based theories of employee motivation

Needs-based theories of employee motivation are based on the premise that employees are motivated to perform work in order to fulfil their needs. There are different needs-based theories providing different conceptualisations about what motivates employees. The three needs-based motivation theories discussed are: Maslow's (1943) theory of motivation, Hertzberg's (1968) two factor theory and Aldelfer's (1967) existence, relatedness and growth (ERG) theory.

### Maslow's theory of motivation

In Maslow' theory, the motivator for employees is unmet needs. In Maslow (1943) five human needs are identified in the model. These human needs in ascending order are: physiological, safety, love, esteem, and self-actualisation (Maslow, 1943).

The human needs are based on the premise that humans are perpetually wanting beings. Human needs lower in the hierarchy must be fairly well satisfied before higher needs can become dominant (Maslow, 1943). For as long as the current needs of a human are unsatisfied, the person will not consider needs higher up in the hierarchy of needs. Maslow' theory can be applied in this study to identify which of the five human needs are dominant at motivating engineers in South Africa.

### Hertzberg's two factor theory of motivation

According to Herzberg (1968), humans have two basic types of needs: ones based on man's animal nature and others based on man's ability to achieve. The fulfilment of these needs is what motivates a person. The two needs motivate humans to work in order to provide for themselves and their families, and to strive for achievements.

In Herzberg's theory of employee motivation, there are sources of motivation and sources of dissatisfaction (Herzberg, 1968). Sources of motivation are factors that motivate employees, while the sources of dissatisfaction are factors that result in employees being unhappy at work. The lack of motivation factors does not result in dissatisfied employees, rather in unmotivated employees. The lack of satisfying factors does not result in unmotivated employees, rather in dissatisfied employees.

The factors resulting in motivation and dissatisfaction avoidance (hygiene) at work differ and are mutually exclusive (Herzberg, 1968). Motivation factors are part of the work performed, while hygiene factors are part of the environment within which work is performed. Motivating factors found in jobs are: achievement, recognition for the achievement, job content, responsibility and job advancement. Hygiene factors found in the work environment on the other hand are: policies, supervision, interpersonal relationships, working conditions, salary, status and security (Herzberg, 1968). Herzberg's theory can be used to identify which motivation and hygiene factors are dominant amongst engineers in South Africa.

**Alderlfer's ERG theory of motivation**

Alderlfer's ERG theory categorised human needs into three categories: existence, relatedness and growth needs (Alderfer, 1967). Existence needs are physiological needs, while relatedness needs are emotional needs and growth needs relate to the need for human being's to fully utilise their talents, and to develop new talents they deem necessary (Alderfer, 1967; Schneider & Alderfer, 1973).

Aldelfer's ERG theory is a re-categorisation of Maslow's five human needs. Physiological and safety needs relating to material possessions are categorised into existence needs (Schneider & Alderfer, 1973). Safety needs relating to interpersonal interactions, the need for love and esteem relating to interpersonal relationships are categorised as relatedness needs (Schneider & Alderfer, 1973). Lastly, esteem related to how a person perceives themselves and self-

actualisation are categorised as growth needs (Schneider & Alderfer, 1973). Aldelfer's ERG theory can be used to identify whether existence, relatedness or growth needs are dominant in motivating engineers in South Africa.

## Process-based theories of employee motivation

Process-based theories are based on the premise that employees are motivated by cognitive processes. It is assumed human behaviour is largely influenced by beliefs, expectations and anticipation of future events (Steers & Porter, 1975). The theories reviewed are expectancy theory, goal setting theory, intrinsic and extrinsic motivation theory and the self-concept theory of motivation. Similarly to needs-based theories, process-based theories also provide different conceptualisations on what motivates employees.

### Expectancy theory of motivation

Expectancy theory is based on the premise employees are motivated by rewards (Parijat & Bagga, 2014). Employee motivation is influenced by the desirability of the expected outcome. The more desirable the expected outcome the higher will be the motivation of an employee who desires the outcome.

In expectancy theory, there are four variables that affect employee motivation: individual effort, individual performance, organisation rewards and personal goals (Parijat & Bagga, 2014). From these variables, three relationships exist: expectancy, instrumentality and valance.

The first relationship is expectancy which is the relationship between individual effort and performance (Parijat & Bagga, 2014). Expectancy is based on the premise that an employee's effort influences their performance. An increase in effort exerted is expected to result in a corresponding increase in performance.

The second relationship is instrumentality, which is a relationship between individual performance and organisation rewards (Parijat & Bagga, 2014). The relationship is based on a premise that the rewards an employee receives are based on their performance.

The third relationship is valance, which is a relationship between organisational rewards and personal goals (Parijat & Bagga, 2014). Valance is the value an employee places on the rewards they receive for their performance. Expectancy theory can be used to measure whether the dominant sources of motivation of engineers in South Africa are expectancy, instrumentality or valance.

**Goal setting theory of motivation**

Goal setting theory describes motivation based on the achievement of goals. The theory is based on the premise that action is due to a purpose (Locke, 1996). Goals act as a motivation source for people to act. The desire to achieve a goal can increase the performance of employees. The achievement of goals is, however, dependent on the person's commitment, the ability to attain the goals and conflict amongst different goals (Locke & Latham, 2006). It is important the goals are accepted by employees in order to get commitment to achieving them. If employees do not accept goals developed by management, they will not be motivated to achieve them. One of the methods that can be used to get commitment from employees is to include them in goal setting exercises (Lunenburg, 2011).

In goal setting theory, there are four relationships between performance and goals. Firstly, difficult and specific goals result in higher levels of performance compared to vague or easy goals (Locke, 1996; Locke & Latham, 2006). Employees need to be given specific goals which are difficult but attainable. This is because goals direct effort away from non-goal relevant activities (Locke & Latham, 2006). This assists employees to focus their efforts to achieving the set goals, which in turn improves performance. In addition, achieving goals is dependent on existing and acquired skills (Locke, 1996; Locke & Latham, 2006). This is why it is important to set goals which are achievable, but stretch

employees through their comfort zones. Lastly, goals together with self-efficacy can assist other sources of motivation (Locke & Latham, 2006). Goal setting theory can be applied to identify which goals motivate engineers in South Africa.

### Intrinsic and extrinsic motivation theory

According to intrinsic and extrinsic motivation theory, motivation is either intrinsic or extrinsic (Ryan & Deci, 2000). Intrinsic motivation is doing a task for internal gain, while extrinsic motivation is doing a task because of the expectation of external rewards (Isen & Reeve, 2005; Ryan & Deci, 2000). The performance of employees differs substantially for intrinsic and extrinsic motivation (Ryan & Deci, 2000). In some cases intrinsic and extrinsic motivation can be in conflict (Benabou & Tirole, 2003). Intrinsic and extrinsic motivation theory can be used to identify whether engineers in South Africa are motivated by intrinsic or extrinsic sources of motivation.

### Self-concept theory of motivation

The self-concept is based on the influence a person's traits, competencies and values have on their motivation (Leonard et al., 1999). A person has three self-concepts: the perceived self, ideal self and social identity (Leonard et al., 1999).

The perceived self contains the perception a person has relating to their traits, competencies and values (Leonard et al., 1999). The perceived self is developed through task feedback and social feedback (Leonard, Beauvais, & Richard W. Scholl, 1995). Task feedback is feedback through the realisation of the successful completion of tasks. Social feedback is feedback received from communicating with others regarding whether a task was completed successfully or not.

The ideal self is representative of the traits, competencies and values a person believes they possess (Leonard et al., 1999). The development of the ideal self can be internally or externally directed depending on the kind of feedback received from those around the person. According to Leonard et al. (1995), if

feedback is positive and unconditional, the person internalises the traits, competencies and values that resulted in the feedback. This results in the person becoming internally directed. However if feedback is negative or is positive but conditional, the person at best might partially internalise the traits, competencies and values that resulted in the feedback (Leonard et al., 1995). This person becomes externally directed by requiring constant feedback as a means to determine if the traits, competencies and values they portray are acceptable. Internally directed people are motivated by pleasing themselves, while externally directed people are motivated by pleasing others (Leonard et al., 1995).

Social identity defines a person's identity (Leonard et al., 1999). It assists people to identify where they fit in with society. Social identity is developed through interaction with others in social circumstances. If a person wants to fit in with a particular social group, they will develop the required traits, competencies and values necessary (Leonard et al., 1995).

The self-concept theory of motivation can be applied to identify if engineers in South Africa are motivated by how their competency is perceived by others or are motivated by the perceptions they have about their own competency.

## Theoretical framework adopted

Needs-based and processed-based theories of motivation investigate a particular aspect of motivation, while motivation is a multifaceted and complex phenomenon. According to Leonard et al. (1999), no single theory of motivation can adequately describe employee motivation as it comes from multiple sources.

In this study, Leonard et al. (1999) metatheory of integrated sources of motivation was used. The approach taken in the development of the framework is that motivation does not come from a single source because people have different levels of motivation from different aspects (Ryan & Deci, 2000).

Leonard et al. (1999) developed the framework using process-based theories of motivation.

According to Leonard et al. (1999) and Ryan (2014), there are five sources of motivation. The five sources of motivation are intrinsic process motivation, instrumental motivation, goal internalisation motivation, external self-concept motivation, and internal self-concept motivation.

An individual can possess multiple sources of motivation. However, the dominant motivation source is determined by the relative strength of the five sources of motivation (Ryan 2014).

Analysis performed by Barbuto and Scholl (1998) on needs-based theories demonstrated they also formed part of the metatheory of integrated sources of motivation framework (Table 1). Each factor is then discussed below.

**Table 1: Integrative typology of sources of motivation (Barbuto & Scholl, 1998).**

| Theory | Intrinsic Process Motivation | Instrumental Motivation | External self-concept motivation | Internal self-concept motivation | Goal Internalisation Motivation |
|---|---|---|---|---|---|
| **Maslow's theory of needs** | Physiological needs | Safety needs | Love | Esteem needs | Self-actualisation |
| **Hertzberg's two factor theory** | - | Hygiene factors | Hygiene factors | Motivators | - |
| **Aldelfer's ERG theory** | Existence | - | Relatedness | Growth | - |

### Intrinsic process motivation

Employees motivated by intrinsic process motivation are primarily motivated by the tasks they perform (Bugenhagen & Barbuto, 2012; Leonard et al., 1999). The employees find the tasks performed to be enjoyable, which is what motivates them to continue performing these tasks. Task and social feedback does not serve to motivate these employees (Leonard et al., 1999). These employees will remain motivated for as long as they are enjoying performing the

tasks (Leonard et al., 1999). It is therefore important to keep work enjoyable for employees motivated by intrinsic process motivation.

### Instrumental motivation

Employees motivated by instrumental motivation are primarily motivated by tangible rewards they will gain when they successfully accomplish tasks (Leonard et al., 1999; Ryan 2014). The rewards can be in the form of a performance bonus, pay increase, and so on. These employees will remain motivated as long as they perceive they will gain tangible rewards once the task is successfully completed (Leonard et al., 1999).

### External self-concept motivation

Employees with an external self-concept based motivation are motivated by the perception the success or failure of an activity will be personally attributed to them. They perceive the success or failure will affect their social identity and association with a successful group (Leonard et al., 1999). These employees require continuous positive feedback to ensure they remain motivated.

Employees motivated by external self-concept motivation believe the success or failure of tasks will be attributed to them (Leonard et al., 1999). As a result, employees will be motivated to success in-order to receive positive feedback from others.

### Internal self-concept motivation

Employees with internal self-concept based motivation attribute successful completion of tasks to their expertise and competencies (Leonard et al., 1999). According to Leonard et al. (1999), the employee is not concerned with what others believe about their competencies, but rather their own perceptions about their competencies (Leonard et al., 1999). Employees motivated by internal self-concept motivation will remain motivated as long as they believe the successful completion of tasks is due to them (Leonard et al., 1999).

### Goal internalisation motivation

Employees motivated by goal internalisation are motivated by the achievement of goals (Bugenhagen & Barbuto, 2012; Leonard et al., 1999). It is important to obtain commitment to the goals by including employees in the goal setting exercise (Lunenburg, 2011). In addition for goals to motivate employees, they should be specific, difficult to achieve but achievable (Locke, 1996; Locke & Latham, 2006). Employees are therefore motivated to achieve these goals, resulting in improved employee performance (Locke, 1996; Locke & Latham, 2006).

Employees motivated by goal internalisation will continue to be motivates for as long as they are progressing towards accomplishing the set goals (Leonard et al., 1999).

### Application of the theoretical framework in research

The metatheory of integrated sources of motivation has been used in different studies as a framework to measure the five sources of motivation of different professions in different countries. In the United Kingdom (UK) the framework has been used by Ryan (2014) to measure the dominant sources of motivation of research scientists. The framework was also used by Bodur and İnfal (2015) to identify dominant sources of motivation of nurses working in a state university hospital and public hospital in Turkey. In South Africa, the framework was used by Chipunza and Matsumunyane (2018) to measure sources of motivation of middle managers working at a university.

The framework was also used by Barbuto et al. (2004) to measure dominant sources of motivation of farm managers and farm employees working in the USA. Browne (2013) also used the framework in the USA to measure the dominant sources of motivation of engineers and knowledge workers working for a Fortune 100 company in the USA. The framework has been used by Latta and Fait (2016) to measure the sources of motivation of teachers and

classroom aids in a public school district and labourers working for a tool manufacturer in Northwest Pennsylvania.

### Research questions

To accomplish the purpose of the study, four research questions were developed. Research question 1 was, ‘what are the dominant sources of motivation of licensed and unlicensed engineers in South Africa?’ Research question 2 was, ‘what are the dominant sources of motivation of male and female licensed and unlicensed engineers in South Africa?’ Research question 3 was, ‘is there a significant difference in the sources of motivation between licensed and unlicensed engineers in South Africa?’ Research question 4 was, ‘is there a significant difference in the sources of motivation between male and female licensed engineers and between male and female unlicensed engineers in South Africa?’

## Research design

The research design developed details how the study was conducted (Malhotra & Birks, 2003). Research design describes how the data on the sources of motivation for engineers in South Africa was collected and analysed (Bless & Higson-Smith, 2000). The research design utilised enabled the study to answer the developed research questions in-order to accomplish the purpose of this study (Bless & Higson-Smith, 2000).

Descriptive research design was used to conduct the study. To be able to perform the study within the prescribed time constraints, a cross-sectional study was performed. As a result, data from the sample was collected at a single point in time (Baker, 1994; Bless & Higson-Smith, 2000; Malhotra & Birks, 2003).

### Research approach

The empirical research method was used in the study as it is research based on evidence observed from nature (Bless & Higson-Smith, 2000). According to

Khalid, Hilman, and Kumar (2012), empirical research uses scientific procedure to answer research questions. The two types of research methods used to perform empirical research are qualitative and quantitative research methods (Khalid et al., 2012).

Quantitative research methods are used when the data being analysed has to be quantified (Williams, 2007). The research method is used to discover how the measured variables relate to each other (Williams, 2007). In addition, findings from quantitative research can be generalised to the population if probability sampling is used. On the other hand, qualitative research methods are used to explore the complexities of the phenomenon studied (Williams, 2007). Qualitative research methods are based on the premise the world is socially constructed, complex and changing (Murray, 2003).

In this study a quantitative research method was used. The research method was chosen because the study firstly, aimed to identify the dominant sources of motivation of engineers in South Africa and secondly, to quantify if they significantly differed by gender.

## Research method

Data was collected using a survey. A survey is a data collection tool utilising a pre-defined list of questions (Chu & Ke, 2017). According to Fink (2003), a survey is a tool used to collect data on or about people with the intention to describe, compare or explain a phenomenon studied. Surveys can be used to collect either primary or secondary data (Fink, 2003). Primary data is collected directly from the subjects for use in a research, while secondary data is data that has was collected by other researchers for their own purpose which is used in new research (Fink, 2003).

Surveys can be administered as: self-administered surveys, interviews or structured record reviews (Fink, 2010). With self-administered surveys, the subject fill's in the survey without assistance from the researcher. Administering

the survey through interviews involves the researcher interviewing the subjects using survey questions. Researchers use structured record reviews to collect secondary data. To be able to gather data from a large sample within the allocated time frame for the study, a self-administered survey was used.

Self-administered surveys can either be paper or online based. Paper based surveys need to be re-captured into a statistical software for further analysis. This poses the risks of the introduction of data entry errors (Ilieva, Baron, & Healey, 2002). On the other hand, online based surveys require the participants to have access to the internet and this might prevent some engineers participating in the survey. However delivering online surveys is quicker compared to paper based surveys. In addition, an online survey can be scaled up quickly, and the response time on online surveys is quicker compared to paper based surveys (Ilieva et al., 2002). The response time on online surveys is also quicker compared to paper based surveys (Ilieva et al., 2002).

An online survey was used to collect data on the sources of motivation for engineers in South Africa. An online survey was used due to the associated benefits of employing this type of survey. A link to the survey was distributed to the sample using e-mail, WhatsApp and LinkedIn.

## Research participants

### Population

According to Baker (1994), a population is the total number of all the subjects the research is focused on. The population for this study consisted of ECSA licensed and unlicensed engineers who were working in the South African engineering industry. The population of unlicensed engineers consisted of engineers registered with ECSA as candidate engineers, and engineers who were not registered with ECSA.

## Sample and sampling method

A sample is all the subjects sampled from a population that will be investigated (Baker, 1994). Sampling can be done using either probability sampling or non-probability sampling (Baker, 1994).

Probability sampling ensures the probability of including each subject in the sample is known (Bless & Higson-Smith, 2000). When using probability sampling, it becomes possible to determine the degree with which the findings of the study are representative of the population (Baker, 1994). It should however be noted, in order to use probability sampling, a sampling frame should exist from which the sample is selected (Malhotra & Birks, 2003).

Non-probability sampling is based on the judgement of the researcher (Malhotra & Birks, 2003). This results in the probability of any participant being included in the sample being unknown (Malhotra & Birks, 2003). If non-probability sampling is used, the findings of the study cannot be generalised to the population as it is not possible to calculate the probability of including any participant in the sample (Fink, 2003).

In this study, snowball non-probability sampling was used. An online link to the survey was sent to licensed and unlicensed engineers working in the South African engineering industry. The participants were asked to forward the online link to their acquaintances who were also licensed and unlicensed engineers working in the South African engineering industry.

## Sample size

The sample size is the number of subjects that will be studied. The sample size affects the accuracy with which the sample is representative of the population (Bless & Higson-Smith, 2000). The sample size for this study was calculated using statistical power analysis. Statistical power analysis uses the relationship existing between the four variables in statistical inference which are:

significance criterion (α), statistical power, effect size (d) and sample size (Cohen, 1992).

The significance criterion represents the probability of failing to support a null hypothesis by committing a Type I error (Cohen, 1992). A Type I error of 5% is generally acceptable (Cohen, 1992) and it corresponds to a confidence level (Z) of 95% (Equation 1).

$$\boldsymbol{Z = 1 - \alpha} \qquad \text{Equation 1}$$

The statistical power measures a Type II error (β), which is the probability of failing to reject a false hypothesis (Cohen, 1992). A Type II error of 0.2 is generally acceptable in research (Cohen, 1992) and it corresponds to a statistical power of 0.8 (Equation 2).

$$\boldsymbol{Statistical\ Power = 1 - \beta} \qquad \text{Equation 2}$$

The effect size determines the degree to which the null hypothesis is believed to be false (Cohen, 1992). The effect size was calculated using equation 3. The calculation of the effect size uses the means of the independent samples ($M_A$, $M_B$) and the standard deviation of the means (σ) (Equation 3).

$$\boldsymbol{d = \frac{M_A - M_B}{\sigma}} \qquad \text{Equation 3}$$

In the study, an effect size of 0.8 was used to determine the size of the sample required to perform the t-test. A large effect size was selected to detect if a large differences in the sources of motivation between the different groups of engineers would result in a significant difference (Cohen, 1988).

Based on the values of the significance criterion, statistical power and effect size required, a minimum sample size of 26 participants per group was required for the study (Table 2). However, the study consisted of licensed male and female engineers and unlicensed male and female engineers which made up the four groups. Therefore, a total sample size of 104 participants was required for the study (Table 3).

**Table 2: Minimum sample size per group (Cohen, 1992).**

| Statistical Inference Variables | Value |
|---|---|
| Significance criterion (α) | 0.05 |
| Statistical power | 0.8 |
| Effect size (d) | 0.8 |
| **Sample Size (N)** | **26** |

**Table 3: Minimum sample size required for the study.**

| Sample groups | Sample Size |
|---|---|
| Licensed male engineers | 26 |
| Licensed female engineers | 26 |
| Unlicensed male engineers | 26 |
| Unlicensed female engineers | 26 |
| **Total Sample Size** | **104** |

## Measuring instrument

An online survey was used to collect categorical and ordinal data for the study. The survey was divided into two sections. Section A related to the participant's demographic data. The survey collected categorical data by requesting participants to categorise their demographic data based on their gender, the industry they worked in and whether they were registered with ECSA.

Section B collected the participants' ordinal data on motivation source using the Measurement of Motivational Sources (MMS) instrument which was developed by Ryan (2011). The MMS instrument measured the five sources of motivation defined by Leonard et al. (1999) metatheory of work motivation. The MMS instrument required participants to respond to 28 questions by indicating the extent to which they agreed with each statement based on a five point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (5). The instrument measured instrumental motivation, external self-concept motivation, intrinsic process motivation, internal self-concept motivation and goal internalisation motivation (Ryan 2011).

## Statistical analysis

### Validity and reliability

When conducting empirical research, the survey instrument must be reliable and valid (Drost, 2011). The validity and reliability of the survey instrument results in credible research findings. The validity of the survey instrument deals with whether the tool measures what it is trying to measure (Baker, 1994; Drost, 2011). Reliability of the research instrument refers to whether the research findings are repeatable (Drost, 2011). It should be noted a survey instrument can be reliable, but not valid. A survey instrument can consistently measure the variables each time it is used, however the variables measured might not represent the characteristics being measured.

External validity measures how generalisable the findings of a study are (Drost, 2011; Yilmaz, 2013). To improve external validity, literature was reviewed, and the metatheory of integrated sources of motivation was identified as an ideal theory to measure sources of motivation because the theory integrated different theories of motivation (Barbuto & Scholl, 1998; Leonard et al., 1999).

Internal validity measures if the relationship identified between two variables is causal or not (Yilmaz, 2013). A measurement tool that has internal validity measures what it is meant to measure. The MMS instrument developed by Ryan (2011) was used to measure the sources of motivation for engineers in South Africa. This instrument was validated by Ryan (2011). However to ensure internal validity of the instrument to this study, factor analysis was used to test if the instrument was measuring only five factors as in Ryan (2011). Where it was identified that for a single construct of the sources of motivation the measurement instrument measured more than a single factor, questions were removed to ensure only a single factor was measured.

Reliability measures if a survey instrument can replicate the findings of the research (Drost, 2011). The reliability of a survey instrument can be measured using the internal consistency of the measurement tool's questions (Drost, 2011). Internal consistency measures how well the scales of a Likert scale measure the characteristic measured (Drost, 2011). The internal consistency of a survey instrument can be measured using the Cronbach's alpha coefficient (Drost, 2011). A Cronbach's alpha coefficient of at least 0.6 indicated satisfactory internal consistency reliability in the study (Malhotra & Birks, 2003).

**Data analysis**

Descriptive statistics were used to analyse the demographic and sources of motivation data collected from survey participants. Pie graphs were used to graphically represent the demographics data of the survey participants. Bar graphs were used to represent the means of the five sources of motivation. The means of the five sources of motivation of licensed and unlicensed engineers were used to answer research question 1. The means of the five sources of motivation of male and female licensed engineers and of male and female unlicensed engineers were used to answer research question 2.

Inferential statistics was used to test if the means of the sources of motivation were significantly different between the different samples of engineers in South Africa. The independent samples t-test was used to test if there was a statistically significant difference ($p<0.05$) in the means of the five sources of motivation between licensed and unlicensed engineers in order to answer research question 3. The independent samples t-test was also used to test if there was a statistically significant difference in the means of the five sources of motivation between male and female licensed engineers and between male and female unlicensed engineers in order to answer research question 4.

## Ethical considerations

### Anonymity of participants

The anonymity of participants was maintained through the use of an online survey which was accessed using an online link. The link to the survey was distributed to the sample using snowball sampling. The researcher could not link survey data to any particular participant because the survey tool used assigned randomly generated identification numbers to each survey filled in.

### Permission to use the MMS instrument

Permission to use the MMS instrument that measures the sources of motivation based on Leonard et al. (1999) metatheory of integrated sources of motivation was granted by Dr C. Ryan who developed and tested the instrument in Ryan (2011).

### Wits Business School ethical clearance

The project proposal and ethical clearance letter was submitted to the Wits Business school to request ethical clearance for the study. Ethical clearance, protocol number WBS/BA0311148W/560 was granted by Wits Business School. In addition the survey developed for the study was distributed to collect data after ethical clearance had been granted to perform the study.

### Consent from participants

Participants were required to grant consent electronically. At the beginning of the online survey, participants were requested to indicate if they grant their consent to participate in the survey. Only participants who gave their consent to participate in the survey were allowed to continue. In addition, a participant could withdraw from the survey at any point in time by closing the survey window.

# STUDY RESULTS

## Survey participants

There were 115 engineers who accessed the survey. Of the 115, 98 (85%) surveys were complete and 17 (15%) surveys were incomplete.

## ECSA registration category

To identify whether participants were licensed or not, they were asked to select if they were registered with ECSA as a professional engineer, candidate engineer or not registered. Participants who selected they were registered with ECSA as professional engineers were categorised as licensed engineers. Participants who selected they were registered with ECSA as candidate engineers or were not registered with ECSA were categorised as unlicensed engineers.

The participants in the survey consisted of 37 (38%) engineers registered as professional engineers, 37 (38%) engineers registered as candidate engineers and 24 (24%) engineers not registered in any category with ECSA (Figure 1). In total there were 37 (38%) licensed engineers and 61 (62%) unlicensed engineers that participated in the survey.

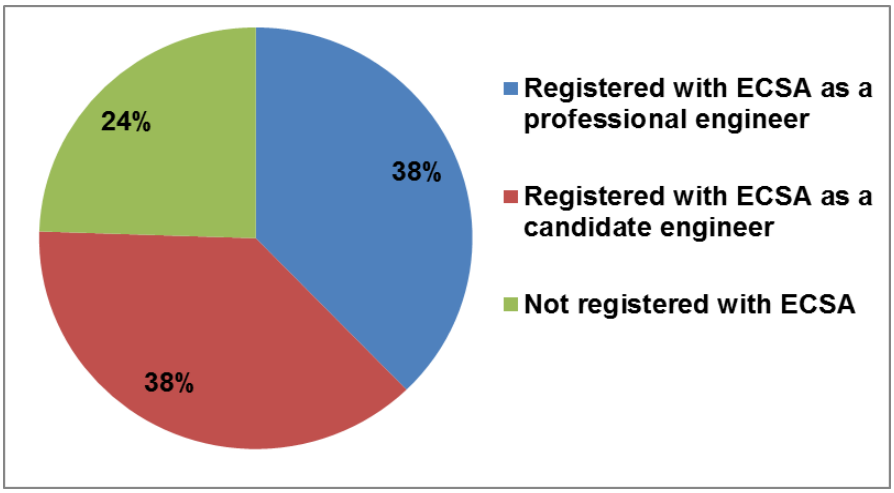


**Figure 1: ECSA registration category.**

## Gender of participants

Licensed engineers who participated in the survey consisted of 30 (31%) males and 7 (7%) females (Figure 2). Unlicensed engineers who participated in the survey consisted of 43 (44%) males and 18 (18%) females (Figure 2). In total, 75% of the engineers who participated in the survey were males and 25% were females.

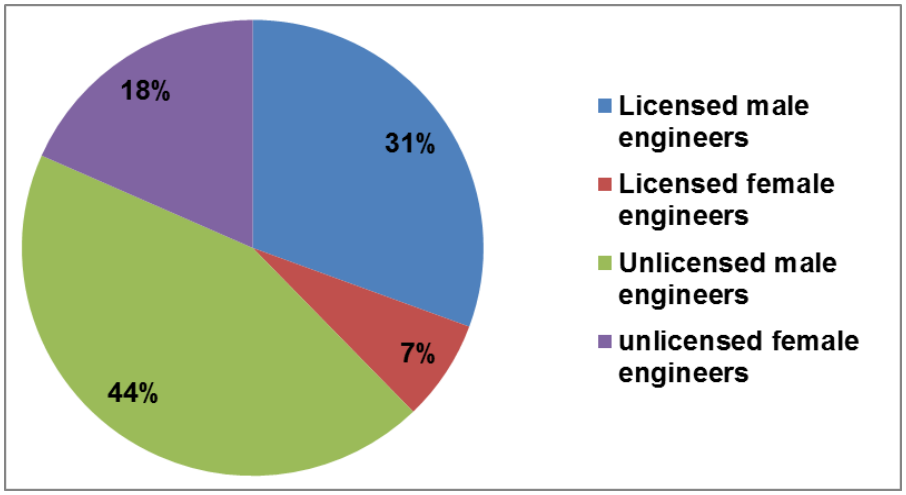


**Figure 2: Gender of participants.**

## Engineering industry

Engineers who participated in the survey had nine choices to indicate the engineering industry they were currently working in. 55 (56%) of engineers who participated in the survey worked in the energy industry, 3 (3%) worked in academia, 6 (6%) worked in mining, 13 (13%) worked in manufacturing, 2 (2%) worked in telecommunications, 4 (4%) worked in construction, 7 (7%) worked in consulting and 8 (8%) selected other and provided the name of the industry they worked in as it was not part of the default list provided (Figure 3).

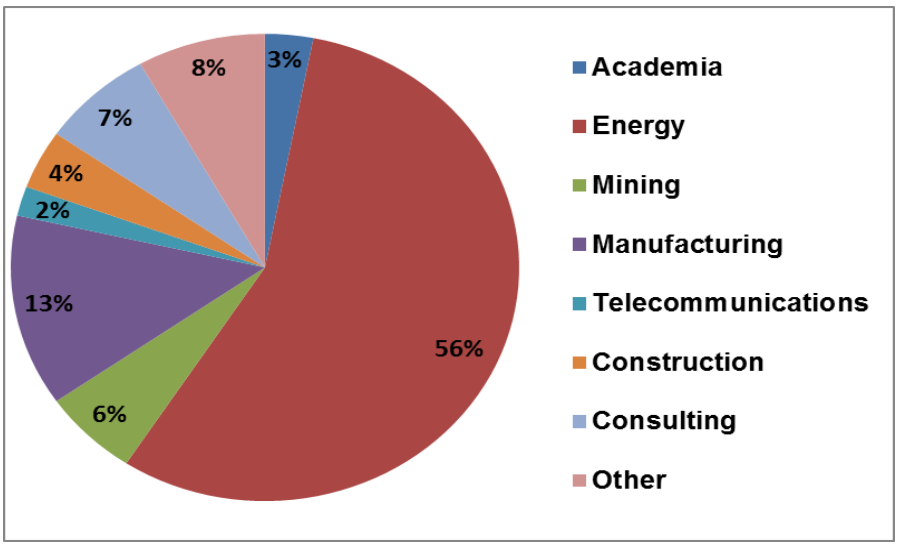


**Figure 3: Engineering industry.**

## Trustworthiness of the data

### Validity

The MMS instrument was validated in Ryan (2011) for internal validity, and has five factors that it measures, namely, instrumental motivation, external self-concept motivation, intrinsic process motivation, internal self-concept motivation and goal internalisation motivation. To determine the validity of the MMS instrument in this study, factor analysis was performed for each of the five factors to test if each of their questions only measured a single factor. Factor analysis was used to test if each question loaded above 0.3 with the factor it was supposed to measure Ryan (2011).

For each source of motivation, the Kaiser-Meyer-Olkin measure of sampling adequacy and Bartlett's test of sphericity were applied to the data to assess its suitability for factor analysis. For the data collected to be adequate, the Kaiser-Meyer-Olkin measure of sampling adequacy should be greater than 0.5 (Kaiser, 1974) and the Bartlett's test of sphericity should be significant ($p<0.05$). For all the five sources of motivation, the Kaiser-Meyer-Olkin measure of sampling adequacy was greater than 0.5, and Bartlett's test of sphericity was found to be

significant ($p<0.05$). These findings allowed factor analysis to be performed on the data collected for each motivation source.

The questions measuring instrumental motivation were found to be loading with a single factor (Table 4). Factor analysis identified, all six questions measuring instrumental motivation could be used in the study to answer the research questions.

**Table 4: Instrumental motivation factor analysis.**

| Questions | Factor 1 |
|---|---|
| Q1.1 | 0.500 |
| Q1.2 | 0.666 |
| Q1.3 | 0.719 |
| Q1.4 | 0.767 |
| Q1.5 | 0.812 |
| Q1.6 | 0.725 |

The questions measuring external self-concept motivation were found to be loading with two factors (Table 5). It was identified that question 2.3 and 2.6 loaded for a different factor compared to the other four questions. These findings prevented the use of all six questions to evaluate external self-concept motivation.

**Table 5: External self-concept motivation factor analysis.**

| Questions | Factor 1 | Factor 2 |
|---|---|---|
| Q2.1 | 0.524 | |
| Q2.2 | 0.694 | |
| Q2.3 | | 0.776 |
| Q2.4 | 0.834 | |
| Q2.5 | 0.738 | |
| Q2.6 | | 0.644 |

The questions measuring intrinsic process motivation were found to be measuring two factors (Table 6). Questions 3.2 and 3.5 loaded for a different factor compared to the other questions. It was also identified, question 3.3 loaded on both factors measured by the scale. These findings indicated the questions were not only measuring intrinsic process motivation. Based on the

results, question 3.3 which was ‘If choosing between two jobs, the most important criterion is “which would be more enjoyable”?’ confused participants and this resulted in the question measuring more than a single factor. These findings prevented the use of all six questions to evaluate intrinsic process motivation.

**Table 6: Intrinsic process motivation factor analysis.**

| Questions | Factor 1 | Factor 2 |
|---|---|---|
| Q3.1 | 0.742 | |
| Q3.2 | | 0.881 |
| Q3.3 | 0.658 | 0.433 |
| Q3.4 | 0.593 | |
| Q3.5 | | 0.750 |
| Q3.6 | 0.749 | |

The questions measuring internal self-concept motivation were found to be measuring two factors (Table 7). Questions 4.1 and 4.2 loaded for a different factor compared to the other four questions. These findings prevented the use of all six questions to evaluate internal self-concept motivation.

**Table 7: Internal self-concept motivation factor analysis.**

| Questions | Factor 1 | Factor 2 |
|---|---|---|
| Q4.1 | | 0.856 |
| Q4.2 | | 0.825 |
| Q4.3 | 0.755 | |
| Q4.4 | 0.642 | |
| Q4.5 | 0.680 | |
| Q4.6 | 0.729 | |

The questions measuring goal internalisation motivation were found to be loading with a single factor (Table 8). Factor analysis identified the four questions were valid at measuring goal internalisation motivation.

**Table 8: Goal internalisation motivation factor analysis.**

| Questions | Factor 1 |
|---|---|
| Q5.1 | 0.542 |
| Q5.2 | 0.773 |
| Q5.3 | 0.735 |
| Q5.4 | 0.732 |

## Reliability

Cronbach's alpha was used to measure the internal consistency reliability of the MMS instrument for each of the five sources of motivation measured. The Cronbach's Alpha for instrumental motivation was calculated as being 0.787. These results indicated satisfactory internal consistency reliability for the measurement of instrumental motivation (Malhotra & Birks, 2003). In addition, all the questions in the instrumental motivation scale measured a single factor, therefore no question was removed from the scale.

The Cronbach's Alpha for external self-concept motivation was calculated as being 0.593. However, questions 2.3 and 2.6 measured a different factor compared to the other four questions. These two questions were subsequently removed from the scale. This improved the Cronbach's Alpha to 0.663. These results indicated satisfactory internal consistency reliability for the measurement of external self-concept motivation (Malhotra & Birks, 2003).

The Cronbach's Alpha for intrinsic process motivation was calculated as being 0.693. However, questions 3.2, 3.3 and 3.5 measured a different factor. These questions were subsequently removed from the scale. Removing these three questions reduced the Cronbach's Alpha to 0.553. These results indicated unsatisfactory internal consistency reliability for the measurement of intrinsic process motivation (Malhotra & Birks, 2003). The Cronbach's Alpha for intrinsic process motivation could be improved by increasing the number of questions measuring this factor (Malhotra & Birks, 2003). However, increasing the number of questions can result in redundant questions that increase Cronbach's Alpha without adding value to the measurement instrument (Malhotra & Birks, 2003). The study used the data collected for intrinsic process motivation for further

analysis even though the Cronbach's Alpha was less than 0.6 due to a study performed by Chipunza and Matsumunyane (2018) also using Leonard et al. (1999) metatheory of integrated sources of motivation to measure sources of motivation of middle managers working at a South African university accepted a Cronbach Alpha of at least 0.5 as indicating acceptable internal consistency reliability.

The Cronbach's Alpha for internal self-concept motivation was calculated as being 0.584. However, questions 4.1 and 4.2 measured a different factor, as a result these two questions were subsequently removed from the scale. This improved the Cronbach's Alpha to 0.659. These results indicated satisfactory internal consistency reliability for the measurement of internal self-concept motivation (Malhotra & Birks, 2003).

The Cronbach's Alpha for goal internalisation motivation was calculated as being 0.652. These results indicated satisfactory internal consistency reliability for the measurement of goal internalisation motivation (Malhotra & Birks, 2003). Since all the questions in the scale measuring goal internalisation motivation measured a single factor, no question was removed from the scale.

## Sources of motivation for engineers

Analysing the means of the sources of motivation identified licensed and unlicensed engineers had the highest mean score for internal self-concept motivation followed by goal internalisation motivation (Figure 4). Therefore, the data identified the dominant sources of motivation of licensed and unlicensed engineers in South Africa were internal self-concept motivation followed by goal internalisation motivation. These findings imply licensed and unlicensed engineers were motivated by their expertise and competencies and the achievement of goals (Leonard et al., 1999).

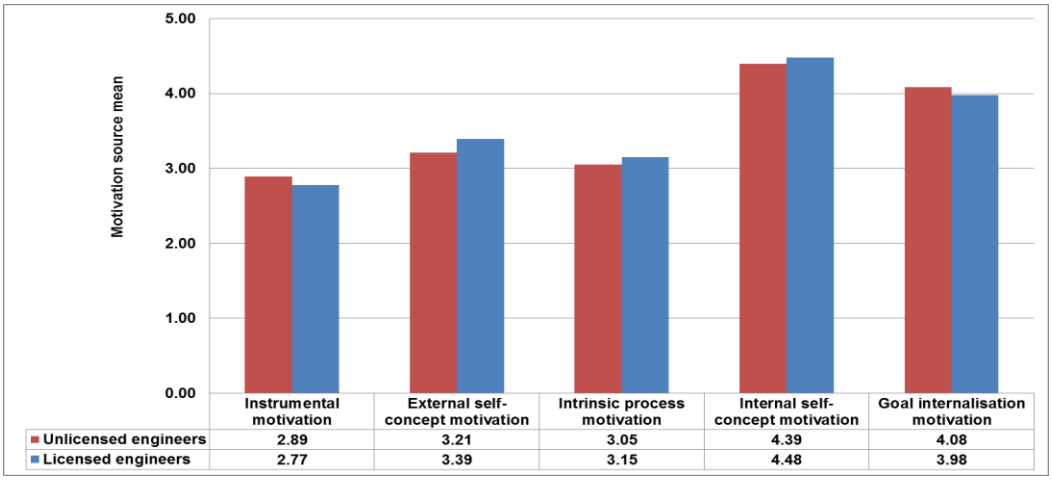


**Figure 4: Sources of motivation of licensed and unlicensed engineers.**

## Sources of motivation of male and female engineers

Analysing the means of the sources of motivation for male and female licensed engineers identified internal self-concept motivation had the highest mean score followed by goal internalisation motivation (Figure 5). Analysing the means of the sources of motivation for male and female unlicensed engineers also identified internal self-concept motivation was the most dominant followed by goal internalisation motivation (Figure 6). These findings imply both male and female licensed and unlicensed engineers were motivated by their expertise and competencies, followed by the achievement of goals (Leonard et al., 1999).

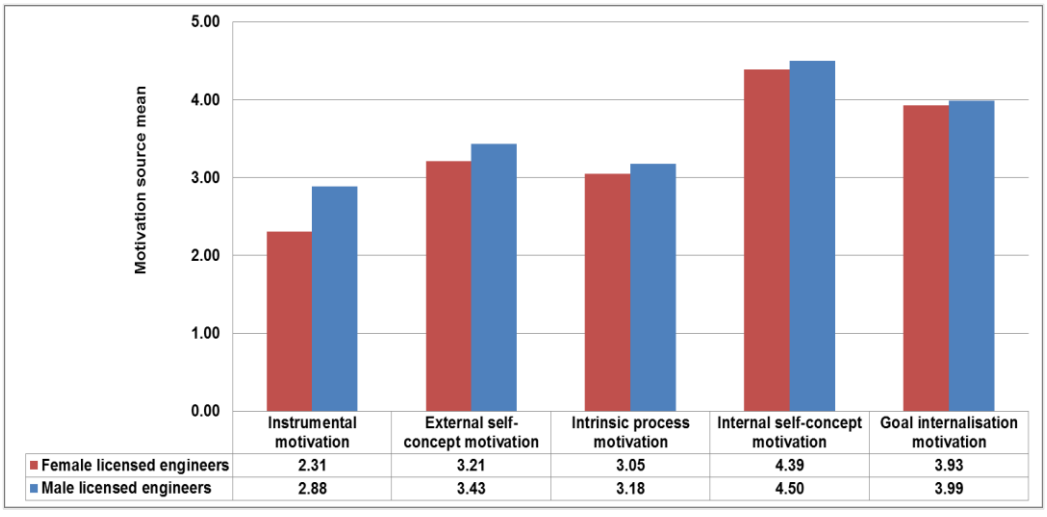


**Figure 5: Sources of motivation of male and female licensed engineers.**

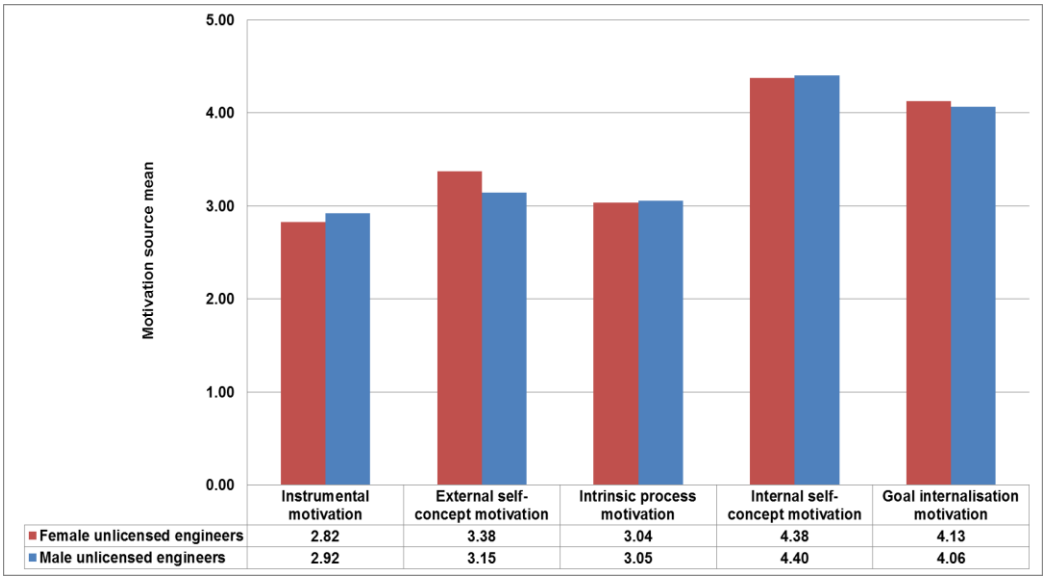


**Figure 6: Sources of motivation of male and female unlicensed engineers.**

## Comparison of licensed and unlicensed engineers sources of motivation

The Leven's test for equality of variance had a p-value greater than 0.05 when the means of sources of motivation for licensed and unlicensed engineers were compared (Table 9). This indicated equal variances in the means could be assumed.

The independent samples t-test for equality of means had a p-value greater than 0.05 when the means of sources of motivation of licensed and unlicensed engineers were compared (Table 9). These results indicated there was no statistically significant difference in the sources of motivation of licensed and unlicensed engineers. These findings mean licensed and unlicensed engineers in South Africa were motivated by similar sources of motivation in the workplace.

**Table 9: Comparison of licensed and unlicensed engineers.**

| | Leven's test for equality of variance (p-value) | t-test for equality of means (p-value) |
|---|---|---|
| **Instrumental motivation** | 0.514 | 0.447 |
| **External self-concept motivation** | 0.559 | 0.265 |
| **Intrinsic process motivation** | 0.672 | 0.535 |
| **Internal self-concept motivation** | 0.653 | 0.339 |
| **Goal internalisation motivation** | 0.530 | 0.424 |

## Comparison of sources of motivation of licensed engineers

The Leven's test for equality of variance had a p-value greater than 0.05 when the means of instrumental motivation, external self-concept motivation, intrinsic process motivation and goal internalisation motivation were compared between male and female licensed engineers (Table 10). This indicated equal variances in the means could be assumed for these sources of motivation. The Leven's test for equality of variance had a p-value less than 0.05 when the means of internal self-concept motivation were compared between male and female licensed engineers (Table 10). These results indicated the means could not be assumed to have equal variances.

The independent samples t-test for equality of means had a p-value greater than 0.05 when the means of the sources of motivation were compared between male and female licensed engineers (Table 10). These results indicated the sources of motivation of male and female licensed engineers did not a have statistically significant difference. This implies male and female licensed engineers in South Africa were motivated by similar sources of motivation in the workplace.

**Table 10: Comparison of male and female licensed engineers.**

| | Leven's test for equality of variance (p-value) | t-test for equality of means (p-value) |
|---|---|---|
| **Instrumental motivation** | 0.061 | 0.075 |
| **External self-concept motivation** | 0.703 | 0.485 |
| **Intrinsic process motivation** | 0.231 | 0.712 |
| **Internal self-concept motivation** | 0.049 | 0.377 |
| **Goal internalisation motivation** | 0.345 | 0.795 |

## Comparison of sources of motivation of unlicensed engineers

The Leven's test for equality of variance had a p-value greater than 0.05 when the means of instrumental motivation, intrinsic process motivation, internal self-concept motivation and goal internalisation motivation were compared between male and female unlicensed engineers (Table 11). This indicated equal variances in the means could be assumed for these sources of motivation. The Leven's test for equality of variance had a p-value less than 0.05 when the means of external self-concept motivation were compared between male and female unlicensed engineers (Table 11). This indicated the means of internal self-concept motivation could not be assumed to have equal variances.

The independent samples t-test for equality of means had a p-value greater than 0.05 when the means of sources of motivation were compare between male and female unlicensed engineers (Table 11). These results indicated there was no statistically significant difference in the sources of motivation of male and female unlicensed engineers in South Africa. These findings indicated male and female unlicensed engineers were motivated by similar sources of motivation in South Africa.

**Table 11: Comparison of male and female unlicensed engineers.**

| | Leven's test for equality of variance (p-value) | t-test for equality of means (p-value) |
|---|---|---|
| **Instrumental motivation** | 0.739 | 0.636 |
| **External self-concept motivation** | 0.042 | 0.380 |
| **Intrinsic process motivation** | 0.280 | 0.939 |
| **Internal self-concept motivation** | 0.126 | 0.842 |
| **Goal internalisation motivation** | 0.438 | 0.736 |

# DISCUSSION

## Outline of the results

### Survey participants

The survey had a lower than required participation because a sample size of at least 104 participants comprising 26 participants who were licensed male engineers, licensed female engineers, unlicensed male engineers and unlicensed female engineers respectively was required. In total 115 engineers accessed the survey, but only 98 completed the survey. The survey completion rate was 85%. This was achieved by dividing the survey into pages, and the participants could not continue to the next page of the survey until all questions on the current page were answered. This ensured during the process of completing the survey, participants did not omit answering any question.

### ECSA registration category

The participants consisted of 38% licensed engineers and 62% unlicensed engineers. These results were not reflective of the ECSA engineers registration statistics as there were 16,733 (65%) licensed engineers and 8,896 (35%) unlicensed engineers in the 2016/17 ECSA financial year (ECSA, 2017a).

In this study there is an over representation of unlicensed engineers. This can be attributed to the population of unlicensed engineers being made up of engineers who are registered with ECSA as candidate engineers and those who are not registered. The ECSA statistics are only reflective of engineers who are registered with ECSA as professional or candidate engineers. As a result in this study within the sample of unlicensed engineers, 37 (38%) were registered with ECSA as candidate engineers, while 24 (24%) were not registered with ECSA.

**Gender of participants**

There was a high number of male licensed engineers 30 (31%) and male unlicensed engineers 43 (44%) who participated in the survey. There was a low number of female licensed engineers 7 (7%) and female unlicensed engineers 18 (18%) who participated in the survey.

The low participation of female engineers in the survey is reflective of the dominance of males in the profession. In the ECSA 2016/2017 financial year, out of 16,733 licensed engineers, there were 865 (5%) female engineers (ECSA, 2017a). In addition during the same financial year, out of 8,896 unlicensed engineers registered with ECSA, 1,824 (20%) were females (ECSA, 2017a).

**Engineering industry**

The majority engineers (56%) who participated in the survey were working in the energy industry, followed by manufacturing (13%), consulting (7%), mining (6%), construction (4%), academia (3%) and telecommunication (2%). The remainder of the participants (8%) selected other as an industry they were working in. The large participation of engineers working in the energy industry was due to the large number of engineers the researcher knew who were working in this industry. As a result, a disproportionately large number of surveys were sent by the researcher to engineers working in the energy industry.

**Research questions**

Research question 1 was, ‘what are the dominant sources of motivation of licensed and unlicensed engineers in South Africa’? The research question was developed to resolve the first sub-problem of the study which was to ‘identify the dominant sources of motivation of licensed and unlicensed engineers in South Africa’.

Data analysis performed using descriptive statistics identified the dominant sources of motivation of licensed and unlicensed engineers in South Africa were internal self-concept motivation followed by goal internalisation motivation. These findings were consistent with findings by Browne (2013) that identified engineers were motivated by internal self-concept motivation followed by goal internalisation motivation. This implies licensed and unlicensed engineers were motivated by similar sources of motivations which are based on their individual expertise, competencies and the accomplishment of goals. These findings could imply that licensed and unlicensed engineers prefer to work individually as opposed to working in large teams.

Research question 2 was, ‘what are the dominant sources of motivation of male and female licensed and unlicensed engineers in South Africa’? The research question was developed to resolve the second sub-problem of the study which was to ‘identify the dominant sources of motivation of male and female licensed and unlicensed engineers in South Africa’.

Data analysis performed using descriptive statistics identified the dominant sources of motivations of male and female licensed and unlicensed engineers in South Africa were internal self-concept motivation followed by goal internalisation motivation. These findings were consistent with the findings of Browne (2013) that also identified engineers were motivated by internal self-concept motivation followed by goal internalisation motivation. These findings also indicated male and female licensed and unlicensed engineers were motivated by similar sources of motivation which are based on their expertise, competencies and the accomplishment of goals.

Research question 3 was, ‘is there a significant difference in the sources of motivation between licensed and unlicensed engineers in South Africa’? The research question was developed to resolve the third sub-problem of the study which was to ‘identify whether there was a significant difference in the sources of motivation between licensed and unlicensed engineers in South Africa’.

Data analysis performed using inferential statistics identified the sources of motivation of licensed and unlicensed engineers in South Africa did not significantly differ. These findings indicate that the licensing of engineers does not significantly change what motivates them. These findings indicate there is no need to differentiate the motivation of engineers based on whether they are licensed or not. Other researchers who have researched the motivation of engineers also did not stratify engineers based on whether they were licensed or unlicensed (Browne, 2013; Gomersall, 1971; Sach et al., 2011).

Research question 4 was, ‘is there a significant difference in the sources of motivation between male and female licensed engineers and between male and female unlicensed engineers in South Africa’? The research question was developed to resolve the fourth sub-problem of the study which was to ‘identify whether there was a significant difference in the sources of motivation between male and female licensed engineers and between male and female unlicensed engineers in South Africa’.

Data analysis performed using inferential statistics identified the sources of motivation did not significantly differ between male and female licensed engineers and between male and female unlicensed engineers. These findings indicate male and female engineers were motivated by similar sources of motivation in South Africa. These findings were consistent with findings of other studies that also identified males and females were motivated by similar sources of motivation in the workplace (Browne, 2013; Hitka et al., 2015; Ryan 2014).

## Practical implications

### Intended consequences

Identifying the sources of motivation of engineers can assist managers to be more effective at motivating engineers in the workplace by designing engineer-specific incentive schemes instead of using a one size fits all approach (Leonard et al., 1999). The study has important practical implications as it has identified the dominant sources of motivation of engineers in South Africa are internal self-concept motivation followed by goal internalisation motivation. These findings indicate managers should develop the expertise and competencies of engineers in order to motivate them. This is because individuals motivated by internal self-concept motivation attribute their success or failure to their own capabilities (Leonard et al., 1999). In addition, these findings indicate engineers are motivated by the achievement of goals. This requires managers to assign tasks to engineers which are difficult to achieve but nevertheless attainable. Motivating engineers using the appropriate sources of motivation should result in increased productivity and reduced employee turnover (França et al., 2014).

### Unintended consequences

When the expertise level of engineers is increased due to employers' focus on skills development, engineers may be induced to leave current employment for better opportunities in the labour market. In addition, employers will incur higher training expenses due to the focus on increasing the expertise levels of engineers.

## Limitations

The findings of the study cannot be generalised to the population of engineers working in the engineering industry in South Africa since non-probability snowball sampling was used. The use of non-probability sampling makes it

impossible to calculate the probability of including any participant in the survey (Fink, 2003).

In addition, the study required a sample size comprising of 26 participants from each of the following groups, male licensed engineers, female licensed engineers, male unlicensed engineers, and female unlicensed engineers. However, the required sample size for female licensed engineers and female unlicensed engineers was not achieved. There were 7 female licensed engineers and 18 female unlicensed engineers that participated in the survey. Despite these limitations, the study identified the dominant sources of motivation of engineers in South Africa and demonstrated there was no statistically significant difference based on the gender of engineers, which is consistent with the literature reviewed.

## Recommendations

### Recommendations for employers

The study has identified engineers are motivated by internal self-concept motivation. To motivate engineers, employers should perform a skills gap analysis using key performance indicators (KPIs) for engineers in the respective departments. Engineers should also perform a parallel skills gap analysis to also identify their skills gaps. Employers and engineers should align and prioritise the skills gap identified from their respective analysis. Engineers should identify available skills development interventions to close the prioritised skills gap. Employers should make available the necessary budget to allow engineers to attend the skills development initiatives, and also afford them the opportunity to utilised the learned skills on projects.

The study has also identified engineers are also motivated by goal internalisation. To motivate engineers, employers should assign them projects which are challenging, but able to be accomplished. Employers should identify the expertise level of their engineers, and they should assign tasks and

responsibilities that challenge and stretch the capabilities of engineers to motivate them using the accomplishment of goals.

### Recommendations for future studies

The focus of the study was on identifying the sources of motivation of engineers working in the engineering industry in South Africa. Further research that builds on the findings of this study should be undertaken in the future.

Due to the low licensing figures of female engineers in South Africa, a study can be performed to identify barriers preventing the licensing of female engineers in the country. The findings of the study can assist more female engineers to be licensed in South Africa by reducing these barriers.

Another study can be performed to investigate the effect of engineer's tenure on the sources of motivation. The findings of the study will assist employers to determine if they should develop different motivation schemes for engineers depending on their tenure in the organisation.

Another study can be performed to investigate the effect of age on engineer's sources of motivation. The findings of the study will assist employers identify if they should develop different motivation schemes for engineers based on their age.

## CONCLUSION

The purpose of the study was achieved by developing research questions which were relevant to the study and developing a research design that was adequate to answer these research questions.

The specific purpose of the study was to identify sources of motivation of licensed and unlicensed engineers in South Africa, and also to determine if they significantly differ based on gender. To accomplish the purpose of the study,

four research questions were developed and answered using quantitative research methods.

Descriptive statistical analysis of the data collected on sources of motivation of engineers in South Africa identified they were motivated predominately by internal self-concept motivation followed by goal internalisation motivation. These findings apply to sources of motivation of licensed and unlicensed engineers, therefore answering research question 1. In addition, these findings also apply to sources of motivation of male and female licensed and unlicensed engineers, therefore answering research question 2.

Additional analysis of the data collected on sources of motivation of engineers in South Africa identified there was no statistically significant difference in the sources of motivation between licensed and unlicensed engineers, therefore answering research question 3. The analysis also identified there was no statistically significant difference in sources of motivation between male and female licensed engineers and between male and female unlicensed engineers, therefore answering research question 4.

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