“THE USE OF ENGINEERING ETHICS FOR THE BETTERMENT OF SERVICE DELIVERY: THE CASE OF INGQUZA HILL AND ELUNDINI LOCAL MUNICIPALITIES”

by

Sisekho Sako, née Makunga

A dissertation submitted in fulfilment of the academic requirements for the degree of

Master of Engineering

in the

Department of Civil Engineering and Geomatics

Faculty of Engineering and the Built Environment

at the Durban University of Technology

August 2022

DECLARATION

Except when otherwise noted in the text, I, Sisekho Sako, née Makunga, hereby declare that this dissertation is my work and has not been submitted in part or whole to any other University or University of Technology.

Professor Dhiren Allopi supervised the research, which was carried out at the Durban University of Technology.

---------31/08/2022----------

S. Sako Date

FINAL SUBMISSION APPROVAL

Supervisor's Signature: Prof D. Allopi

DTech (Civil Engineering) (MLST); MDT (Civil Engineering) (TN);

Postgraduate Diploma Engineering (Natal); Diploma Datametrics (Cum Laude) (UNISA); Pr.Tech. (Eng); FMSAICE; MIPET; MSAT; MCILT

ABSTRACT

Service delivery is the central purpose for municipalities and municipal engineers are at the forefront of this function. They must not only perform services according to established standards, but also control public opinion, as the municipal sector has been severely harmed by past unethical activities that have jeopardized municipal engineering's integrity. This research is aimed to investigate “the application of ethical engineering principles can be utilized to improve service delivery”. This will determine if there is an association between engineering ethics and the quality of the services supplied. It will also determine whether engineering ethics can be used to motivate people to provide better service. The research will explore the concept of professional engineering ethics and whether its application could better improve service provision for communities. The study environments are the Ingquza Hill Municipality and the Elundini Municipality which have permitted the researcher to develop an ethical decision-making model that the identified case study municipalities would consider implementing. A pilot study was conducted with employees within the civil engineering discipline who were identified from the municipal organizational structure.

The participants were interviewed using a questionnaire with 42 structured questions and 7 open-ended questions. Inferential statistics were then used to analyse the data. Honesty and integrity were deemed to be primary trepidations for municipal engineers. Political meddling was an additional major concern that was assessed to have an impact on decision-making. Professional service providers who worked for the case study towns were used in the main study. From the main study, fraud and corruption driven by the client were identified as the leading cause of ethical compromise. Organizational promotion of ethical behaviour was found to occur significantly more at Elundini than at Ingquza Hill. Unethical practices are perceived to occur more at Ingquza Hill than at Elundini as evidenced from the responses received from each municipality’s service providers. The study resulted in the formulation of a tool for enabling ethical decision-making. The tool aimed to simplify decision-making, resulting in superior engineering judgment and humanizing the output which is service delivery. Management will be responsible for implementing/testing the model with the researcher’s guidance.

Keywords: engineering ethics, code of conduct, service delivery, municipal engineering, engineering decision making, Engineering Council of South Africa

ACKNOWLEDGMENTS

Wariza, my husband, my guide, and my strength. To you, I dedicate this dissertation. You see the best in me and continue to encourage me to strive for more. Your vision drives me to better myself every day.

To my lovely girls Reabiloe, Sinanziwe, and Lineo, you are my source of joy when all else comes weighing me down. I find strength and comfort in your sweet little kisses and your gentle hugs. To my unborn child, who gave me pregnancy brain during a time when I needed my wits by me. My sister, Zizo Makunga was my inspiration in registering for my masters and has given me the continued encouragement to persevere even when the end seemed so distant.

Without my friends and family, this would have been but a dream. Andisa Merana, Lungiswa Goya Sihlobo, and Phindiwe Diko, you have been true sisters befitting diction. I am truly grateful for your persistence and resilience.

The case study municipalities provided a conducive platform for research. This dissertation was compiled during a very trying time in the local government sphere, during the peak of the Covid 19 pandemic. It was also concluded during a time of the uprising in South Africa wherein there was rife public protest and dissatisfaction due to promises not honoured by the government. This period was also a precursor to the local government elections, a period under which there is tremendous pressure and scrutiny of public services. Without the support of management and the participation of all the respondents, this study would never have been a possibility.

The statistical analysis provided by Gill Hardy has been an invaluable contribution, without which the completion of this dissertation would not have been possible.

For the meticulous work in developing and perfecting this tool, I owe my appreciation to Nonkuselo Sokuthu, Andrew Brodie, Johan Roussouw, and Leonard Le Roux.

My supervisor, you may be last, but most certainly not least. Without your leadership, excision, and prudence this would not have come together. To you, I bestow my profound gratitude, may you continue to show this steadfast support to all those under your stewardship.

“Give thanks to the LORD for He is good: His love endures forever”. Psalm 107:1

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ABRID	Alabama Board for Registered Interior Designers
ACA	American Counselling Association
AEE	Application of Engineering Ethics
ARR	Average Recruitment Rate
ASCE	American Society of Civil Engineers
BCW	Building and Civil Works
CFA	Confirmatory Factor Analysis
CIDB	Construction Industry Development Board
CIB	Chartered Institute of Building
ECSA	Engineering Council of South Africa
ECSECC	Eastern Cape Socio-Economic Consultative Council
EFA	Exploratory Factor Analysis
ELM	Elundini Municipality
EDMs	Ethical Decision-Making Models
FIDIC	Federation of Consulting Engineers
IBM	International Business Machines Corporation
IDP	Integrated Development Plan
IHLM	Ingquza Hill Local Municipality
ISO	International Organization for Standardization
KMO	Kaiser-Meyer-Olkin
MFMA	Municipal Finance Management Act 56 of 2003
MIG	Municipal Infrastructure Grant
MRR	Mean Recruitment Rate

MSA	Municipal Systems Act, Act 32 of 2000
OE	Organizational Ethics
OTP	Office of the Premier
PCA	Principle Component Analysis
PCCAA	Prevention and Combating of Corrupt Activities Act, Act 12 of 2004
PESD	Perceived Effect on Service Delivery
PMU	Project Management Unit
RSA	Republic of South Africa
SAICE	South African Institute of Civil Engineers
SAIMechE	South African Institution of Mechanical Engineering
SANS	South African National Standard
SABS	South African Bureau of Standards
SDBIP	Service Delivery and Budget Implementation Plan
SIPDM	Standard for Infrastructure Procurement and Delivery Management
SPSS	Statistical Package for the Social Sciences
STR	Small Town Revitalization
TMU	Technical Management Unit
UN	United Nations
UP	Unethical Practices

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Service delivery is the central purpose for municipalities and municipal engineers are at the forefront of this function. They do not only provide services by set standards, but must also manage public perception. This is due to the municipal sector being extremely exposed because of previous fraudulent acts that jeopardized the integrity of municipal engineering. This research is aimed in investigating how “the application of ethical engineering principles can be utilized to improve service delivery”. Being a person who works in the municipal sphere, the researcher has experienced the scrutiny of public perception and has also witnessed colleagues making decisions that are at times compromising to the engineering profession. These decisions were made under immense political pressure which at times does not take into consideration engineering decision-making principles. On several occasions, it has been the researcher’s supposition that had an engineer focused only on engineering principles, it would have yielded better outcomes with long-term political, social, and economic satisfaction.

1.2 RESEARCH PROBLEM

1.2.1 Problem Statement

Communities perceive the quality-of-service delivery by municipalities to be poor, which leads to unrest and service delivery protests, however, this can be improved through the proper application of engineering ethics.

This is substantiated by Shaidi (2013) who argues that recent service delivery protests and incidents of xenophobic violence in South Africa are caused by the economic, social, and political frustrations of increasingly marginalized communities, the apparent unwillingness of the government to take action or pay attention to the concerns of the poor, and the belief in disgruntled communities that violence is the only voice heard by the government.

1.2.2 Nature of the research Problem

There has been public dissatisfaction over the quality of infrastructure services provided by municipalities. The technical factors contributing to quality such as design, poor application of standards, procurement and construction factors have been explored without necessarily providing a solution to the quality issue, as

evidenced by the Construction Industry Development Board - CIDB (2011) study on quality titled “Construction Quality in South Africa: A client perspective”.

The issue is that moral degeneration can be underpinned by a lack of professional ethics. A quest of reverting to basics within the public sector has ensued with a shift in focus being not only on the hard skills of public servants but also soft skills being strengthened to promote good governance. It could possibly be due to the average citizen feeling the consequences of an absence of ethics more acutely today. People are perhaps more sensitive to their own moral responsibilities today than ever before (Connor 2006).

1.3 PURPOSE AND OBJECTIVES

a. To determine whether an engineer’s ability to make complex moral decisions can be used to improve the overall performance of duties of engineers within public service, thus resulting in improved service delivery.
b. To determine the role played by engineering ethics in the identified case study municipalities.
c. An ethical decision-making tool will be developed in order to assist the case study municipalities in improving engineering decision-making,.
d. This research will establish whether there is an association between engineering ethics and the value of service delivery provided. In doing this, it will determine whether the use of engineering ethics can facilitate improved service delivery.

1.4 RESEARCH QUESTION

Can engineering ethics be used to improve service delivery?

1.5 SCOPE, SCALE AND RESEARCH LIMITATIONS

It is understood that various categories of services fall within the realm of service delivery for municipalities, but due to the limitation of practicing disciplines within the targeted case study environments, the research focuses on the civil engineering discipline within the selected case study municipalities. A further limitation exists due to both local municipalities not being water services authorities and rather having a

large portfolio of roads, building, and social amenities projects within their Service Delivery and Budget Implementation Plans (SDBIP).

1.6 SIGNIFICANCE OF THE STUDY

The study is relevant particularly within the South African context as there is limited research in the field of Engineering Ethics in comparison to the large amount of information available internationally. In some countries, the study of engineering ethics is deemed a crucial part of the education system. Professional ethics has become a prominent issue in engineering school, notably in the United States, where there is a greater emphasis on engineers' professional obligations (Hess 2013). Yadav and Barry (2009) attest that there is a paucity of research on engineering ethics education.

To research ethical behaviour or ethics-related subjects, previous studies mainly used the framework of organizational cultures and human characteristics and backgrounds; however, in-depth talks about the features of ethical dilemmas are limited. Studies on ethical behaviour have traditionally focused on the underlying principles, rather than the specifics of ethical episodes and the circumstances in which they occurred. Furthermore, the distinguishing qualities of ethical issues have not gotten enough attention (Yu 2015).

Traditionally, ethics has been split into three categories:

a. meta-ethics - is concerned with matters of justice and right along with ethical assertions and their rationalisation;
b. normative ethics - is concerned with the values and philosophies utilized for deciding whether something is excellent or bad;
c. applied ethics - is focused on applying ethical principles to a particular situation (Feiser 2019).

The study concentrates on municipal engineers' applied ethics, giving particular attention to applied ethics within the field of engineering.

Engineers working for municipalities oversee delivering services. Lately, the decisions made by these public servants have been brought under scrutiny on many an occasion, with the abuse of power and improper usage of state funds being a primary concern. The issue that has been on everyone’s minds is that this is all but

a result of moral degeneration which can be underpinned by a lack of professional ethics within the public sector. It has thus become critical to explore the question of professionalism and ethical question amongst public servants.

With the local government sector being largely dependent on outsourcing of the engineering function, it has become a fundamental cause to examine the role of engineering ethics within this sphere. It is these so-called “soft skills” which are explored as part of professional ethics to determine the overall influence they have in the perceived service delivery environment. The municipal sphere has proven to be a relevant environment for exploring ethics, mainly due to stereotypes that exist showing that municipal servants are largely perceived by the public to be barren of ethics. The research provides the link between the promotion of ethical conduct and optimized service delivery.

1.7 THEORETICAL FRAMEWORK

According to Velasquez et.al. (2021) there are three sorts of ethical theories that are commonly used, these include: consequentialist philosophies; non-consequentialist philosophies and agent-centred philosophies.

Consequentialist philosophies, which focuses on the ethical ramifications of specific actions. Non-consequentialist philosophies, which are interested in the motives of the individual ethical decision maker. Unlike consequentialist and non-consequentialist philosophies, agent-centric philosophies focus on defining the morality of specific behaviours than with the overall ethical standing of persons.

1.7.1 Consequentialist philosophies

According to the School of Oriental & African Studies - SOAS, consequentialist ethics come from the ethical theory's teleological branch(Hasan 2009). The objective of ethical action is at the centre of teleological theories. Consequentialist theories may be classified in a variety of ways based on how they are used and the desired effect, but they are primarily separated into two types: these being Utilitarianism and the Egoistic approach. Act consequentialism views each act individually and decides that the right act is the one that has the most effects that are congruent with the intended outcome (Frost 2011).

Utilitarianism is a consequentialist moral theory that focuses on maximizing the entire good, which encompasses both others' welfare and one's own. Utilitarians are hedonistic, which means they base their moral judgments on pleasure or enjoyment.

As a result, traditional utilitarianism directs ethical decision-makers to make decisions that benefit the greatest number of people (Hart 2011). Because it encourages us to consider the benefits and drawbacks of our acts, utilitarianism is one of the most popular approaches to deciding how to make ethical decisions, especially those involving large groups of people Velasquez et.al. (2021).

The egoistic point of view is considered either descriptive or normative. According to descriptive egoism, every person has a single definitive goal that is his or her personal happiness. Rather than describing what one does, normative varieties of egoism make statements about what one ought to do (Shaver 2002). The egoism idea underpins capitalist claims that a corporation's exclusive responsibility is to its shareholders. However, some forms of social and environmental responsibility can be compatible with egoism since egoist decisions may attempt to satisfy long-term self-maximizing purposes rather than urgent moral obligations (Hasan 2009). Ethical egoism is a non-viable hypothesis because egoism tends to disregard objective moral norms to satisfy one's own desires (Febrero 2017).

A variation of the consequentialism school of thought called ‘the common good approach’ has also been largely argued by philosophers. Despite their disparate goals, most invocations of the common good share a basic approach to it. The common good is a way of putting public welfare ahead of selfish or parochial concerns. It is hardly unexpected that the common good is frequently linked with the other guiding principle, given its universally positive valence (Beerbohm and Davis 2017).

1.7.2 Non-consequentialist philosophies

Non-consequential theories subscribe to the deontological school of thought. Deontological school of thought accords logical priority to moral judgments, rather than to rules or principles. The principle thinking and reasoning is “do the right thing” (Calhoun 2015). Non-consequentialism is generally a normative theory of morality. It is a hypothesis that the rightness or wrongness of an action, a system of laws, or another object is decided, at least in part, by something other than the (non-moral) goodness or badness of the results (Kamm 2007). The four methods are: duty-based, rights-based, fairness or justice-based, and divine command-based approaches that can be roughly classified under non-consequential theories.

Kamm (2007) argues that Kant's second formulation of the Categorical Imperative, which states that we should always consider rational humanity in ourselves and

others as an end-in-itself and never as a means, as well as his distinction between perfect and imperfect responsibilities, have piqued interest.

Although the duty-based approach is drawn from older non-consequentialists who were frequently explicitly religious and advocate the importance of personal will and intention and God's omnipotence (which is cognizant of this mental state) to ethical decision making. Doing what is right, according to Kant, is about having the proper purpose when doing, not about the consequences of our acts (over which we have no control) (Velasquez et.al. 2021).

The rights method is based on Kant's deontological thesis that we must treat everyone as an end in themselves, rather than as a means to our aims, because each individual is autonomous and rational, and hence has inherent worth (Hasan 2009). The Universal Declaration of Human Rights affirms all members of the human family's inherent dignity and inalienable rights, which is vital to freedom, justice, and peace (UN General Assembly 1948). The Bill of Rights was written in South Africa to protect the rights of all citizens and to affirm democratic values such as human dignity, equality, and freedom (Republic of South Africa 1996).

A Theory of Justice by philosopher John Rawls is a work of ethical political thinking in which he attempts to provide a moral theory that is not utilitarianism. A contemporary version of Kantian philosophy, as well as a variant of classical social contract theory, are incorporated into the theory. The minimal notion of relevantly similar cases (persons) being treated equally is common to all definitions of fairness or righteousness. "Distributive justice" relates to the dispersal of social advantages and problems; "retributive justice" is concerned with issues of punishment and correction; and "procedural justice" is concerned with social processes (Cushman 2018).

All of the principles of the Divine Command Approach are inherited from God. In order to believe in divine command theory in this sense, one must believe in a wilful and rational God who has provided ethical direction (McCartney and Parent 2015). The divine command proponent can work from one of two paradigms, according to tradition. The first stresses God's directives as the foundation of normative deontology, whereas the second emphasizes God's will (rather than mandate) as the most important factor in determining moral duty (Evans 2007).

1.7.3 Agent-centred philosophies

In agent-centred theories, the distinction between those who emphasize the role of intention in establishing morally significant kinds of agency and those who

emphasize the acts of agents as playing such a role is well-known (Stanford 2007). The moral life is understood by agent-focused theories particularly pertaining to what it means to be a virtuous individual, with virtues being interior tendencies. Aristotelian theory is an example of an agent-based theory. Agent-focused theories, on the other hand, are more radical in that they judge actions based on ethical judgments about the inner lives of the agents who perform them (Athanassoulis 2020). Slote (2001) argues that there are three main types of agent-centred virtue ethics: "morality as inner strength" (influenced by Plato, the Stoics, and Nietzsche); "morality as universal kindness" (inspired by Hutcheson); and "morality as caring" (inspired by Hutcheson and by Gilligan and Noddings).

1.8 METHODOLOGY

A desktop review of literature on the research topic was part of the research process to offer a conceptual framework for the investigation. Ethical clearance was obtained with the Faculty Research Committee for the researcher to undertake research with human study participants. The pilot and the main study consisted of structured interviews in the form of questionnaires to provide an analytical experience of the concept under investigation and to provide a more practical outcome to the research question. Observations were obtained from the research environment.

An analysis of the data was collected during the pilot and the main studies and presented under research findings. The information from the interview questionnaires was discussed and the results were explained in a manner that maintained participant confidentiality. The information from the questionnaire analysis assisted in determining causal linkage on the work being undertaken by public service engineers and primarily the code of conduct for registered persons. The findings of the research will then be conveyed back to the research environment in the hope that they can be applied to provide improved service delivery.

1.9 A SUMMARY OF THE CHAPTERS

There are seven chapters in this dissertation as outlined in Table 1-1 below.

Table 1-1 Research overview

Chapter 1	Introduces the study's title and context. Aims and objectives, research questions, study significance, research problem, and conceptual or theoretical framework are all included in this chapter.
Chapter 2	The theoretical background informed by the literature significant to the research. This is where the argument of the research is expanded. It also provides a conceptual framework for the research, where the research is built up or shaped in the direction it will take. Argumentative comparisons and discussions will be conducted under this section.
Chapter 3	This will discuss the design of the research and how it is intended to contribute to the overall outcome of the research. It will expand on the following sections: 1. Research approach 2. Research design 3. Sampling (sample frame, sample size, and sample design) 4. Research instrument 5. Tools for data analysis 6. Reliability and validity
Chapter 4	Pilot study research findings and data analysis. Presents a background of the case study environment and the results of the pilot study.
Chapter 5	Main study research findings and data analysis. Presents a statistical analysis & discussion of the main study results.
Chapter 6	Provides a theoretical background for the formulation of the ethical decision-making tool. Presents an overview of the tool.
Chapter 7	Presents the conclusion and recommendations.

CHAPTER 2:THEORETICAL BACKGROUND

2.1 WHY STUDY ENGINEERING ETHICS?

Engineers are faced with tackling increasingly complicated issues of a magnitude never seen before as society evolve and populations rise to unprecedented proportions. Resolving these difficulties necessitates more than simply the methodological and diagnostic skills provided in engineering scholar curriculum in the past. Engineers in the future will be expected to have crucial non-technical skills that will allow them to comprehend and manage the social, political, economic, cultural, environmental, and ethical aspects of the technical projects they are working on (Paul et al. 2018). Engineering mentorship is a method of passing on engineering skills in South Africa, which is aided by legislation that establishes engineering regulations for the profession. These same laws and standards will be used in any examination into an engineering failure to determine engineering skill and liability are important, but what about an engineer's "moral" virtue, which must be taught as well so that engineers can attain their utmost professional ability? (Doherty 2014).

The Royal Academy of Engineering (2011) in its publication “Engineering ethics in practice: a guide for engineers” determines that furthering research in engineering ethics “is part of the ongoing process of providing support to professional engineers in the development of their ethical skills, such as their ability to recognize the ethical aspects of engineering decisions, and to fulfil the ethical expectations of the general public.”

The publication goes on to further identify crucial essentials in these skills as follows:

a. to Identify the distinctions, as well as any competing ethical concerns they may have
b. to investigate the issues that may be at the root of those worries and
c. to respond to those concerns in an efficient manner

Professional ethics encompass moral behaviour in the application of corporate standards of good governance. Professional standards imply the existence of broader obligations, one of which is the recognition of the influence of activities on the public (Uff 2003). Ethics deals with concerns of right and wrong, proper, and inappropriate behaviour, and what defines good or evil. Ethical behaviour is guided by a set of principles known as values or norms, and the goal of this study is to look at such norms and values as they apply to public workers. These are important components of strong professional judgment, and they work in tandem with other

technical abilities to construct an engineer's professional competency (The Royal Academy of Engineering 2011).

Doherty (2014) promotes the need to study engineering ethics in that the use of a recognized ethical framework by engineers can imply the transformation from a disastrous to a successful engineering endeavour. Doherty (2014) further advocates that it is insufficient to solely examine technical competency in terms of knowledge base, because moral considerations can occasionally override rational reasoning. Evidence from around the world reveals that the individuals who work in the public sector are one of the most critical variables in the state's ability to achieve its goals and be effective in bringing about societal reform (Department of Planning Monitoring and Evaluation (DPME) 2016).

2.2 DEFINING KEY TERMS

2.2.1 Ethics in the context of engineering

Engineering ethics is a branch of applied ethics that investigates and develops standards for engineers' public-facing responsibilities, their clients, their employers, and the profession. It encompasses every facet of professional practice (South African Institution of Mechanical Engineering (SAIMechE 2018).

The Rules of Conduct for Registered Persons issued by the Engineering Council of South Africa (ECSA 2006) do not make use of the word ethics or ethical but instead define a virtue paradigm of a registered professional. A code of professional ethics results when a field organizes itself into a profession. The resulting code is central to advising those professionals how to conduct themselves, to judge their conduct and to understand the profession (Schwartz 2014). It sets off as defining the qualities of an Engineer who shows public interest, has integrity, has due regard for the environment and upholds dignity of the profession. The ECSA later issued the Code of Conduct (ECSA 2017) as an update to the original publication. It guides engineers on how they can ethically operate within their area of proficiency, working with integrity, respecting public interest and the environment whilst upholding the esteem of the profession. There is also an assumption that persons with academic credentials or who have received training on the Code of Conduct and other programs will demonstrate the required levels of professionalism in any career, including those in the public sector. Qualifications are the least reliable predictors of professionalism when compared to other essential features of professions such as academic and social values, based on a large body of evidence from both the public and private sectors. As a result, the Constitutional Values and Principles serve as

the foundation, in addition to meritocratic appointments and promotions for an ethical, responsible, and accountable public service (Ngcaweni 2020).

Ethical problems may arise during engineering activities as in other occupations. Business conduct, incentives or unfettered impacts may contribute to such problems, such as the use of an infrequent and unmaintainable material for a solution that will be essential in the future. Because these virtues are a part of Aristotelian philosophy and are in no way inherent human capabilities, but are instead acquired through practice and coaching, which is why it becomes crucial to study these characteristics, to harness them for the greater development of the profession. An Engineer is therefore required to be adept of distinguishing, examining, and handling ethical dilemmas and problems that arise during engineering work.

The ECSA Code of Conduct has a limitation in that it does not necessarily define what ethics are. In making this determination in the context of engineering, one can take solace in the definition provided by the South African Institution of Mechanical Engineering - SAIMechE which first defines a value system that engineers should prescribe as a foundation for ethical behaviour (SAIMechE 2018). This value system is founded on the following:

a. Quality of life - satisfaction with life as a whole;
b. Health, human potential, empowerment, growth, and excellence - awareness of one's full potential, the aptitude to manifest it, to develop into that potential, to live it, and to do the best they can with it in general;
c. Freedom and responsibility - allowing people to make their own decisions about how they want to live their lives;
d. Justice - living decent and equitable lives for all;
e. Individuals, organizations, communities, cultures, and other human systems must be respected for their dignity, integrity, worth, and fundamental rights. Individual and group participation in achieving results that benefit everyone;
f. In partnerships, authenticity and honesty are essential;
g. Efficacy and alignment - people's ability to produce maximum results at lowest cost by aligning their dynamisms and goals with those of the scheme as a whole, the subschema they're a part of, and the wider organisation of which they're a part;
h. A broad, systemic perspective, as well as a focus on the impacted parties - recognizing that diverse people have interests in the system's results and

fairly valuing those interests; viewing human conduct from the perspective of the entire system that impacts and is prejudiced by that behaviour;

i. Involving a diverse group of stakeholders in the organization, facing problems to find solutions, and making democratic decisions

By appreciating the above, it is significant to understand that ethics and sound judgment differ vastly. Education does not teach all of these attributes, yet they are essential at a personal level. They include acting ethically, exercising judgment, and taking responsibility (ECSA, 2018a). When professionals are unsure of how to respond to a situation that requires action, there can be ethical dilemmas or situations that are ethically problematic.

In many situations, a wide range of ethical difficulties develop, such as:

a. there is a clash of ethical ideals or standards;
b. when there is a disagreement between ethical principles and laws or policies;
c. when moral (personal) and ethical (professional) standards clash;
d. when two professions are in competition;
e. many conflicts of interests;
f. other people's unethical behaviour; and
g. due to the intricacy of the issue or another reason, the implementation of standards is ambiguous (Cottone & Tarvydas 2007 and Jacob-Timm 1999 cited by Johnson 2020).

ECSA (2018a) outlines engineering judgment and taking responsibility under outcome 8-10 as follows:

a. Conduct engineering work in a moral manner.
b. In the process of difficult engineering activities, use sound judgment.
c. Assume responsibility for part or all of the difficult engineering activities.

These can be further outlined below.

2.2.1.1 Conduct engineering activities ethically

The assessment standard for competency as provided by ECSA (2018b) makes the following requirements to assess a candidate's competency in conducting engineering activities ethically:

a. It is essential to identify the main ethical issue;
b. Identifying the parties involved and their interests;
c. looking for conceivable answers to a problem;
d. the assessment of each resolution to a problem according to its suitability and in accordance with the interests of the parties involved; and
e. choosing and justifying the most appropriate solution to the dilemma.

2.2.1.2 Conduct complex engineering activities with sound judgment

Engineers can contemplate a multitude of dilemmas simultaneously and, as a result of addressing such dilemmas, take into account their interconnectedness, their comparative rank, and their significances. A complex engineering problem can be solved by exercising equal judgment, as per the ECSA standard of competency (ECSA 2018b).

This is assessed based on the following requirements:

a. the aptitude to take decisions in the absence of complete knowledge;
b. examining multiple aspects, some of which may be ill-defined or unknown, and their interrelation, connections, and comparative rank, utilize engineering judgment.
c. ensuring that the engineering outputs and impacts are addressed by anticipating the implications of actions and appraising a state even limited evidence; and
d. self-assessing their competence from time to time drawing on experience and knowledge.

2.2.1.3 Assuming responsibility for part or all of the difficult engineering activities

Engineers are rendered professional status and held in high regard by society and the public by their competencies. Engineers are expected to be responsible for their

activities as professionals. As a result, an engineer should understand the importance of being responsible and having experience making judgments that, if made improperly, could have bad implications. An engineer must be able to offer recommendations that show responsible behaviour in agreement with the ECSA Code of Conduct during execution of engineering work, as shown by:

a. maintaining a professional demeanour at all times;
b. demonstrating that technological, societal, ecological, and supportable growth factors are taken into account;
c. obtaining counsel from a reputable authority on any topic that is thought to be outside the scope of their expertise; and
d. assuming responsibility for work output and making decisions.

These outcomes are assessed as part of the competency criteria required for professional registration, meaning that ethical prescripts are inherent to engineering decision-making. An engineering candidate must demonstrate capability in handling ethical issues before being professionally registered by adopting a systematic approach to resolving ethical issues. This requirement would normally hold throughout the engineering function and is continuously monitored in the application of engineering work.

By understanding engineering ethics, one can see that it is not always easy to determine what is right from wrong. Because moral dilemmas can be complex, an engineer can rely on social responsibility vested on the engineering function as a compass for ethical guidance. Contributing to long-term development is the goal of social responsibility. The dedication of an engineer to the well-being of society and the environment has become a key criterion for evaluating overall performance (Organisation for Standardisation 2006).

The Organisation for Standardisation (2006) goes on to further argue that the aptitude to make wise decisions even considering substantive dilemmas is crucial in maintaining the trust relationship society has vested in engineers. This is because when someone walks on a bridge, they can do so with confidence knowing that no shortcuts have been taken but the correct loading has been factored in and the correct materials according to specifications have been used, this now leads us to define the term quality.

2.2.2 Quality: FIDIC

In general, quality denotes how good something is in comparison to other similar things of a similar specification or type. Simply put, it is defined as its degree of excellence. The Standard for Infrastructure Procurement and Delivery Management (SIPDM) as issued by National Treasury (2015) describes quality as the “totality of features and characteristics of a product or service that bears on the ability of the product or service to satisfy stated or implied needs”, meaning that for excellence to be ascertained, it must be in comparison to an established or recognized standard and not only implied needs.

The Chartered Institute of Building (CIB) states that “technical specifications define the type of controls that must be undertaken to ensure the construction works are carried out correctly” (Chartered Institute of Building Construction Management Profession 2020), meaning that for quality to be ascertained, it must be in comparison to an established or recognized standard. Ethical behaviour is the foundation of quality, in which quality and ethics share a mutual care assumption of doing the appropriate thing. It is a tried-and-true method for lowering expenses, increasing affordability, and increasing user contentment. Quality issues will arise because of low ethical standards among building experts. As unethical behaviour becomes more prevalent, the quality of project performance suffers as a result (Hamzah et al. 2010 as cited by Kahlela 2018). Kahlela (2018) postulates that the unethical behaviour of project managers has a negative impact on product quality. Federation of Consulting Engineers (FIDIC) approved its Policy Statement Quality of Construction in 2004. Through its policy, FIDIC mandates that construction should be sustainable, meaning that participants in the engineering process should be dedicated to honouring requirements with regards to meeting Quality. Further to this, FIDIC (2004) provides that the lack of Quality “has been manifested in poor workmanship, unsafe structures, delays, cost over-runs and disputes in contracts”. The measure of quality as defined about service delivery as scoped in this research is thus be measured as determined by workmanship, cost, duration, and disputes relating to the service provided as these factors contribute to the overall value for money achieved in the provision of municipal services. A dedication to ensuring that the best value for money is obtained, or that the resources provided provide the most benefit (National Treasury 2015). There is also a strong perception that majority of the quality-related problems are caused by human-related factors, especially professionalism and ethics (Besterfield et al. 2003).

Besterfield et al. (2003) mentioned that quality is dependent on ethical behaviour, whereby quality and ethics have a common care premise which is to do right things right and it is a proven way to reduce costs, improve competitiveness, and create customer satisfaction.

Because defining and judging service quality is challenging, it has inspired a lot of discussion and controversy in the marketing literature, with no clear consensus building on either (Wisniewski 2001). Quality, when reviewed in the context of engineering technical standards, may be easier to decipher, but in the context of “service delivery,” it becomes a more complex phenomenon to unpack.

An argument can be made that the citizenry's subjective and collective sense of service quality is referred to as "service quality" (Wisniewski and de Visser 2010). The interaction of two components can be used to conceptualize the quality of municipal service, these being:

a. the degree to which citizens are satisfied with the service and

b. the degree of variation in the distribution of service satisfaction among a community's neighbourhoods (Shin 1977).

Given that this research focuses on rural roads as a field of specialization for the identified civil engineers within the case study municipalities, further exploring quality in the context of public expectations over the output achieved in service delivery is crucial. The management of customer expectations has a long-term relationship with improving overall impression on the quality of service and can be beneficial to a relationship such as those between communities and municipalities. This is supplemented by Ojasalo (2001) theory of managing customer expectations whereby he advocates that “customer expectations are a key component of how service quality is measured. In the case of professional services, especially where long-term relationships are at stake, expectation management pays off.”

2.2.2.1 Citizen Satisfaction as a measure of quality

If the level of citizen satisfaction is used as the first measure of quality, it is therefore important to examine the factors that contribute to the perceptions of quality service from the public perspective as the recipients of the service. Quality municipal services are linked to customer satisfaction. Customer or citizen happiness is crucial to any organization's success, particularly in the public sector (Mohamed et al. 2012). The most critical step in establishing and delivering quality service is to understand exactly what citizens want. Citizen input is extremely useful in determining how well

a municipality meets the demands of its customers. The data can be utilized in quality improvement initiatives to assist municipal councils in identifying opportunities to improve services and foster a positive public perception (Mokhlis 2011). One way to get the government closer to the people on a local level is to provide service that is satisfying, timely, effective, and adequate (Bello et al. 2017). It is important to note, however, that civilian expectations are frequently high, and residents have unrealistic expectations of municipal services, which may hamper quality measurement based on customer satisfaction (Živković and Glogovac 2019). The prevalence of protests over service delivery in South Africa in response to the dissatisfaction over municipal services. The social theory of relative deprivation can be used to explain service provision in recent years. "Relative deprivation" is a situation in which one demographic segment of the population is denied access to products or services to which they believe they are entitled, while another demographic segment of the population enjoys them. According to Runciman (1972), a sense of relative deprivation may have an impact on attitudes and perceptions of service delivery. Distribution of services as a measure of quality.

The provision of high-quality municipal services should be viewed as meeting residents' needs, fostering local community growth, and contributing to affordability (Nigro 2012).

In terms of access to fundamental services and amenities, South Africa today is marked by vast discrepancies. Basic services are provided to groups of people who live together and share resources as households, rather than to individuals (Eastern Cape Socio-Economic Consultative Council (ECSSEC) 2018). The ability to offer services may be harmed when looking at the geographic spread of homes within towns. These are designated as rural municipalities in the context of the two case study municipalities. In the rural development framework, Eastern Cape Socio-Economic Consultative Council - ECSECC (2000) defined rural areas as having the two traits listed below:

a. villages and small towns are distributed throughout these sparsely inhabited areas, people who farm or rely on natural resources live in these areas.

b. large villages in former homelands that rely on migrant labour and remittances, as well as government social grants, to survive, and which often have traditional land tenure arrangements.

Because it addresses infrastructural backlogs vs rising community requirements, the distribution of services provided by the municipality can serve as a more reliable basis for measuring quality. Such service providers can operate in accordance with defined standards, which serve as a tool for assessing quality rather than subjective opinions.

2.2.3 Service delivery within the context of public administration

“Service delivery” is a term used in South Africa to define how basic services such as water, electricity, sanitation facilities, land, and housing are distributed to inhabitants (Campbell 2014). The Constitution of the Republic of South Africa (Republic of South Africa 1996) further mandates municipalities “to ensure the provision of services to communities in a sustainable manner”. As a result, it is critical that public service delivery be viewed as a process of achieving society commitments governed by ethical considerations within the South African government's constitutional democracy (Sebake and Sebola 2013).

To fully grasp the concept of service delivery as given in the public service, one must understand the functional areas of authority in the South African setting. There are three levels of government which are interconnected and interrelated spheres: national, provincial, and local. Three elected domains of government were established: national government, provincial government, and local government, each with unique functional responsibilities. The Constitution mandates that the three branches of government work together as a single system of cooperative government for the benefit of the entire country (Department of Provincial and Local Government (DPLG) 2007).

Metropolitan municipalities (Category A), Local municipalities (Category B), and District municipalities (Category C) are the three types of municipalities in local administration. Local and district municipalities share executive and legislative authority, whereas in their jurisdiction, metropolitan municipalities have sole executive and legislative authority (Republic of South Africa 1996). The Constitution (Republic of South Africa 1996) goes further to define functional areas for each sphere which has legislative functions inherent to their responsibility as outlined in Schedule 4 and 5 of the Constitution. These functional areas of government give an expectation with regards to the “services” to be delivered by each sphere. The Constitution is silent on the services that municipalities should provide, save for the need that they be delivered in a sustainable way and that socioeconomic

development be encouraged. Figure 2-1 below gives an indication of the governance model as envisioned in the Constitution.

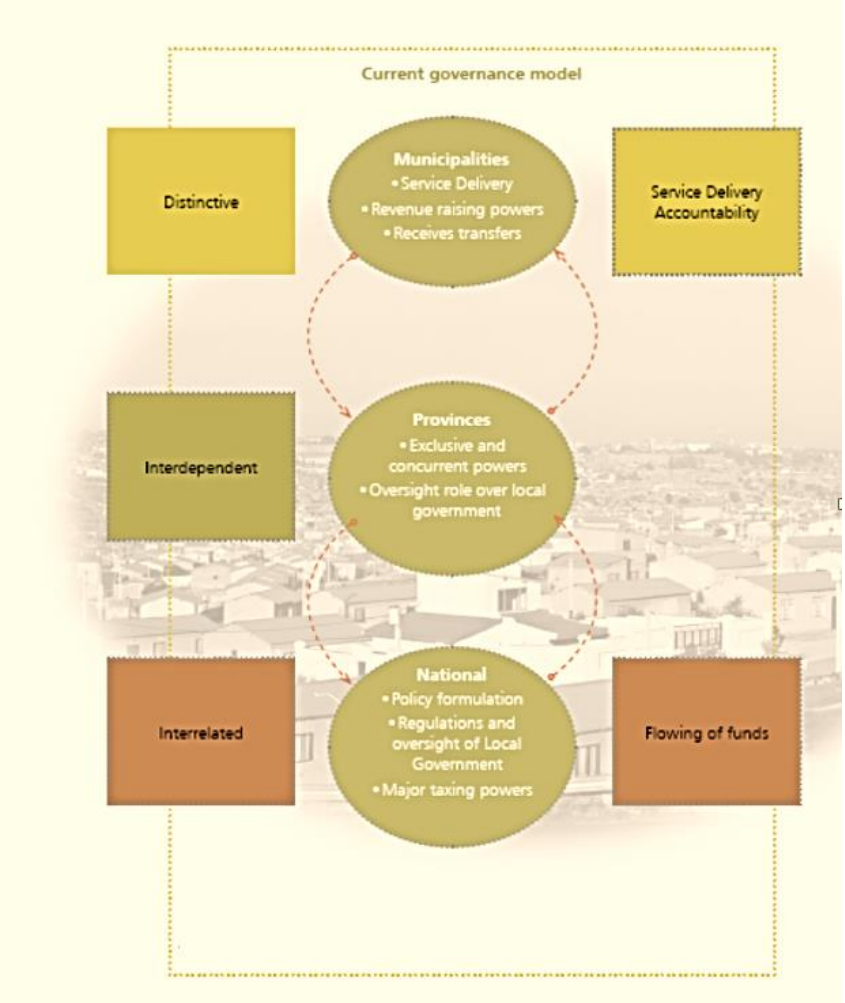


Figure 2-1: South African Spheres of government

Source: Department of Provincial and Local Government (2007)

The Municipal Systems Act (Republic of South Africa 2000) specifies certain responsibilities and criteria for all municipalities, including prioritizing local community needs, supporting local community development, and ensuring that all members of the local community have at least the bare minimum of basic services.

Functions and powers are assigned or delegated to municipalities in various ways. When a function is transferred to a local government, the assignment refers to the whole authority being given over (Bekink 2006).

The services deal with at the local authority level directly and immediately impact the quality of life of the people within the community that a municipality serves. In the instance of poor roads provided, this can impact the ability to provide emergency services and inherently affect health and community safety. Poor services can limit attraction of businesses towards an area thus decreasing job opportunities for people residing in the area. In rural areas, basic services may differ from those necessary in urban areas.

Municipalities should follow certain basic principles when it comes to the services they provide, according to the White Paper on Local Government (Republic of South Africa 1998b). Municipal services should be:

a. as a constitutional requirement, communities should be able to receive at least a basic level of services;

b. simple and practical to use;

c. as low-cost as feasible; and

d. Services must meet a set standard, which means they should be appropriate for the task at hand, delivered timeously, safely, and accessible at all times.

The level [or quality] at which municipal services are provided is an important subject to investigate because the legislative requirement for municipal services is stated as "basic level of service." The Public Service Charter (PSCBC 2013) recognizes that government must set defined service standards to ensure efficient provision of services. Affordability and community demands determine the degree of service provided. Municipalities should examine the service's long-term viability while deciding on the degree of service to provide. The costs of providing a higher-quality service rise when a municipality does so, accordingly, so does the amount that the municipality is required to charge its consumers. Because local governments rely significantly on user fees. The municipality loses money and is unable to perform services if the fees are unreasonably high and people are unable to pay (Education and training unit for democracy and development 2020). Table 2-1 outlines the diverse ranks of service for the most essential municipal services:

Table 2-1: Service Levels Shasha (2012)

Service Type	Level 1 Basic	Level 2 Intermediate	Level 3 Full
Water	Communal standpipes	Yard taps, yard tanks	In house water
Sanitation	(Sewage collection/disposal	VIP Latrine Septic tanks	Full waterborne
Electricity	5-8 Amp or non-grid electricity	20 Amps	60 Amps
Roads	Graded	Gravel	Paved/tarred & kerbs
Stormwater drainage	Earth lined open channel	Open channel lined	Piped systems
Solid Waste disposal	Communal (Residents)	Communal (Contractors)	Kerbside

Source: Education and Training Unit (2020)

2.2.4 Successful service delivery in ethically compromised settings

It can be argued that the idea that more ethical behaviour by engineers will improve service delivery is trite on the one hand and can be flawed on the other in that it has been perceived that it is possible to have successful service delivery with unethical procurement practices. Lues (2007) contends that ethical conduct and ethics are not always the most important factors in determining how well a service is delivered. Some ethical beliefs are likely to have a significant impact on service delivery particularly when paired with other factors that have the potential to create a cumulative effect. For instance, unethical behaviour, together with other flaws such as a lack of resources and infrastructure could cause poor service delivery. Furthermore, even if it is only considered as a natural extension of the government's ethical and moral code, it is an important component of the public sector's leadership and mentorship function. Certain ethical norms should govern the functioning of public institutions and the behaviour of public service administrators. Even if it is just seen as a feature inherent to the public sector's role as a leader and mentor, it should serve as an extension of the current government's ethical and moral code. The debate on the relationship between corruption and economic development has led to two schools of thought: the moralists and the revisionists. These perspectives differ fundamentally in their perceptions of the effects of corruption on economic development. The revisionists argue that corruption and economic development are mutually beneficial. According to the moralist school of thinking, corruption has a

detrimental impact on economic growth and development because it increases the cost of doing business and creates enormous ambiguity in decision-making (Oluwaseun 2013). Sebake and Sebola (2013) argue that corruption, in many forms, has an influence on the delivery of public services in South Africa.

Mauro (1995) claims that corruption deters investment and slows economic growth. He claims that there is a permanent negative association between corruption on the one hand and investment and growth on the other, in contrast to the revisionist position that corruption can enhance growth in countries with burdensome bureaucratic laws. Corruption and poor management, according to Mpehle (2012) many South African communities, are the cause of a lack of basic shelter, decent sanitation, energy, and safe and inexpensive transportation. Lerrick (2005) further argues that corruption is the core cause of bad service delivery, not just a symptom of it in Africa. Zitha and Mathebula (2015) cover the overarching impact corrupt practices in public service have had on service delivery in their study “Ethical conduct of procurement officials and implications on service delivery: a case study of Limpopo provincial treasury”.

Even though the South African government has made substantial progress in enacting legislation and regulations that could help to prevent corruption in the public sector, the problem persists. Mathebula and Makamu (2014) conclude that for there to be any impact in the fight to eradicate corruption there first needs to be a societal mind shift.

2.3 THE SERVICE DELIVERY PROBLEM

According to Martin and Schinziger (2005), it is deemed that “engineering should be viewed as an experimental process. It is not, of course, an experiment conducted solely in a laboratory under controlled conditions. Rather, it is an experiment on a social scale involving human subjects”.

Public servants lead of service delivery provision. Lately, the decisions made by public servants have been brought under scrutiny on many an occasion, particularly regarding infrastructure projects, Corruption Watch (2014) reflected in the publication “Understanding corruption in tenders”. People can develop their talents by using municipal services, which improves their quality of life and their economic possibilities. Even though these services were extended after 1994, questions have been made concerning their quality and the degree of disparity in service delivery. This has resulted in waves of service delivery demonstrations in recent years (National Planning Commission 2011).

Central to public concern has been the escalating cost of service delivery which has brought into the spotlight the abuse of power and improper usage of state funds by those within the engineering fraternity with many questioning whether there is any value for money in service delivery provided by municipalities. The issue that has been on everyone's minds is that this is all but a result of moral degeneration which can be underpinned by a lack of professional ethics within the public sector. What has been of minimal focus, however, is the role played by engineers employed in local government and how they are to subscribe to a code of practice as governed by their profession. The creation of a culture of public professionalism could be a treatment for immoral and unethical behaviour in the public sector, as well as a preventative measure against corruption (Gildenhuys 2004).

Professional ethics encompass moral behaviour in the application of corporate standards of good governance. Professional standards denote the existence of broader obligations, one of which is the acknowledgement of an activity's impact on the public (Uff 2003). Ethics deals with concerns of right and wrong, proper, and inappropriate behaviour, and what defines good or evil. Ethical behaviour is guided by a set of principles known as values or norms, and this study investigates the norms and values that apply to public workers. These are important aspects of strong professional judgment, and they go hand in hand with the other technical abilities that make up an engineer's professional competency (The Royal Academy of Engineering 2011).

Currently, the problem statement is no longer a question of whether municipalities are delivering the required service to the communities they serve, it has become a question of how such service is provided. Reddy (2016) argues that developmental local government has to become a reality for the majority of South Africans in terms of improving the quality of their life at the local level. We know and comprehend from the Public Service Commission's principles that every public servant in South Africa has an imperative responsibility to perform in a way consistent with honesty, integrity, professionalism, and true service orientation. Most South African politicians attempt to follow these basic principles (Gildenhuys 2004). The South African government passed many pieces of law to make the promotion of ethical behaviour in the public sector a reality. Despite robust and inclusive legislative and policy frameworks for fighting corruption and institutionalizing proficient behaviour and demeanour, academics and members of the public continue to express concern about unethical behaviour in the South African public sector (Manyaka and Sebola 2013).

Some of the areas that are affected by the unethical behaviour of a licensed professional are as follows: Quality of the work, Conflict of Interest, Moonlighting, and “No Show jobs” (Scalza 2011). One of the most common issues in the construction sector is poor project execution and deliverable performance. Most of the projects were completed for substantially more than the contract amount. It is also critical to provide corrective actions in mitigating the steps to improve the construction environment's quality. All these issues will jeopardize the construction industry's viability and long-term viability (Jamaludin et al. 2014). Though, different infrastructures serve to meet different requirements, their quality is not only important to make them sustainable but also contribute to providing services with value at large (Yadav et al. 2016). Unethical actions have a negative influence on the professionals' image and organizations, which has a detrimental influence on the competitive advantage of the organisation (Kahlela 2018).

The call for new measures to ensure more flexibility in the retraining and redeployment of municipal staff, the introduction of a service system that is more client and performance oriented, and the increased responsibility and dedication to delivery within municipal administrations has been widely voiced. This is advocated by Muzhedzi (2016) as he argues that the current public accountability mechanisms are inefficient and ineffective.

Local government is at the heart of service delivery, and any failure in this area could affect the country's overall socioeconomic development, not only in terms of public perception of the entire government system (Ncube 2014). Many municipalities are unable to carry out even basic obligations, leading to a loss of trust in the government by local people. Violent service delivery demonstrations; misuse of political power and rising corruption; financial issues; poor infrastructure design, maintenance, and investment. Local governance has been marked by political turbulence and factionalism, as well as personnel instability (Reddy 2018).

Last year, 237 protests against towns were registered by a specialized local government data and intelligence organization across the country, Municipal IQ. This surpassed the previous high of 191 demonstrations set in 2014 (Municipal IQ 2019). Municipal IQ further provides that averaged over the entire 2004 – 2019 period, Gauteng dominated as the most protest-prone province; In 2018, the Eastern Cape overtook Gauteng as the most protest-prone province, and it continues (slightly) ahead of Gauteng (so far) in 2019. Although service delivery protests decreased significantly in 2020, part of this can be attributed to the lockdown months, during which public gatherings were restricted and policing was increased to enforce State of Disaster regulations. In 2020, the proportion of violent protests declined

(evidenced in 75% of incidents), when compared to 78 percent in all years since 2004 (Municipal IQ 2021).

Kevin Allan, M.D. of Municipal IQ, notes “the low figure for 2020 is attributable to a reduction from March to August when the lockdown was most pronounced, and also when service delivery protests often spike.” (Municipal IQ 2021). The provision of municipal services in South Africa is almost universally regarded as inadequate. A survey by the (South African Customer Satisfaction Index 2019) shows that municipalities' low satisfaction scores have been on the rise for three years, so this is not a one-year glitch. This has led to municipal and other public servants being under the spotlight mainly being questioned for their behaviour in administering their duties.

If institutional performance is a factor in service delivery, it stands to reason that the better government performs, the more likely actual service delivery will meet expectations (Kruger 2013). By educating students as socially responsible engineers and scientists, we not only serve the public interest but also strengthen their engineering skills. Their skills are increasingly important in today’s world, particularly in deriving insights (Fu 2013).

2.4 MODELS FOR ETHICAL DECISION-MAKING

An examination of the literature on engineering ethics reveals that it is dense with explanations of codes of ethics, laws, and regulations that control and guide engineers' conduct (Fan 2003). The environment in which engineering work is performed sometimes involves competing considerations for numerous stakeholders who must be considered before uncompromised solutions can be provided. Ethics difficulties arise in such a professionally obligated circumstance, influencing the problem solution's course of action. Alternatively, ethical issues are poorly organized and there are not any prescriptive or enumerable answers. Ethical problems are also "grey" problems and present similar challenges to engineers and as such, they need practical tools for solving these ethical problems (Bero and Kuhlman 2011). In instances where numerous ethical rules may apply, but the decision is ambiguous, ethical problems develop. Despite the absence of clarity or precision in ethical principles, professionals must consider ethical considerations before deciding on a course of action (Johnson 2020).

Models for ethical decision-making provide recommended and well-established procedures for the critical reasoning required to resolve ethical challenges. Models

of ethical decision-making can aid in the development of the ability to work through an ethical dilemma and make an ethical decision. Ethical decision-making based on formal frameworks is considered best practice (Handelsman et al. 2009).

There are numerous ethical models in the literature, the most of which are similar in style and substance. Each model's goal is to give you a foundation for making the best decision you can in any given situation. The purpose of creating these models is to help professionals make ethically sound decisions in a variety of situations. The models provide a basic framework for understanding the ethical duties that this profession implies, rather than asking professionals to make ethical decisions on a case-by-case basis (Arthur 2020).

Most of these models use principle-based reasoning, which was developed by philosophers Beauchamp and Childress in 1979. Ethics, duties, and ideals are embodied in these models. They promote the use of published evidence, data, and peer review. For resolving challenges, some of these models contain multiple steps, but they all encourage comprehensive thinking through the decision model's construction (Beemsterboer et al. 2020).

According to Johnson (2020), numerous theoretical underpinnings are widely stressed throughout the history of ethical decision-making as applied to professional practice. Beauchamp et al. (1979) created principles, which are overarching criteria, to guide ethical decision-making in the medical industry Hare (1981), a philosopher, brought moral theories and reasoning to psychiatric ethics. He divided moral reasoning into two stages: intuitive and critical appraisal, which he believed are used differently depending on the situation's complexity. When the situation is clear, absolutist standards are used to decide, with the bulk of findings based on prima facie obligations and principles. Kitchener (1984) combined Beauchamp and Childress' (1979) concepts and guidelines with Hare's (1985) two levels of moral thought. Using Hare's critical assessment of the intuitive application of principles in all situations, helping professionals can improve moral understanding and decision-making. Since then, ethical decision-making models have expanded to encompass a wide spectrum of theories and research (Cottone 2012).

2.5 ANALYSIS OF MODELS FOR ETHICAL DECISION

When faced with an ethical issue, models for ethical decision-making provide steps, or instructions, on how to make an ethical conclusion (Johnson 2020). Various studies have been conducted to analyse ethical decision-making models (EDMs).

Steers, Mowday, and Shapiro (2004) contend that models of ethical decision-making must not only be theoretically sound but also practically valuable.

Dillon (1998) puts forth three types of models that dominate the literature. He provides a simple way of distinguishing between these models of decision making as follows:

Descriptive: What people do or have done.

Prescriptive: What people should and can do.

Normative: What people should do (in theory).

Whittier et al. (2006) further expand that a normative model of ethical decision-making emphasizes how decision-makers should ideally perform the activities in the decision-making process. Descriptive models of ethical decision-making, on the other hand, consider empirical facts about how decision-makers carry out the activities involved in the decision-making process. Finally, prescriptive ethical decision-making models take empirical evidence into account to assist decision-makers in improving their decision-making performance in the light of the complicated setting in which judgments are made.

2.5.1 Normative models of ethical decision making

Normative models, such as Bayes' theorem, were employed as rough explanations of judgment and decision-making behaviour during the 1960s (Dougherty et al. 2010 citing Edwards 1968). They also believe that normative models, particularly Bayes' theorem, continue to have a distinct place in the literature on judgment and decision-making.

In response to questions posed by gambling, normative theories of how to choose risk emerged in the eighteenth century (Johnson and Ratcliff 2014). The phrase 'risk taking' is used to describe the normative approach's decision-making behaviours. Risk-taking appears to be influenced by both the situation and the decision-traits (Weber 2001).

Normative models are evaluation standards. They must be justified in the absence of observations of people's decisions and judgements. When the "correct solution" is not evident, philosophical and mathematical reasons are usually used to justify it (Baron 2004). They are useful when it is necessary to measure deviations from the single best response (Baron 2012). While descriptive theories explain how people

make judgments, normative models propose how people should make decisions (Whittier et al. 2006).

2.5.2 Descriptive models of ethical decision making

The forces that influence ethical decision-making in companies are described in descriptive models of decision-making (Whittier et al. 2006). The goal of descriptive decision theory is to characterize and explain regularities in people's decision-making processes (Chandler 2017).

Yu (2015) in the “Comparative Analysis of Jones’ and Kelley’s Ethical Decision-Making Models" credits Jones, Bartlett, Kelley, and Elm who have made valuable contributions in descriptive model theories. Much of the effort in this field, according to Chandler (2017), has been devoted to the development and testing of formal models aimed at improving the descriptive adequacy of a framework known as "Subjective Expected Utility" (SEU).

Moral judgment can be developed in various people, according to the descriptive model. Furthermore, it does not offer a blanket judgment about "good ideas" or "bad thoughts," but rather focuses on the ability to critically assess the moral components of a decision (Strong and Meyer 1992).

2.5.3 Prescriptive models of ethical decision making

The line between descriptive and normative theories has blurred as research has progressed. A third classifier has recently been introduced. A prescriptive that can and should be utilized by a genuine decision maker that is tailored to the decision-individual maker's situation and needs. Prescriptive models are built on both normative theory's strong theoretical foundation as well as descriptive theory's observations (Dillon 1998).

At the very least, the utilitarian, rights, and justice moral principles will be included in a suitable ethical judgment model (a prescriptive model) (Whittier et al. 2006).

Whittier et al. (2006) go on to say that prescriptive aids, such as procedural manuals and decision aids, should be used. Prescriptive measures are supposed to be included in procedural guides and decision aids to lead and enhance the decision-making process.

2.5.3.1 Prescriptive aides for decision making

The following prescriptive aides have been considered in the formulation of the ethical decision-making tool derived for this research:

2.5.3.1.1 Bowen's Model for Strategic Decision Making

Bowen's Model for Strategic Decision Making is based on Immanuel Kant's (1724–1804) deontological philosophy, which offers a useful framework for analysing ethical difficulties. The human mind, according to Kant's 'Critique of Pure Reason,' is an active agent that imposes patterns on the physical world; observations are accepted or rejected according to pre-conceived hypotheses (Williams 2017).

The rational approach to decision-making underpins the deontological school of ethics. The logical brain, rather than religious or legislative standards, is the source of moral decision-making, according to Sullivan (1994). Rationalism, according to Flew (1979), is the view that people can learn about the nature of something solely by reason. This viewpoint views faith, habit, prejudice, and religion to be illogical, and favours deductive reasoning to guide ethical decisions. Rationalism is defined as the concept that humans can learn about the nature of anything solely via reason (Bowen 2005, citing Flew 1979).

Ethical difficulties are managed, according to Bowen (2005), by meticulous analysis of ethical decisions and balanced communication. Bowen's strategy is based on a professional's ability to make independent decisions. As a result, freedom from external pressures that could influence one's judgments is crucial under this concept. The model aids the professional in making a decision based on the primary duties of the client and the public (Fan 2003). Bowen's (2007) research was organized around the following three questions:

a. What is the organizational structure of issues management and issue decision-making, including access to the dominant coalition (e.g. autonomy) - This study topic looked at organizational structure to see if the autonomy required for ethical decision-making was available.
b. How important is ethics to managers in their issue management decision-making? – Bowen wanted to know if there was a formal analysis of ethical issue implications in an organization when decisions were taken, and if there was a desire to make ethics more prominent in decision-making.

c. Does the organization primarily rely on a utilitarian or deontological understanding of ethics? - This question tried to determine whether organizations worked with the deontological intention of moral benevolence, or "doing the right thing."

2.5.3.1.2 Blanchard and Peale method

Most people know right from wrong, according to Blanchard and Peale (1988), but they place themselves in difficult situations because they have taken unethical actions knowingly. They argue that it is simple to rush ahead without thinking and then rationalize one's actions later. According to Blanchard and Peale, the existence of a "grey area" between right and wrong is no justification to disregard ethics. They suggest that most of the "greyness" in ethical dilemmas may be eradicated by just taking the time to think about a decision.

Blanchard and Peale pose these three questions for ethical management and offer it as a system to check whether a decision is ethical before making it:

a. Is it legal? Will I be violating civil law or company policy? Will I be violating the code of conduct?
b. Is it balanced? Is it fair to all parties concerned, both in the short-term as well as the long-term? Does it promote win-win relationships?
c. How will it make me feel about myself? Will it make me proud? Would I feel good if my decision was published in the newspaper? Would I feel good if my family knew about it?

Answering yes to any, or all of the questions is not a guarantee that an ethical decision will be reached. However, one may feel more confident of having made an effort to make an ethical decision (Blanchard and Peale 1988).

2.5.3.1.3 Potter's Box for Decision Making

This is perhaps one of the simplest, yet most used ethical decision-making frameworks. This model was created by Ralph Potter, a social ethics professor, and is widely utilized in a variety of fields. This method guides people through a four-step process that includes 1) assessing the problem, 2) identifying values to be employed, 3) recognizing guiding principles, and 4) selecting loyalties to be applied. According to this paradigm, professionals must understand values, beliefs, and loyalties to make the best ethical decision (Fan 2003). Figure 6-2 reflects the interrelationships within Potter's box.

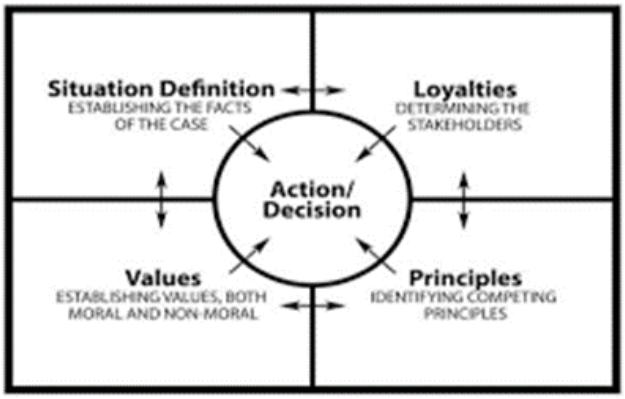


Figure 2-2: Potter's box for ethical decision making

Source: Harvard Divinity School (Potter 2020) website (https://hds.harvard.edu/)

In addition to the Potter's box for decision making, Velasquez et al. (2021) suggest the following framework for ethical decision making:

a. According to utilitarianism, the most ethical course of conduct is the one that benefits the greatest number of people, or, in more extreme circumstances, the least harm.
b. The ideal decision is one that respects and defends human dignity and moral rights, according to the rights approach. "People have a right to be considered as ends in themselves, not only as means to other objectives," says the report.
c. The justice or fairness approach states that all people should be treated equally. If treating everyone equally isn't possible, there must be a fairness norm that applies to everyone.
d. Actions should benefit public life, according to the common good perspective. This strategy is used to lobby for welfare-related laws and public services.

2.5.3.1.4 McKinsey 7s model

The model is made up of hard elements that are specified and influenced by management, as well as ambiguous soft factors that are influenced by business ethos (Kenton 2019). Waterman and Peters (2004) suggest 7s for looking at the art and science of management in their book "In Search of Excellence." They

concentrate on the following hard elements: structure, strategy, and systems. They go on to look at the following soft elements: Shared ideals, talents, personality, and personnel. McKinsey's 7s model is depicted in figure 6-3 below.

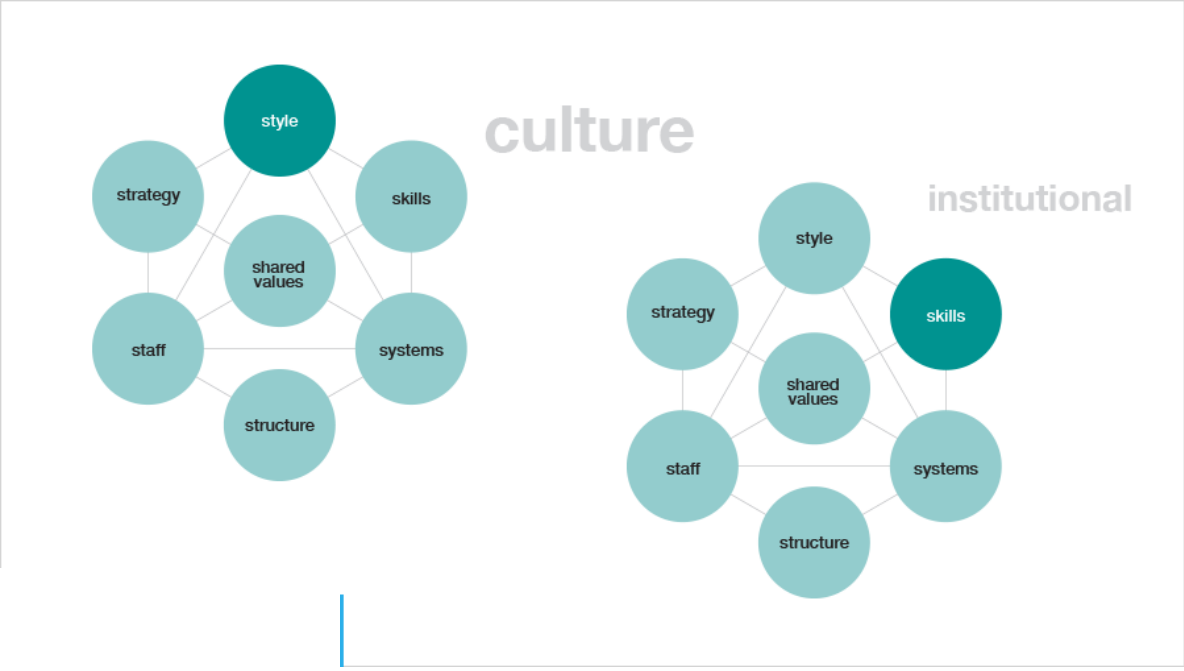


Figure 2-3: McKinsey 7s model

Image source: McKinsey Quarterly (2008)

The context of the organizational environment in which decision-making takes place is significant because it determines the nature of the decisions made. Placing shared values in the model's centre underlines the importance of these values in the development of all other important parts. According to the concept, for good decision-making to occur, the seven elements must be balanced and reinforced (Mind Tools 2021).

2.5.3.1.5 Congruence model

The background of the organizational setting in which decision-making occurs is significant because it determines the nature of the decisions made. Placing shared values in the model's centre underlines the importance of these values in the development of all other important parts (Sabir 2018). According to the concept, for good decision-making to occur, the seven elements must be balanced and reinforced (Mind Tools 2021). The better the organization's performance and the faster it fulfils its goals, the more these four components are in sync. When these four components

are out of harmony or inconsistent, problems arise, resulting in poor organizational performance (Belyh 2020). According to Nadler and Tushman (1989), the ability to comprehend individual, group, and organizational behaviour patterns, forecast what behavioural responses certain managerial initiatives will produce, and finally, the management assignment requires you to use your knowledge and predictions to attain control. The context of the organization in which decision-making happens is critical since some of the criteria revealed in the pilot study point to the institutional setting as a source of inability to apply engineering ethics. Nadler and Tushman's Congruence model is reflected in Figure 6-4 below.

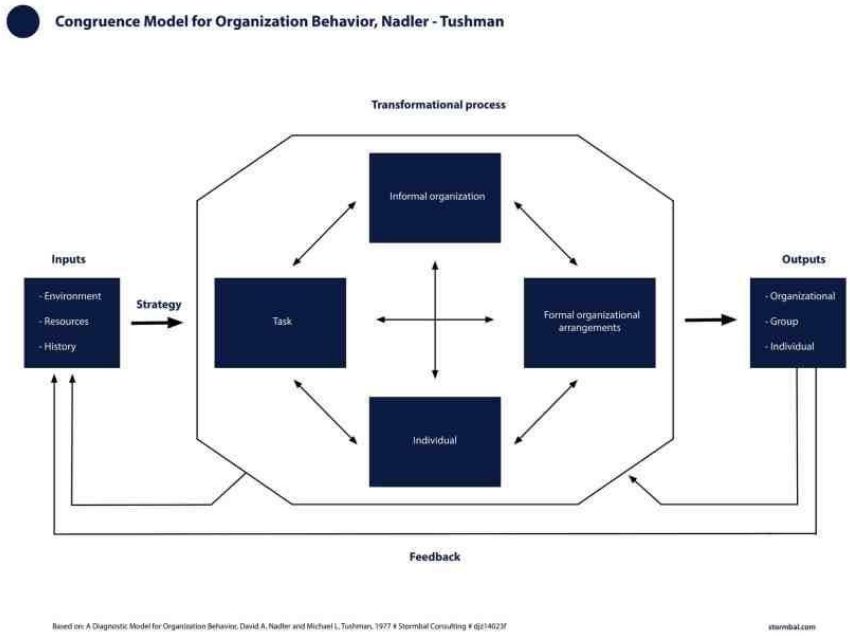


Figure 2-4: Congruence Model for Organization Behaviour, Nadler Tushman

Source: https://www.stormbal.com/100/congruence-model-nadler-tushman

2.5.3.1.6 Stadler's decision-making approach

Some of the criteria identified in the pilot study point to the institutional setting as being the source of incapacity to apply engineering ethics:

a. Would I recommend this course of action to another in a similar situation? Would I condone my behaviour in anyone else? (Universality)

b. Would I tell others what I intend to do? Would I be willing to have the actions and rationale for them published? (Publicity)

c. Would I treat another service user in the same situation differently? If the service user was a well-known political leader or a relative of the Chief Executive, Isabelle Trowler, or Lyn Romeo, would I treat him or her differently? (Justice)

2.5.3.1.7 Forester – Miller and Davis ethical decision-making model

For the American Counseling Association, Forester-Miller and Davis (2016) developed an ethical decision-making matrix (ACA). They maintained that it was critical to recognize that even when confronted with the same problem, various specialists may take different approaches. This was founded on the belief that complicated ethical situations rarely have a single correct response.

Their concept provided a methodical approach to ensuring that one could provide a professional justification for the course of action taken. They combined the work of Van Hoose and Paradise (1979), Kitchener (1984), Stadler (1986), Haas and Malouf (1989), Forester-Miller and Rubenstein (1992), and Sileo and Kopala (1993) into the following practical, chronological, seven-step ethical decision-making model:

a. Identify the problem.
b. Apply the ACA Code of Ethics.
c. Determine the nature and dimensions of the dilemma.
d. Generate potential courses of action.
e. Consider the potential consequences of all options, choose a course of action.
f. Evaluate the selected course of action.
g. Implement the course of action.

2.6 ETHICAL CONSIDERATIONS

To keep our society stable without imposing excessive formal controls on every conduct, ethical judgment is required (SAICE 2017). Ethics: Guidelines for Professional Conduct for Civil Engineers by the American Society of Civil Engineers (2008) was created to help engineers conduct their professional and business activities daily. As such, it provides the following ethical dilemmas for consideration by Civil Engineer.

2.6.1 Conflict of Interest

Conflict of interest is defined as "any situation in which someone in a position of trust has competing professional or personal interests that make it difficult for him to fulfil his duties impartially," "any situation in which an individual or organization is in a position to exploit a professional or official capacity in some way for his personal or corporate benefit," or "any situation in which incompatibility or contradictory interests exist," according to SANS 10845-3 (Organisation for Standardisation 2011). The public, the customer, the employer, and the profession must all benefit from an engineer's professional and business decisions. Conflicts of interest, real or imagined, can occur in a variety of circumstances (Organisation for Standardisation 2021).

2.6.2 Ensuring Legal Compliance

Legislative compliance does not essentially realize an individual's entire ethical responsibility but contributes significantly to the performance of one's professional duties during engineering work. Apart from ensuring their professional legislative compliance, engineers have been vested with an obligation to encourage excellence within the engineering profession (ECSA 2020) and as such have a responsibility to ensure that any violations of safety standards or conditions that endanger the safety of other workers, contractors, clients, or the public are reported as quickly as possible to the appropriate person or authority.

2.6.3 Role of leadership and political governance

The role of oversight bodies, such as city council committees and local government officials, is critical in enhancing resource utilization and holding the executive and administration accountable (National Treasury 2018). In comparison to national and provincial governments, local governments operate in a more complex framework. The municipal council is effectively the employer of all municipal employees because it is designated as the executive by the Constitution. To some extent, legislation has attempted to isolate the council from the administration. Senior managers (i.e., the municipal manager and managers who report to him or her; see s. 82(1)(a) Municipal Structures Act and s. 56 Municipal Systems Act) must be appointed by the municipal council, with the administration making additional appointments (Republic of South Africa (RSA) 1998a). The Councillors' Code of Conduct contains a provision that

prohibits councillors from interfering with the administration (item 11 Schedule 1 Systems Act). Taking a more strident stance, the Municipal Finance Management Act prohibits councillors from participating in tender decisions (section 117 MFMA) and has numerous clauses aimed at separating the council from the administration (de Visser 2010).

2.6.4 Employee and Public Safety

The first objective stated in the ECSA (2017) Engineers must utilize their information and competence for the benefit of the public and the environment when performing engineering work, according to the Code of Conduct. In addition to this, the Code of Conduct further reflects engineers should not prejudice public health and safety. Equally, this can be applied to fellow employees, in that engineers should have reverence for the interests of the public and respect the standing of the profession.

2.6.5 Workplace Quality

Value management evaluations at the right stage(s) may help to ensure project success. However, late-stage assessments might be ineffectual and have a negative influence on the program and expenditures (FIDIC 2016).

2.6.6 Employer's Assets: Use and Protection

Employers have a variety of valuable assets, including cash, real estate, intellectual trade secrets, and confidential information. Every employee is responsible for safeguarding these assets against loss, theft, and misuse (ASCE 2008). The obtainability of governmental means and budgets to address all concerns quickly is limited. Unauthorized, irregular, pointless, and wasteful expenditure in municipal government has also been alleged to have reached alarming levels. This has exacerbated popular perceptions of resource squandering and other forms of public resource mismanagement going unchallenged (National Treasury 2018).

2.6.7 Maintaining Accurate and Complete Records

It is impossible to stress the necessity of keeping precise and full records, particularly for municipal engineers who are audited extensively. King IV – King of Code of Governance Principles calls for integrated reporting, i.e. reporting of financial information with sustainability issues of social, economic and environmental impacts

(Institute of Directors 2016). Proper record-keeping is further emphasised in Section 62 (1) (b) of MFMA and Section 2 of the Local Government Systems Act (Republic of South Africa (RSA) 2000). It is therefore prudent that complete and accurate records that are not falsified or modified in any manner must be kept.

2.6.8 Gifts, Meals, Services, and Entertainment

Regulation 46 (2) (c) of the Supply Chain Regulations to the Municipal Finance Management Act (Republic of South Africa (RSA) 2003) impose an obligation to the municipality that a Code of Conduct of ethical standards of the municipality must stipulate that a government official or other participant in supply chain management strategy implementation may not receive any kind of compensation, gift, favour, generosity, or other advantages directly or indirectly, including any close family member, partner, or acquaintance of that person. Engineers who are municipal officials must comply with this duty and report to the accounting officer (Municipal Manager) any awards, gifts, favours, hospitality, or other perks promised, presented, or awarded to them or to any close family member, partner, or associate. This declaration is done in compliance with Schedule 2 of the Municipal Systems Act, Act 32 of 2000, which relates to the Code of Conduct for Municipal Staff Members, Section 8 refers to rewards, gifts and favours (Republic of South Africa (RSA) 2000).

2.6.9 Confidential or Proprietary Information

Confidentiality is a technique for keeping all information hidden. This applies to information deemed beneficial to conceal. The term "maintenance of secrecy" refers to the non-disclosure of any material about a company's profitable or technical procedures that isn't already public (Brait and Pollock 2004)). Brait and Pollock (2004) establish that employees are not permitted to utilize confidential information as a "springboard" for causing harm to their employer.

2.6.10 Outside Employment/Activities

Outside work or business operations that are unrelated to the employer's responsibilities must not jeopardize the employee's capacity to perform his or her job duties. A conflict of interest must not be created, or appear to be created, by such outside employment or commercial activity. Without the previous knowledge and agreement of the employer, time or resources provided by the company, such as telephones or electronic media, may not be utilized for outside employment or

personal business operations (American Society of Civil Engineers (ASCE) 2008). To this end, municipal employees must sign a statement of interest disclosing outside employment or revenue-generating activities not related to their job. These are by Schedule 2 of the Municipal Systems Act, Act 32 of 2000, which relates to the Code of Conduct for Municipal Staff Members. These are particularly cited in Section 5 (refers to disclosure of benefits) and Section 5a (refers to the declaration of interests) of the said Act (Republic of South Africa (RSA) 2000).

2.6.11 Purchases of Goods and Services

Unrelated to infrastructure delivery, public procurement usually involves standard, well-defined, easily scoped, and specified goods and services. Procurement for new infrastructure or the rehabilitation, renovation, or adjustment of existing infrastructure, on the other hand, covers a large and diversified range of goods and services required to deliver or change the state of immovable assets on a site. As a result, the procurement process for infrastructure delivery entails the original and ongoing update of planning procedures, as well as the procurement and administration of a network of suppliers, including subcontractors, to manufacture a product on site (National Treasury 2015). According to Zitha and Mathebula (2015), Procurement's purpose is to get the finest possible supply of goods and services from the market in terms of quality, time, and cost, while also managing risks and achieving socio-economic goals such as stimulating competition and maintaining integrity.

The National Planning Commission of South Africa's National Development Plan 2030, published in 2011, advises that the following five areas be prioritized in establishing a procurement system that can give better value for money while reducing the risk of corruption:

a. to balance opposing goals, take a strategic procurement approach above the project level, rather than seeing each project in isolation;
b. fostering confidence and cooperation with the private sector; and
c. by training and accreditation, establish professional supply chain management capacity

Engineers within the municipal sphere must apply the above taking into consideration the requirements of section 112(1) of the MFMA, which sets out the requirements for supply chain management within the municipal value chain.

2.6.12 Bribes and Kickbacks

The most prevalent kind of commercial corruption is when someone pays a bribe or kickback in exchange for a contract. The thing of value (which the Act refers to as "gratification") in this scenario is frequently money, and the power abuse is when a contract is handed to someone who is not the best or cheapest. Both the one who offers the bribe (the corruptor) and the one who accepts it (the corrupted) will be found guilty of corruption (RSA 2004).

Bribery of public officials is primarily regulated under the Prevention and Combating of Corrupt Activities Act, 2004 (PCCAA). It makes bribes and corruption illegal. Some complex legislation and regulations, on the other hand, deal with numerous industry-specific forms of corruption (Bernstein and Shaw 2016).

2.6.13 Relationships with Competitors

Discussions with current or potential competitors about similar challenges must be undertaken with caution to protect any delicate or patented employer information or information that could otherwise advantage opposing parties (ASCE 2008).

2.6.14 Relationships with Outside Contractors, and Consultants

Any state employee who has a kingship relationship with a supplier, including a blood relationship, is obligated to report such an interest. by Schedule 2 of the Municipal Systems Act, Act 32 of 2000, which relates to the Code of Conduct for Municipal Staff Members Section 5a (refers to the declaration of interests) of the said Act. Suppliers could be outside contractors or consultants (Republic of South Africa (RSA) 2000).

2.6.15 Environmental Protection

Sustainability and energy efficiency concerns are rapidly becoming commonplace in all areas of construction. Sustainability, which includes environmental, economic, water, materials, energy, health and safety, and social priorities, should be a prominent element of any project (FIDIC 2016). Engineers must obey with appropriate environmental, health, and safety laws and regulations. This obligation is aligned to the Ten Principles of the United Nations Global Compact (UN Global Compact 2016) which puts responsibilities as follows:

- businesses should advocate for a cautious approach to environmental issues;
- take steps to encourage more environmental awareness; and
- stimulate the creation and spread of ecologically friendly technology.

2.6.16 Whistle Blowing

The King II- King of Code of Governance Principles report recommends that, an organization's ethical norms should be monitored, and accessible safe reporting channels (whistleblowing) should be established as part of the organizational integrity framework. The organization must respond to offenses and prevent them from happening again. Whistleblowing is concerned with raising a real concern about an organization's malfeasance. It is an important instrument for developing individual and corporate accountability (Institute of Directors 2002). King IV further goes on to advocate for protected disclosure mechanisms as a means to detect breaches in ethical code. It further encourages management to effectively deal with disclosures made through whistle blowing (Institute of Directors 2016).

Whistle-blowers behave in good faith and in the public interest when they report concerns about possible misconduct at work. A whistleblowing method can serve as an early warning system for management, allowing them to avoid potential threats to the company. As a result of an effective whistleblowing strategy, the municipality will be able to detect problems early enough to take corrective action.

2.7 CASE STUDIES IN PRINCIPLE BASED ENGINEERING DECISION MAKING

ECSA has published on its website case studies arising from contravention of ECSA's Rules of Conduct for Registered Persons as a learning guide to engineers as well as to minimise the risk of recurrence. These case studies offer a learning tool to see how easy it may be to miss the opportunity to make principle based engineering decision making. A case study of significant note cited by ECSA is that of Case Study No. 2012/5 (ECSA 2012). This case study was based on a residential dwelling unit constructed with numerous faults and defects, arising in part (as conclude in an investigation by the regulatory authority) from unprofessional performance by the Engineer. The case study is based on a dwelling was which was one of a number of similar units in a cluster development situated in a suburban area. The development was undertaken by a contractor who retained the services of the Engineer to provide the necessary professional engineering services. The quality of

materials and workmanship produced by the Contractor left much to be desired. The level of substandard building work gave rise to numerous defects and justified a complaint to the Architectural Council. This was aggravated by other faults and defects, apparently of an engineering nature. On receipt of a complaint from the Employer after the dwelling unit was ostensibly completed, ECSA commissioned an expert to investigate the matter. This revealed that the dominant fault involving the Engineer concerned a reduction in the floor to floor height between ground and first floors. When this action was queried by the Employer the Engineer made a written misrepresentation to the Employer (now the Owner) to cover up for his client the Contractor. It was considered this transgressed Rule of Conduct 3(2) (h) of ECSA in that the Engineer had failed to give any decision, recommendation or opinion that was objective and based upon prevailing facts. The regulator found that in building or construction contracts such as the one above, where the Engineer is employed by his client (in this case the Contractor), his duties include administering the contract, not only in the interests of his employer, but also in a manner which is fair and impartial. As a professional therefore the Engineer may well give a decision which appears against the interests of his employer – here the Contractor – but if the Contractor is at fault the need to decide impartially becomes paramount and the Engineer cannot side with his employer.

2.8 CONCLUDING REMARKS

The literature review first sought to establish why it was essential to study engineering ethics. Secondly, the context of the research was established. Wide-ranging terms specifically linked to engineering ethics were then defined. An analysis of data present in the literature related to successful service delivery in an ethically compromised environment was outlined. That was then followed by a broad review on models for ethical decision-making as they apply to this present research. A case study extracted from the Engineering Council of South Africa was used to further argue the need for principle-based reasoning in an engineering context. This was lastly followed by scenarios identified in previous research which provide for ethical considerations, and these were then contextualized in the environment of public service in which municipal engineers operate.

The literature available in this regard is quite vast which provides for a strong theoretical framework to proceed with the research. The findings of the review indicate that there are well defined principles on what is understood to be ethical practice. It goes on to further establish a framework for principle based engineering reasoning. From the literature, it is apparent that there is sound argument from both

spectrums, ie for those who support ethical decision making in engineering and those who argue for the separation of ethics from engineering decision making.
From the literature reviewed, it is clear that there are key fundamentals which define the concept of engineering ethics and sets it apart from generally understood ethical practice. There are also fundamental values for ethics within engineering which come in the form of codes of conduct, as such the understanding of engineers within the research environment will need to be established during the study. It will also be pertinent to establish the commitment or an engineer's ability to apply such values in their decision making in the implementation of service delivery. The information unearthed during the literature review was critical in assisting the researcher to compile the research tool for conducting the study.

There is also a strong argument that engineering should be considered as an experimental process. Of course, it is not an experiment that is only carried out in a lab with strict controls. Instead, it is a sociological experiment with human people. This therefore means that for the research to be successful, it is critical that a research tool also reflects the varying opinions that engineers may want to express. This information has therefore been used to compile the open ended section of the research tool.

.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 OVERVIEW

The nature of this research is exploratory which involves a combination of quantitative and qualitative research techniques. Gatekeeping authorisation was obtained from both case studies municipalities as part of the ethical clearance process for conducting the research.

The research utilizes data gathering methods in the form of questionnaires distributed to a choice of subjects within the case study municipalities. The questionnaire comprises of questions that are ranked on a Likert scale exploring the following constructs:

a. Concept of ethics
b. Fundamental values or guides for conduct
c. Application of engineering ethics

The formation of the research tool was informed largely by the findings of the literature review and also incorporated open ended questions. It places reliance on descriptive analysis for data processing.

3.2 RESEARCH APPROACH

The approach for the research is pragmatic. Rather than getting mired down in philosophical disputes over whether methodology is ideal, the pragmatic approach to science employs the method that appears to be best suited to the research issue. As a result, pragmatic researchers are free to use any quantitative or qualitative research method, methodology, or approach. They recognize that each tactic has its own set of limitations, and that numerous approaches may work in tandem (Alzheimers Europe 2009). According to Leedy and Omrod (2014), the term "methodology" simply refers to an operational framework within which facts are placed to better understand their meaning. Qualitative and quantitative methods can be used for corroboration (hoping for similar results from both methods), elaboration (using qualitative data to explain or interpret quantitative data, or to demonstrate how quantitative findings apply in specific cases), complementarity (where qualitative and quantitative results differ but generate complementary insights), or contradiction

(where qualitative and quantitative results differ but generate complementary insights), complementarity (where qualitative and quantitative results differ but generate complementary insights), or contradiction (when qualitative and quantitative findings differ but provide complementing information or when qualitative and quantitative data yield different results) (Brannen 2004).

3.2.1 Qualitative Research Methods

The qualitative method is used in this study to determine the relationship between human behaviour (ethical decision-making of engineers) and the environment and the contribution it would make towards the improvement of service delivery.

Qualitative research is a powerful tool for exploring and comprehending the meanings that individuals and groups place on social and human issues (Creswell and Creswell 2017). A qualitative research approach is beneficial since it strengthens the understanding and interpretation of meaning as well as the goals that underpin human interaction (Denzin and Lincoln 2005). Qualitative research methods are intended to show a target audience's behaviour and attitudes on a specific topic. In-depth interviews, focus groups, ethnographic research, content analysis, and case study research are just a few examples of qualitative research methods.

3.2.2 Quantitative Research Methods

The purpose of the study is to understand the many factors that influence an engineer's ethical judgment. Therefore the quantitative method is advantageous. Quantitative research is the process of gathering data for quantitative study and calculating and arithmetical statistics interpretation. It can be used to look for patterns and averages, make predictions, assess causal linkages, and extrapolate results to larger groups (Bhandari 2020). Experimental, quasi-experimental, and non-experimental designs are the three major types of quantitative research investigations (Whittemore and Melkus 2008).

3.3 RESEARCH DESIGN

The focus of a pragmatic study is on a single decision-maker in a real-world setting. The first stage in conducting a pragmatic study is to identify a topic and consider it in its broadest sense. As a result, a study is conducted with the goal of gaining a better understanding of the problem and, eventually, resolving it. Finally, study

findings frequently result in legislative recommendations, new environmental initiatives, or social change (Salkind 2010).

Data is collected through structured interviews, which are used in qualitative research methods. In comparison to strictly quantitative methods, interviews and other qualitative procedures are supposed to provide a "deeper" understanding of social concerns. They are also useful for diving into sensitive topics when people are unwilling to discuss them in a group setting (Gill et al. 2008).

A desktop review is undertaken on the subject matter supported by engagement through interviews and questionnaires with engineers practicing within the local government who have been at one stage exposed to situations calling for engineering ethical discernment while executing their duties within the case study municipalities.

The legislative framework provides context for the research and also formulate a guide for assessing ethical conduct within the case study environment. It will assist in the alignment of the exact ethical questions that need to be directed to engineers within public service. This will include exploring legislation around good governance as a foundation towards setting the culture of engineering ethics within the municipalities.

The use of questionnaires with controlled and open-ended questions serves as a critical source of data for the research. A series of observations on the environments being sampled will couple the information from the questionnaires.

An analysis of the individual educational background, social disposition, as well as religious affiliation of public servants as precursors towards building professional ethics, is undertaken through personalized interviews with the identified public servants in the case study environment. It looks at how an engineer’s ability to recognize and analyse the ethical aspects and problems in engineering practice can better shape infrastructure delivery.

The research looks at the environmental setting of municipalities by examining the bearing of political influence and the planning components linked to service delivery as precursors for ethics application. It also dissects the opportunities presented for ethical conflicts, such as the tendering system, costing and design of engineering works, community participation as well as project management during implementation. The evidence of ethical conflicts during these stages will be based on case studies as well as contributions extracted from one-on-one interviews with selected candidates.

An interrogation of values as underpinned in the constitution and the public service charter is carried out in comparison to the values set by municipal institutions in their codes of conduct as well as in their policy documents. This assists in determining whether the national focus on professional ethics is carried out in the workplace.

Due to the inextricable linkage between quality and ethics, the research looks at quality as a determinant of the improved service delivery perception. The measure of quality is done by assessing awareness of the generally accepted engineering standards of quality as regulated and how the identified sample group ensures compliance during project implementation.

The primary data is collected by the researcher through individual interviews utilizing a preliminary research questionnaire designed for the pilot study component of the project. A portion of the findings are presented in a qualitative format. Descriptive and explanatory approaches are used.

The secondary data is information-based on previous research conducted in this area of study, most of which has been addressed as part of the literature review. The data collection tool is refined during the pilot study and the final validated questionnaire is then used to conduct the main study. The research culminates in the formulation of a monitoring tool for use by engineers to resolve ethical dilemmas.

The research makes use of quantitative methods to identify ethical conflicts faced by engineers whilst they carry out duties in public service and will correlate these to the case study environments and analyse the impact on service delivery. Secondary research methods are used to establish the existence of a relationship between the product of service delivery and engineering ethics which are defined as quality versus the cost of service of the final product. An analysis of the contributing factors towards professional ethics are undertaken by scrutinizing contributing factors towards decision-making.

3.4 SAMPLING

There are two types of sampling techniques: probability sampling and non-probability sampling. The researcher begins with a complete sampling frame of all eligible persons from which the sample is chosen through probability (random) sampling. This ensures that all eligible individuals are considered for the sample, and the researcher is better able to generalize the study's findings.

Non-probability sampling methods take longer and cost more money than probability sample approaches. Because the researcher does not start with a complete

sampling frame in non-probability (non-random) sampling, certain people have no chance of being chosen. As a result, the impact of sampling error cannot be calculated, and there is a significant risk of obtaining a non-representative sample with non-generalizable results. Non-probability sampling, on the other hand, is less expensive and more practical, making it perfect for exploratory research and hypothesis development (Shantikumar 2018).

In this study, probability sampling procedures were applied. This type of sampling ensures that the entire population is represented in the sample. The researchers used a combination of stratified and systematic sampling. Stratified sampling divides the population into strata based on some trait rather than geography. In this case, the population was divided into distinct categories based on their organizational roles. Random, systematic, or convenience sampling can be used to get a sample from each of these strata. Systematic sampling was used in the research (Hayes et al. 2021)

3.4.1 Sample frame

The sample frame for the pilot study is limited to the entire population of practicing officials, including senior, middle management and entry level officials employed in the field of civil engineering in the identified municipalities. This is done so as to get an institutional representation of findings. The sample frame will be expanded in the second phase of the study, wherein the externally contracted professional service providers within the civil engineering discipline in the case study environment are invited to participate in the data collection.

3.4.2 Sample size

The sample size is based on the organizational structure of each of the case study municipalities and is also influenced by the contracts register of professional civil engineering service providers currently being utilized by the municipality.

According to Leedy and Omrod (2014), researchers should use the following guidelines to increase sample size:

a. For small populations of fewer than 100 people or other units, sampling is pointless; instead, survey the entire population;

b. If the population size is around 500, 50% of the population should be sampled; if the population size is around 1 500, 20% should be sampled; and

c. Beyond a certain point (at about 5 000 units or more), the population size is almost irrelevant, and a sample size of 400 should be adequate.

The pilot study focuses on sampling senior and middle management at the municipality whilst the second phase of the study will be expanded to incorporate the entire personnel involved in the engineering services within the civil engineering discipline as well as professional service providers contracted in this regard. It is anticipated that at both stages, the sample size may be below 100 people, thus the entire population has to be sampled in this instance.

3.4.3 Sample design

With the local government sector being largely dependent on outsourcing of the engineering function, it has become a fundamental cause to examine the role of engineering ethics within this sphere, looking at not only those in the permanent employ of the state but also engineers contracted to public service.

The targeted groups for the interviews are those vested with decision-making powers that direct the engineering function within the case study municipalities. These are traditionally the likes of technical administrators as well as professionally registered engineers and technologists lending their services in the delivery of services within infrastructure directorates.

The research incorporates interviews with existing practicing engineers within these municipalities in the following categories:

a. Technical Director or Head of the department

b. Civil Engineering Middle Managers within the department

c. Project Managers / Technicians

d. Foremen

e. Professional Service Providers (outsourced civil engineering services)

An initial pilot study was undertaken using only a selected few of the population group. This informs the revision of the initial interview questionnaire to make it better suited to achieve the research objectives based on interactions with the selected

candidates. The revised questionnaire was then be distributed to the entire population within the identified municipalities.

Due to the limitation of practicing disciplines within the targeted environments, the research will focus on the civil engineering discipline within the case study municipalities.

All participants were given a chance of anonymity and will be empowered to withdraw their consent during the research should they wish to do so. The outline in the manner of questioning will be distributed to the interviewees to allow them to make a knowledgeable choice about whether they want to partake in the study.

3.5 RESEARCH INSTRUMENT

The research makes use of interview questionnaires coupled with published information on journals and other available literature as sources of data.

A quest of delving deep into the code of conduct of engineers practicing within the public sector, coupled with other legislation governing ethics within the public sector, will enable the definition of the legislative framework for engineers operating within the sector.

The data collection was undertaken using a mix of qualitative and quantitative approaches. Qualitative methods were used for analysing data collected by conducting interviews. A series of observations were deduced from the interviews. The case studies were based on the identified municipalities, which are the Ingquza Hill and Elundini Municipalities. Interviews with the selected groups were held through customized questionnaires which provided the participants with questions surrounding the subject matter. The questionnaire is provided as an appendix to this dissertation. Participants were asked a series of controlled answers as well as asked to provide their contributions on items characterized to be of ethical importance.

3.6 TOOLS FOR DATA ANALYSIS

Questionnaires distributed in face-to-face structured interviews were used as the primary method for data collection for the pilot study. Argument has been made that one-on-one interviews may be prone to the researcher leading the answers from participants due to body language amongst others, as such the suitability of the data collection method through interviews will be explored as part of the pilot study objectives.

The questionnaires comprised three sections. This first section related to demographic data, the second consisted of study variables regarding the ethical decision making ranked on a Likert scale whilst the last section incorporated open-ended questions. Questionnaires for both the pilot and main study are included in the appendices.

The use of IBM SPSS Statistics was made for statistical analysis of the questionnaire data and responses received. Re-coding and categorizing of variables were undertaken before processing. Data processing is comprised of editing and coding. To ensure accuracy and completeness, the data gathered was examined and corrected in a methodical manner. Each response was classified in a data processing format with a useful title or symbol as part of the coding procedure.

Percentages, mean scores, standard deviation, Cronbach's alpha coefficient, and factor loading were used in the analysis. Descriptive and inferential statistics were used for further analysis of patterns in the data. Open-ended questions were qualitatively analysed.

The range of replies and their recurrence were investigated using descriptive frequency statistics. The summarised scores of responses from the interview responses were analysed using inferential analysis.

CHAPTER 4: PILOT STUDY

The information contained in this section reflects the description of the pilot study, the findings and analysis obtained from the Pilot Study

4.1 INTRODUCTION

Dooty and Dooty (2015) defined a pilot study as “a small-scale version of a planned study conducted with a small group of participants similar to those to be recruited later in the larger-scale study”. This definition is quite applicable to the pilot study of this research.

4.1.1 Objectives

The primary objective of the pilot study was to check to see if the study instrument(s) is asking the right questions, the format is understandable, and the validated tool is acceptable for the target group.

The pilot study had the following secondary objectives:

a. test the appropriateness of data collection method by deciding between two competing study methods, such as the selected interview technique (face-to-face) or to establish whether a self-completed questionnaire would be appropriate

b. Test the data collection procedure, including the time it takes to complete the questionnaire and the individuals' desire to take part in the research.

c. assemble preliminary data for the main outcome measure

d. by providing information on the expected replies to questionnaire items, you can aid in the calculation of sample size

4.1.2 Method

The pilot study was conducted using the preliminary research questionnaire as approved by the Faculty Research Committee (FRC). The researcher framed the questions based on information unearthed during the literature review. Once the proposed questionnaire was drafted, this then underwent ethical clearance by the

Faculty Research Committee. The researcher was also required to undertake ethical training as part of the clearance procedure.

This questionnaire was self-completed by participants in the presence of the researcher who clarified any ambiguous questions and interact with the participants to determine the understanding of the questions being posed.

The participants were taken from the municipal organogram of the case study municipalities and were only be limited to senior and middle management as defined in the institutional organizational structure. The entire population available from the filled positions of all senior and middle managers was interviewed.

Prior to participants undertaking the questionnaire, the researcher explained voluntary consent and also outlined the objectives of the study. Each participant was required to sign a consent form as per the approved ethics consent form from the university as prescribed in the research procedures.

4.1.3 Study design

The pilot study makes use of the process flow as reflected in Figure 4-1 below for establishing the intended objectives:

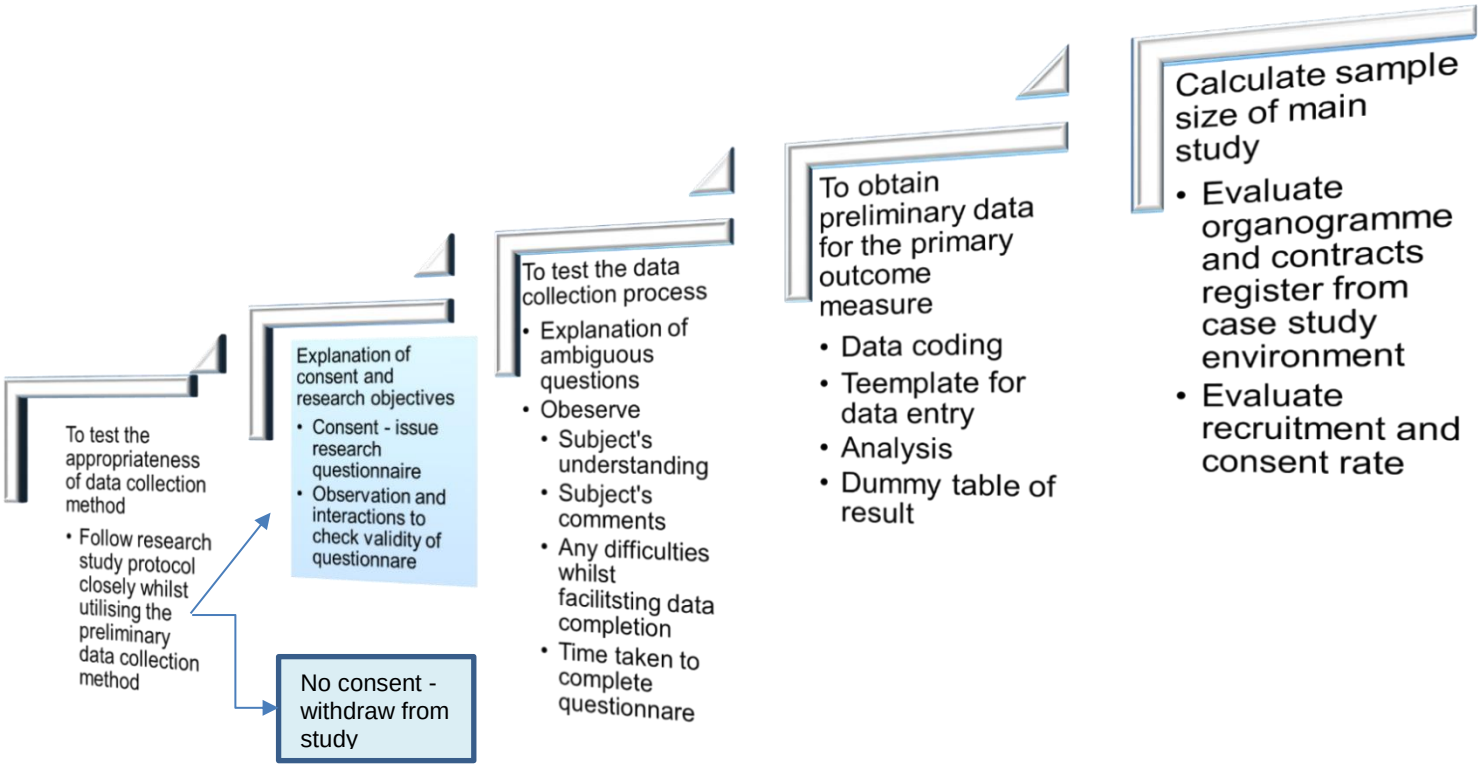


Figure 4-1: Pilot Study process flow

4.1.4 Participants

The intended population of the study was determined by making use of the municipal organogram as well as the contract register of serviced providers. During the pilot study, only the senior managers and the middle managers identified in the organogram were interviewed. Due to the small population size of these positions, the entire population group was sampled. The direct respondents in these positions who were participants in the pilot trial would not be eligible to take part in the complete study. This is done to limit influence from having previously participated as the completion of the previous questionnaire may have triggered them to research further on the subject matter. Participants for the main study would be taken from the remainder of the population in the targeted groups.

4.1.5 Procedure

The pilot questionnaire was administered through face-to-face interviews with participants and the researcher asked structured questions to the participants the researcher was able to offer clarity if some questions were clarity was sought by the participants. The researcher used observation techniques to determine the willingness of the participants as well as their attitude towards the questions being asked.

The results of the pilot study informed the procedure going forward on whether the researcher proceeds with face-to-face interviews or whether a self-completed questionnaire would be more suitable.

The participants were advised of the choice to pull out at any point throughout the study and participants continued completing the questionnaire at their discretion. The procedure as outlined in the process flow in section 4.1.3 was utilized.

4.1.6 Outcomes

The following outcomes were expected as outputs from the pilot study:

a. Decision on the data collection method

b. Revised data collection tool

c. Preliminary finding for the main study objectives

d. Estimate the main study's sample size

4.1.7 Outcome measure

The main study would be feasible if the participation rate of the pilot study exceeds 90% of the targeted participants. To determine the feasibility of the study protocol, the provisional study protocol was strictly adhered to and deductions from the data

analysis and observations made during the face-to-face interviews would be utilized to conclude in line with the objectives of the pilot study.

Upon interacting with the study participants, the researcher had an opportunity to refine the questions in the study questionnaire to eliminate confusion and ambiguity, this resulted in a revised questionnaire for the main study. To determine the sample size, the use of the municipal organograms as well as the contracts register for the enlisted service providers in each of the case study municipalities was made.

4.2 DATA COLLECTION

4.2.1 Case study environment

To understand the contextual environment in which the case study municipalities operate, it is important to go over the environment under which municipalities operate.

The Republic of South Africa is located on the African continent's southernmost tip. It is bordered on the north by Namibia, on the north by Botswana and Zimbabwe, and on the east by Mozambique. The country is organized into local municipalities, allowing for localized governance. Every municipality has a council that takes decisions, as well as municipal officials and workers who carry out the duties of the municipality.

Local ordinances and bylaws are voted on by the council, which is made up of elected members. The municipality's budget must be passed by the council every year. They must also make decisions about the development and delivery of services in their municipal areas. A mayor, who is elected by the council, oversees the council's operations. A councillor-led executive or mayoral committee backs up the mayor. The mayor, jointly with the mayoral executive, supervises the work of the municipal manager as the accounting officer and that of the heads of department.

The municipality’s management, headed by the accounting officer, manages the municipality's operations. S/he oversees hiring and supervising staff to complete all projects approved by the council. All national departments and their provincial equivalents keep their policy-making and regulatory responsibilities, which include governance, administration, planning, projects, and operations, and cover the entire spectrum of municipal activity. Furthermore, the constitutional ability of departments and provinces to intervene directly in municipal matters is preserved (Republic of South Africa 1996).

4.2.2 Municipal engineering function

According to the Department of Provincial and Local Government (2004), the municipal infrastructure engineering function is premised on the following principles:

a. Concentrate on the infrastructure necessary to provide a basic level of service.

b. Targeting the poor by directing funds to services targeting this group.

c. Equity in the distribution and use of money to make uniform progress in bridging the infrastructure gap.

d. Maximizing economic benefits by ensuring that local economic spin-offs from infrastructure provision are maximized.

e. Efficient use of money by ensuring that monies are used to offer the greatest feasible improvement in basic service access at the lowest possible cost.

f. Decentralization of spending authority within national standards by making decisions at the local level about municipal infrastructure spending priorities, such as project identification, selection, and approval.

g. Reinforcing local, provincial, and national development objectives

h. Predictability and transparency in the carrying out of the planning and delivery process to ensure accountability.

The major objectives of the municipal engineering role, considering the concepts mentioned above, are to:

a. Fully subsidize the capital expenses of delivering basic services to poor families: this means that addressing poor households' fundamental infrastructure demands, such as providing suitable bulk, connection, and internal infrastructure in critical services, must be prioritized;

b. distribute municipal infrastructure financing in a fair, transparent, and efficient manner, promoting a coordinated approach to local development and maximizing development outcomes;

c. support multi-year planning and budgeting mechanisms to offer a vehicle for the coordinated pursuit of national policy priorities on fundamental municipal infrastructure initiatives while minimizing duplication and inefficiency; and

d. establish a platform for the coordinated pursuit of national policy priorities related to fundamental municipal infrastructure programs, while minimizing duplication and inefficiency.

4.2.3 Ingquza Hill Local Municipality

4.2.3.1 Municipal background

The Ingquza Hill Local Municipality (IHLM) municipal IDP for 2019/20 financial year (Ingquza Hill Local Municipality 2019) gives the following background for the municipality:

The O.R. Tambo District Municipality has jurisdiction over five local municipalities, including Ingquza Hill Local Municipality. The municipality is bordered on the north by Mbizana Local Municipality, on the south by Port St Johns Local Municipality, and on the west by Ntabankulu Local Municipality, Nyandeni Local Municipality, and on the east by the Indian Ocean. The magisterial areas of Lusikisiki and Flagstaff are included. Ingquza Hill has a surface area of 2477 km^2 and a population density of 112,4 people per square kilometre. According to the Community Survey, the municipal territory is divided into 32 wards and has a total population of 303 379 people (Statistics South Africa (Stats SA) 2016). Figure 4-2 below reflects the settlement distribution for the Ingquza Hill Local Municipal jurisdiction.

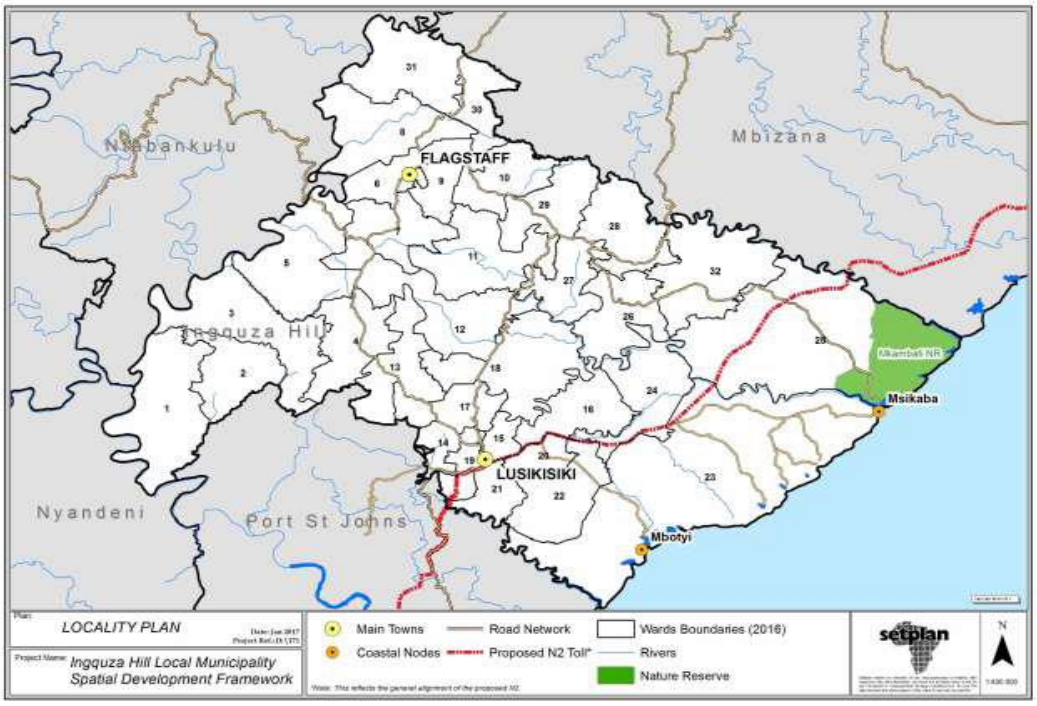


Figure 4-2: Map showing settlement distribution

Source: Ingquza Hill Local Municipality (2019)

4.2.3.2 Size and Distribution of the Population

According to the Community Survey by Statistics South Africa (2016), the overall population of the Ingquza Hill Local Municipality is 303 379, with females making up 160 549 and males 142830, up from 278 481 in 2011. Between 2001 and 2011, the population of South Africa expanded by roughly 7 million to 51,770,560 people (Statstics South Africa 2011). The country's population is young, with more than half of the people under the age of 39. There are 160 549 females and 142 830 males in

the population. 41,000,938 people (79.2%) are black, 4,615,401 are coloured, 1,286,930 are Indian or Asian, and 5,586,838 people (9.6%) are white.

4.2.3.3 Situational Analysis

Personnel within the Civil Engineering discipline reside within the technical services department. The department has three units and is responsible for the provision of roads, buildings, social amenities as well as electrification. The municipality does not hold a distribution license, thus its structure is limited to the project management function which carries out electrification on the Eskom network. Due to the focus of this research being on the Civil Engineering function, a deeper look was therefore taken in the units within the Technical Services directorate which provide services within the Civil Engineering discipline.

When examining the municipal organisational structure, one can see that the civil engineering function is spread within the Project Management Unit (PMU) and the Technical Management Unit (TMU). Further details on this can be seen in Figure 4-3 reflecting the organisational structure. The PMU seems to be structured in such a manner that it deals with construction of new roads, sports facilities, and community halls as per the current projects reflected in the municipality's three-year capital plan. The TMU seems to focus on the maintenance of existing infrastructure. The capital funding seems to be a combination of own revenue and conditional grants allocated to the municipality. The current grants funding the municipality are the Municipal Infrastructure Grant (MIG) and the Small-Town Revitalisation (STR) Programme funded by the Office of the Premier (OTP). Current projects that are planned for implementation are as follows:

4.2.3.4 Municipal infrastructure provisions

The municipal project implementation plan reflects a budget of R54 506 000 for infrastructure projects over the 2019/20 financial year. The three-year capital plan reflects planned infrastructure projects to the value of R63 644 000 and R68 920 000 for the 2020/21 and 2021/22 financial years respectively. These budgets are based on grant allocations due to the municipality having a low revenue base. The municipal infrastructure backlogs in terms of infrastructure provision are high relative to the budget allocations and are reflected in the municipal IDP for 2019/20 are reflected in Table 4-1 as follows:

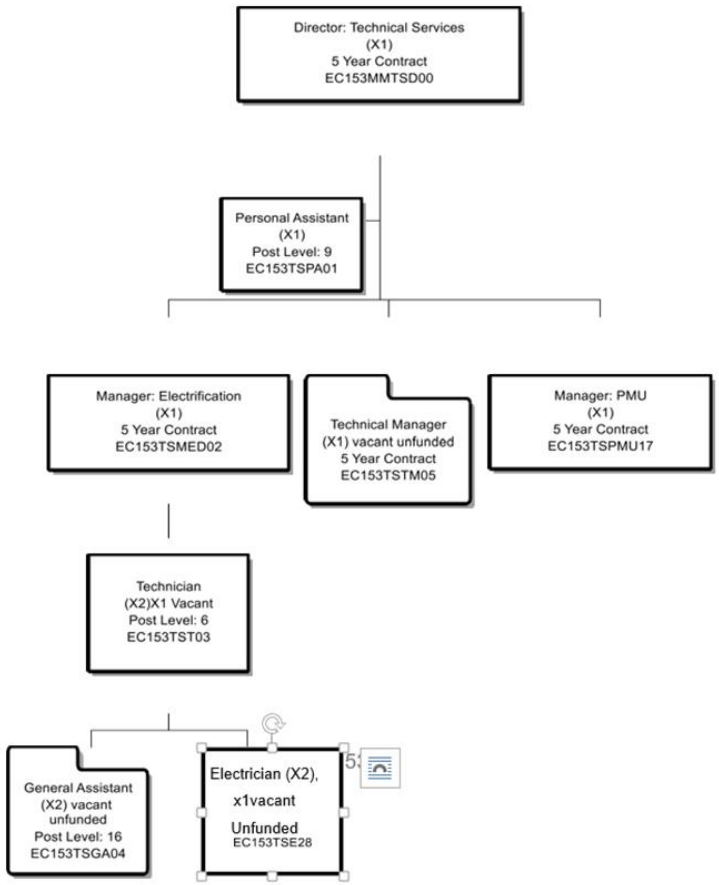
Table 4-1: IHLM municipal infrastructure backlogs

CATEGORY	BASELINE	BACKLOGS	%	SERVED	%	ANNUAL TARGET
Electricity(H/H)	56213h/h	5000h/h	9%	51213/h	91%	550h/h
Access Roads(km)	981,35km	203.69km	21%	777,67km	79%	56,8km
Surfaced roads (km)	26km	15km	58%	8km	42%	7km
Sports fields(No.)	32	28	88%	4	12%	1
Community Halls(No.)	34	4	12%	30	88%	4

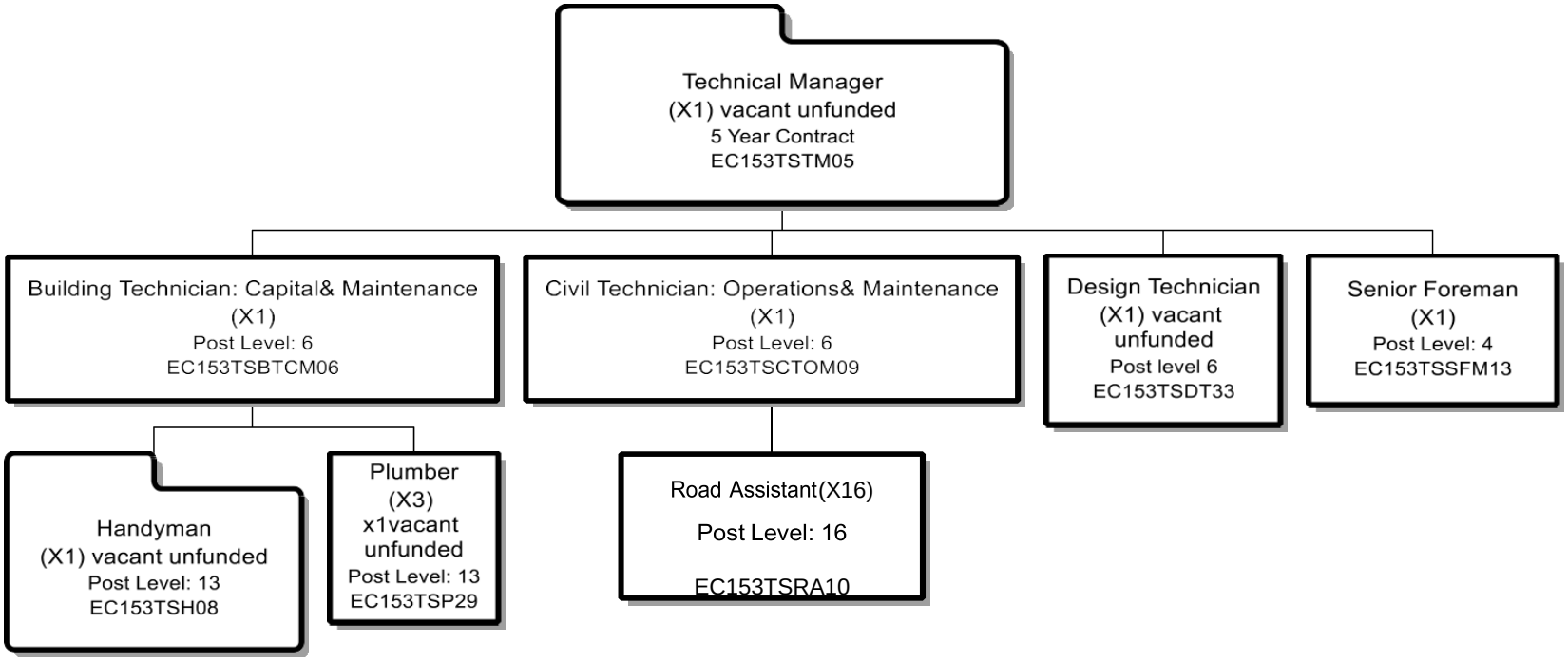
Source: Ingquza Hill Municipal Report (2019)

The organizational structure is as follows:

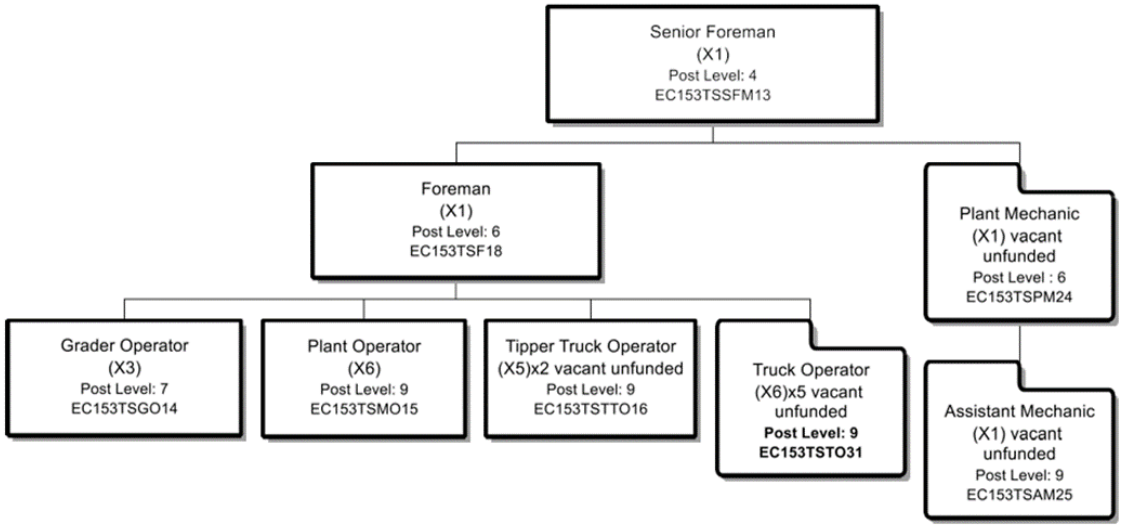
INGQUZA HILL LOCAL MUNICIPALITY: ORGANISATIONAL STRUCTURE: THE YEAR 2019/20 DEPARTMENT: TECHNICAL SERVICES



INGQUZA HILL LOCAL MUNICIPALITY: ORGANISATIONAL STRUCTURE: THE YEAR 2019/20DEPARTMENT: TECHNICAL SERVICES: CIVIL AND BUILDING



INGQUZA HILL LOCAL MUNICIPALITY: ORGANISATIONAL STRUCTURE: THE YEAR 2019/20 DEPARTMENT: TECHNICAL SERVICES: PLANT UNIT



INGQUZA HILL LOCAL MUNICIPALITY: ORGANISATIONAL STRUCTURE: THE YEAR 2019/20
TECHNICAL SERVICES: PROJECT MANAGEMENT UNIT

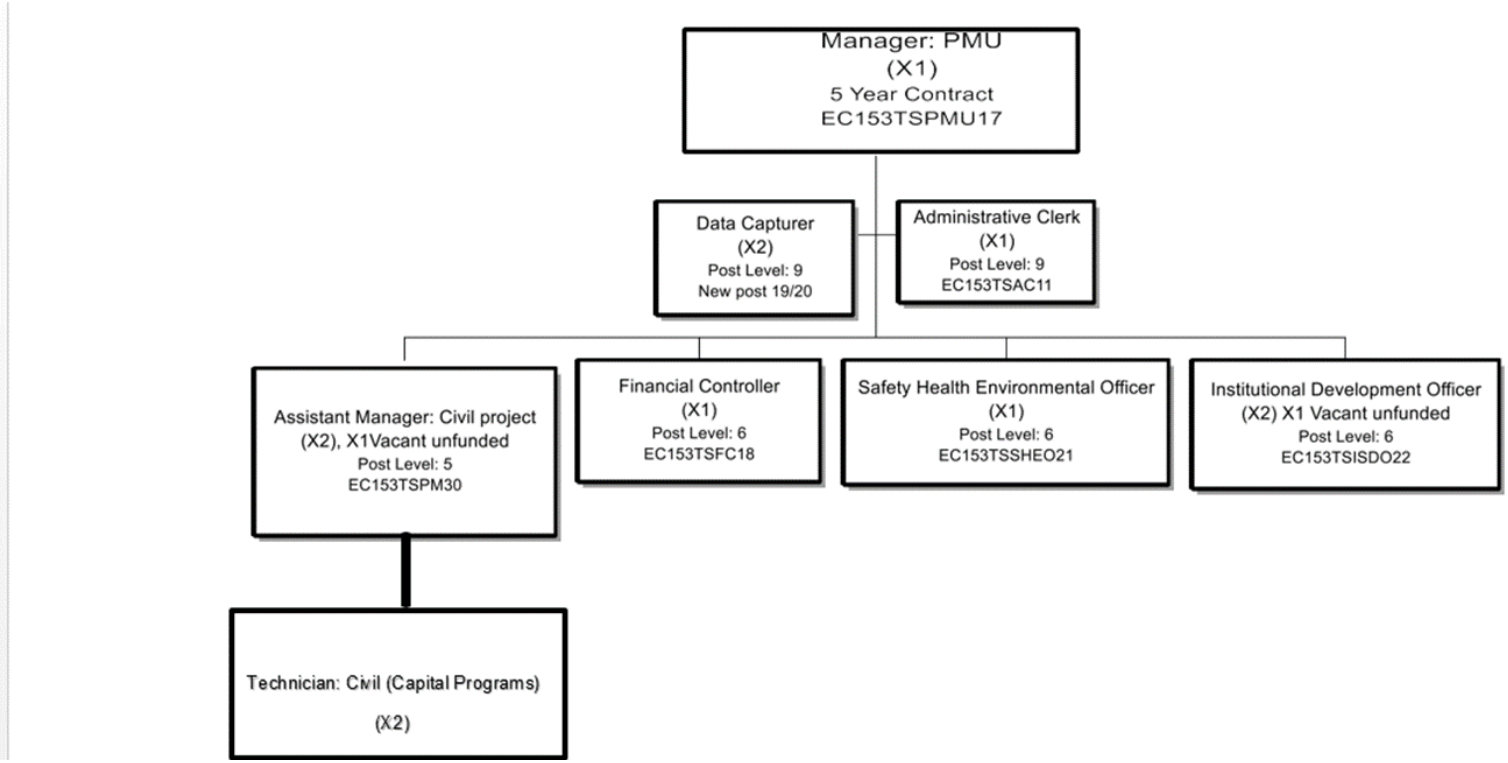


Figure 4-3: Ingquza Hill Technical Services Organogram

Source: Ingquza Hill Local Municipality (2019)

4.2.4 Elundini Municipality

4.2.4.1 Municipal Background

The Elundini Municipal Area is found in the Joe Gqabi District, in the Province of the Eastern Cape's north-eastern region. Lesotho and Senqu Municipality to the west, Chris Hani District Municipality to the south, O.R. Tambo District Municipality to the east, and Alfred Nzo District Municipality to the north define the municipality.

Matatiele and Umzimvubu to the northeast, Ntabankulu to the east, Mhlontlo to the southeast, Sakhisizwe to the southwest, and Senqu to the west border Elundini LM. Because Elundini is in the District Municipality, the towns in Elundini LM are closer to external regional hubs like Mthatha and Matatiele than the towns in the District Municipality (i.e., Aliwal North) according to the Community Survey (Statistics South Africa 2016). The settlement distribution for the Elundini area is reflected in Figure 4-4 below.

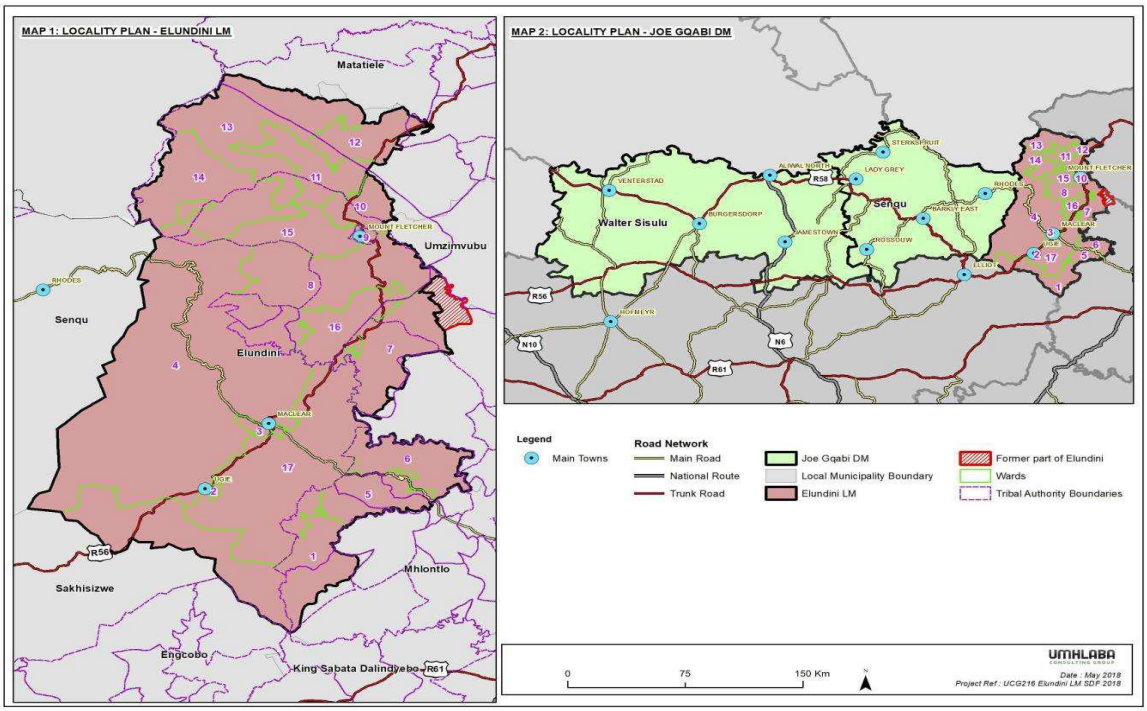


Figure 4-4: Elundini Map showing settlement distribution

Source: Elundini Municipality (2019)

4.2.4.2 Population Size and Distribution

According to the Community Survey released by Statistics South Africa (2016), the Elundini Local Municipality is the most populous in the Joe Gqabi district with an estimated population of 144 929 an increase of 6 788 people, amounting to 4, 7%, from the Census 2011 figures of 138 141 people. The largest population of Elundini is made up of females who constitute 60, 9% (88 247) of the total population, and males constitute 39, 1% (56 682) of the total population.

The ELM is one of the most scenic and attractive areas of the province, with considerable potential lying in its deep, fertile soils and high rainfall but is still largely rural. Due to its relative wealth of natural resources, Elundini has the potential to grow and improve the quality of life for its citizens in comparison to the other municipalities in the Joe Gqabi District (Elundini 2019).

4.2.4.3 Situational Analysis

Personnel within the Civil Engineering discipline reside within the Infrastructure Planning and Development Directorate. The directorate has three units and is responsible for the provision of roads, buildings, social amenities as well as electrification. The municipality holds an electricity distribution license for only two of its three towns, i.e. Ugie and Maclear. In the third town of Mt Fletcher, its function is limited to the project management function which carries out electrification on the Eskom network, and assets are eventually handed over to Eskom for maintenance upon completion. Due to the focus of this research being on the Civil Engineering function, a deeper look was therefore taken in the units within the Infrastructure Planning and Development directorate which provide services within the Civil Engineering discipline.

When examining the municipal organizational structure, one can see that the civil engineering function is spread within the Project Management Unit (PMU) and the Building and Civil Works unit (BCW). The PMU seems to be structured in such a manner that it deals with the construction of new roads, sports facilities, and community halls as per the current projects reflected in the municipality's three-year capital plan. The BCW seems to focus largely on the maintenance of existing infrastructure but undertakes some capital projects aimed at the revitalization of infrastructure. The capital funding seems to be a combination of own revenue and conditional grants allocated to the municipality. The current grants funding the municipality are the Municipal Infrastructure Grant (MIG) and the Small-Town Revitalisation (STR) Programme funded by the Office of the Premier (OTP). Current projects that are planned for implementation are as follows.

4.2.4.4 Municipal infrastructure provisions

The municipal project implementation plan reflects a budget of R67 948 000 for infrastructure projects over the 2019/20 financial year. The three-year capital plan reflects planned infrastructure projects to the value of 68 597 000 and 72 152 000 for the 2020/21 and 2021/22 financial years respectively. These budgets are based on grant allocations due to the municipality having a low revenue base.

The municipal infrastructure backlogs in terms of infrastructure provision are high relative to the budget allocations and are reflected in Table 4-2 below as extracted from the municipal IDP for 2019/20.

Table 4-2: Elundini Municipality Backlogs

Service	Municipal Baseline (Total HH)	Access To Date	Access to Date (%)	Backlog to Date	Backlog to Date (%)
Electricity (h/h)	42981 h/h	23221 h/h	54%	19760 h/h	46%
Access Roads (km)	750 km	525 km	70%	225 km	30%
Surfaced Roads	29.7 km	29.7 km	100%	0km	0%
Community Halls (No.)	17	6	35%	11	65%
Sports Facilities (No.)	17	4	24%	13	76%

Source: Elundini Municipality 2019

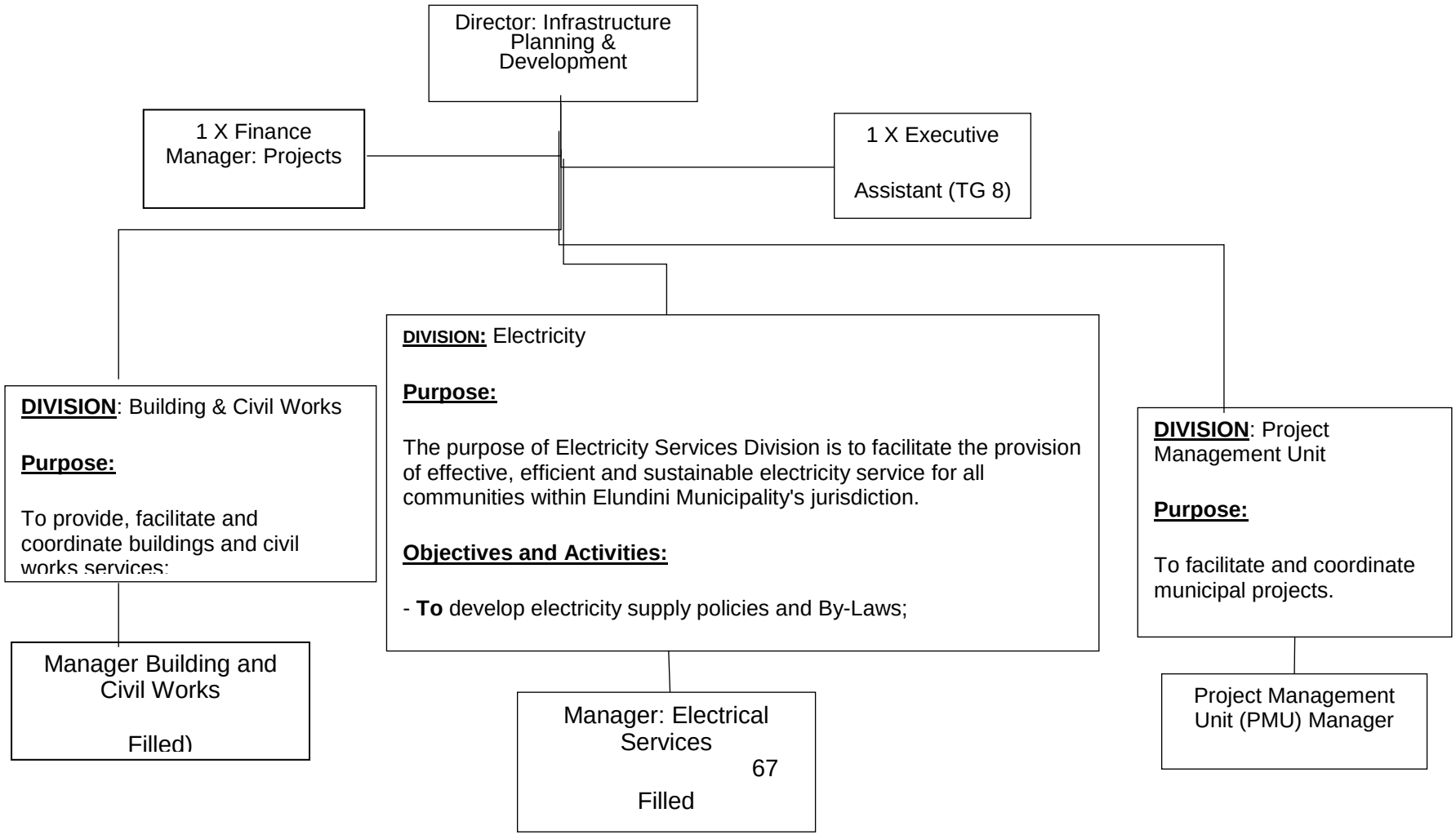
4.2.4.5 Organisational structure

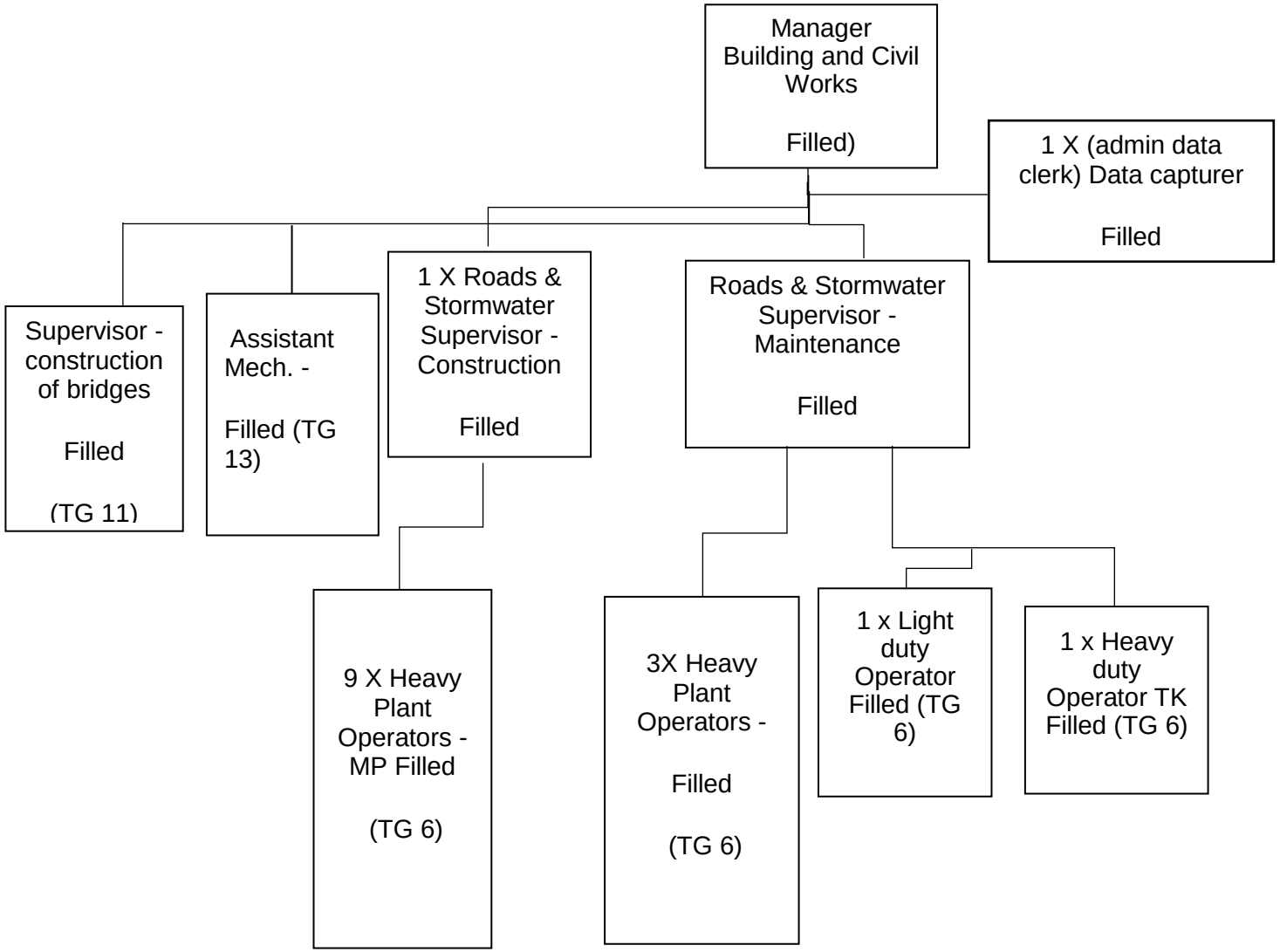
The organisational make up is reflected in Figure 4-5 below.

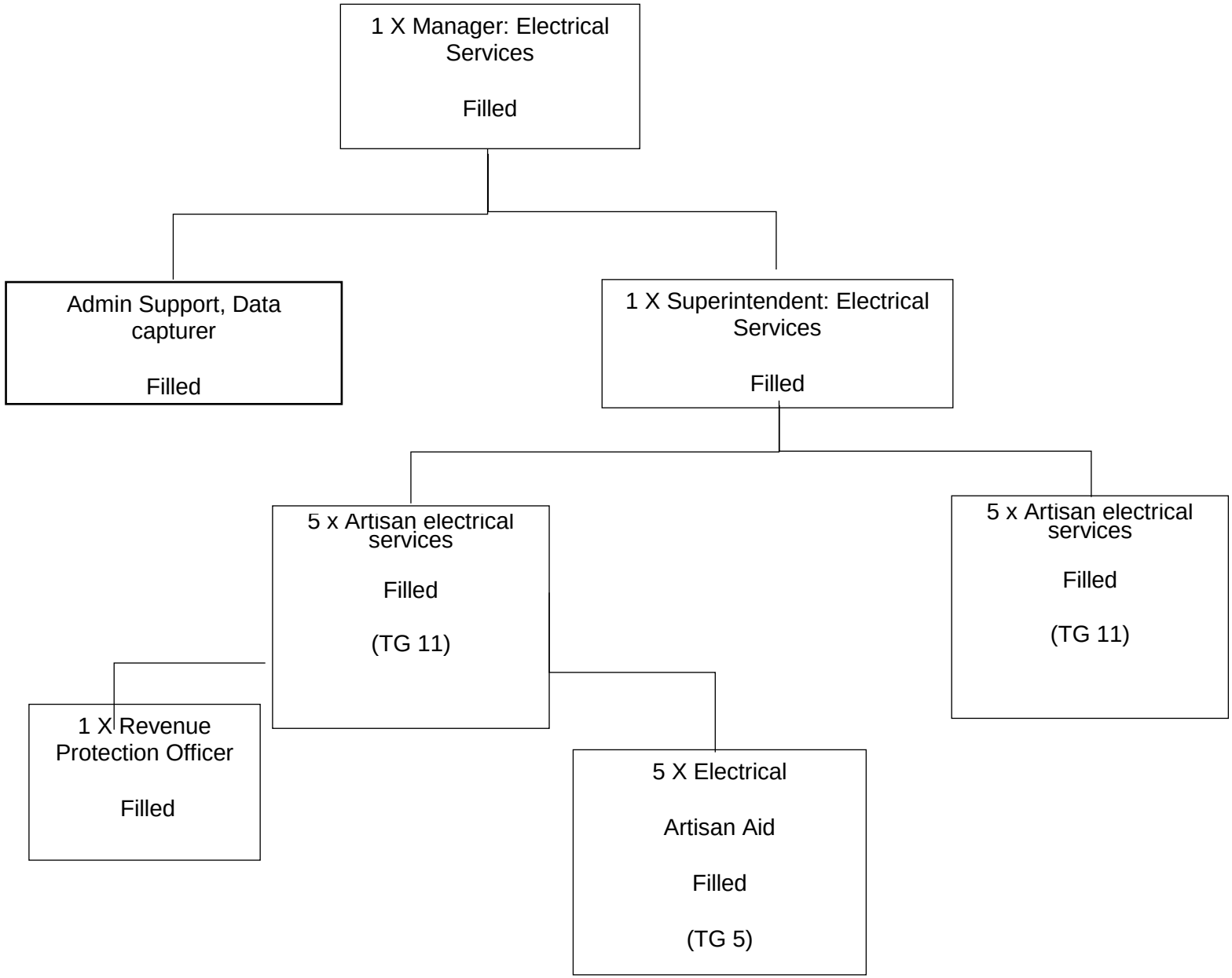
DEPARTMENT: INFRASTRUCTURE PLANNING & DEVELOPMENT

Purpose:

To plan, develop, operate and maintain infrastructure




Manager Building and Civil Works
Filled)
1 X (admin data clerk) Data capturer
Filled
Supervisor - construction of bridges
Filled
(TG 11)
Assistant Mech. -
Filled (TG 13)
1 X Roads & Stormwater Supervisor - Construction
Filled
Roads & Stormwater Supervisor - Maintenance
Filled
9 X Heavy Plant Operators - MP Filled
(TG 6)
3X Heavy Plant Operators -
Filled
(TG 6)
1 x Light duty Operator Filled (TG 6)
1 x Heavy duty Operator TK Filled (TG 6)


1 X Manager: Electrical Services
Filled
Admin Support, Data capturer
Filled
1 X Superintendent: Electrical Services
Filled
5 x Artisan electrical services
Filled
(TG 11)
5 x Artisan electrical services
Filled
(TG 11)
1 X Revenue Protection Officer
Filled
5 X Electrical
Artisan Aid
Filled
(TG 5)

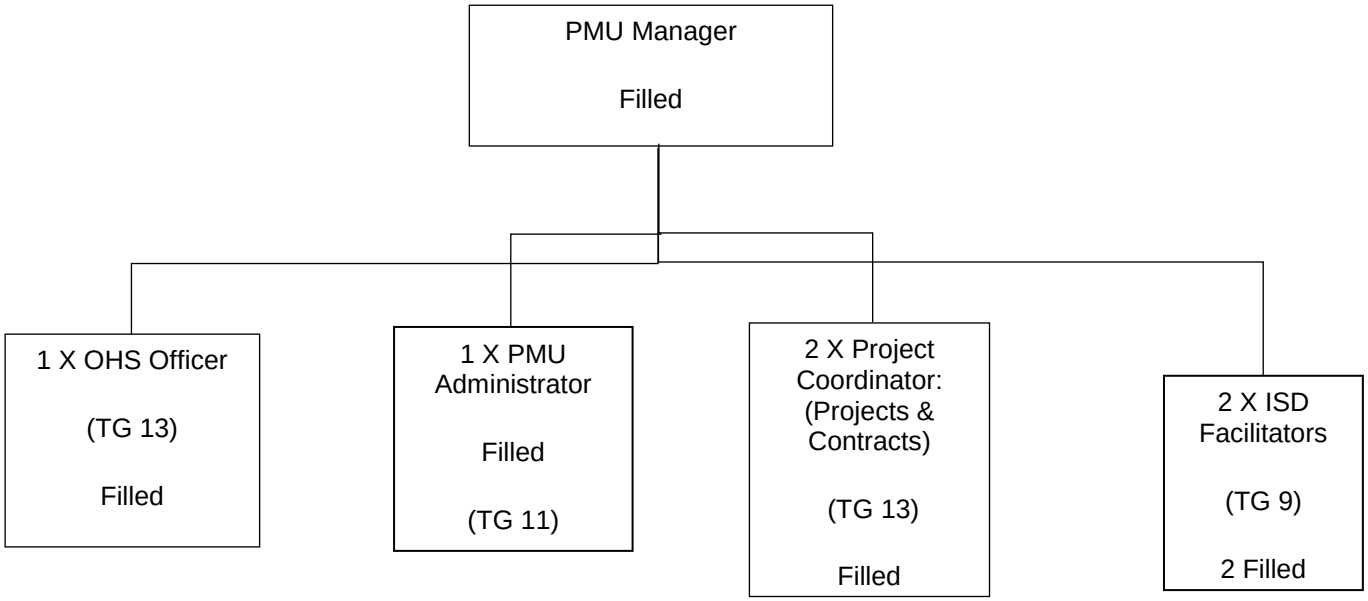


Figure 4-5: Elundini Technical Services Organisational Structure

Source: Elundini Municipality 2019

4.3 COLLECTION PROCESS

In preparation for the pilot study, the researcher obtained the municipal organizational structures for both case study municipalities. The criteria for inclusion in the pilot study was that the positions must be within senior or middle management within the employ of the municipality. The respondents should be practicing within the civil engineering discipline, which meant that senior managers falling outside this category of engineering were excluded from the study. The following positions met the criteria for inclusion in the pilot study as displayed in Table 4-3 below.

Table 4-3: Pilot study population

Position level	Title of position	Ingquza Hill Local Municipality	Elundini Municipality
Senior Manager	Director: Technical Services / Infrastructure	1	1
Middle Manager	Manager: Project Management Unit	1	1
	Technical Manager / Manager Building and Civil Works	1	1
	Assistant Manager: Civil Project	1	No equivalent on organogram
	Technician Operations and Maintenance	2	2
	Design Technician	1	No equivalent on organogram
	Senior Foreman	1	No equivalent on organogram
	Project Manager / Technician Civil	2	2
	Foreman	1	3

Total population	11	10

A total population of 21 participants was therefore identified from the municipal organograms for inclusion in the pilot study.

Based on Leedy et al. (2014) as detailed in section 3.4.2 of this study, the entire population was sampled, except the position of the Director: Infrastructure for Elundini Municipality which is currently filled by the researcher.

Face-to-face interviews were scheduled with the respondents and were conducted on a one-on-one basis with the researcher upon the availability of the participants.

Before commencement of the interviews for the pilot study, the final version of the revised questionnaire, the invitation letter, and the informed consent form was distributed to the participants. During this session, the researcher explained voluntary consent and outlined the research objectives. All participants chose to participate in the study and completed their consent forms. Participants were further advised that they could withdraw consent at any point during the study. The background process and explanation of the research objectives took on average 15 minutes when considering the questions asked by participants, which were specifically on the expected outputs for the research and how the data would be processed to secure anonymity. Participants had no objections in giving written consent but were opposed to the recording of interactions during the interview process.

There were three sections to the questionnaire, which were: demographic details, questions on ethics, and a section on improvement of service delivery. Section one had twelve (12) questions, section two had forty-two (42) questions whilst section three had seven (7) questions.

On average, 20 minutes were taken to complete the research questionnaire by the respondents. There were a few questions of clarity during the data collection process on questions the participants felt were not phrased properly and these were noted for further modification. Participants were generally easy-going when it came to answering general questions on demographics as well as questions that required rating. There was resistance noted on questions where participants were asked to provide their answers and limited responses were received in this regard as can be observed from the completed questionnaires.

During the planned session at Ingquza Hill, some of the targeted interview participants were not available and the interviews for the outstanding participants were postponed to a later date upon confirmation of the participants' availability. The interviews at Elundini were scheduled and occurred as planned with all participants

who had been identified as being present at the first contact session. The distribution of the questionnaires in the face-to-face interviews reduced the possibility of having the questionnaire not being returned by the participants. All completed questionnaires have been filed for record-keeping with completed consent forms of the pilot study participants.

There are two means for calculating the study recruitment rate, these being the Average Recruitment Rate (ARR) as well as the Mean Recruitment Rate (MRR). The ARR of a study is calculated by looking at all recruited patients, summing them up, and dividing by the number of sites where recruitment took place. Even though this method is quite popular among feasibility researchers, some experts have deemed this technique inaccurate since it combines the performance of high-performing sites and low-performing sites, thus not being truly reflective of how low-performing sites affect the recruitment of participants. The MRR of the study is when is established by listing all the median for the participants' recruitment.

The study recruitment rate for the pilot study is calculated as the eligible number of participants as per the identified positions in the organogram versus the number of participants that partook in the study in each case study municipality. The ARR is represented by a total of 20 participants who took place divided by the identified 21 participants, which translates to a recruitment rate of 95% of the intended participants. The MRR is reflected in Table 4-4 below:

Table 4-4: Average participants per site

Site reference	Number of eligible participants	Number of participants who partook in the study
Ingquza Hill LM	11	11
Elundini LM	10	9
Average Participants per site		10

The study has a high recruitment rate since one-on-one interviews for recruitment were conducted, giving the participants ample information and opportunity to interrogate the information provided on the research. The study's recruitment rate was further improved since participants were given ample information and the

opportunity to interrogate the information provided on the research before providing consent.

In addition to the recruitment rate, researchers also need to establish the response rates for their study. The main risk with response rates is that they can inject nonresponse bias into a study's conclusions. What if only those with strong feelings about your research topic fill out questionnaires? If this is the case, we may find that our findings do not accurately reflect reality or, at the very least, that the assertions we can make about patterns found in our data are limited. While high response rates are desirable, recent research suggests that concerns about response rates may be exaggerated (Langer 2003).

Study response rates fluctuate, and researchers do not fully agree on what can be deemed an adequate response rate. In some cases, having three-quarters of the surveys returned would be considered good, even excellent, by most survey researchers whilst in other research this may be deemed inadequate. The importance of the response rates is established per study based on its impact on the validity of the findings.

The response rate for this research is calculated by considering the number of completed questionnaires received back from respondents divided by the number of questionnaires distributed reflects the response rate for the study. This number is then converted into a percentage format. The response rate based on the issued (20) and returned (20) questionnaires is calculated at 100% since all questionnaires that were distributed were returned.

The study has a high response rate since one-on-one interviews for the questionnaire completion were conducted, giving the researcher adequate opportunity to collect the completed questionnaires. This also minimized the waiting time required for the return of questionnaires.

Missing values in questionnaires are avoidable even though their presence is not preferable. This is because some of the respondents had a limited knowledge of some of the questions given as well as the ideas being investigated. The questionnaire was created in such a way that responders would have the option to choose the “unsure” option instead of rating a question incorrectly. The researcher was also available to provide clarity and a better understanding of the questions to eliminate ambiguity but this did not eliminate the presence of unsure answers.

4.4 DATA ANALYSIS

4.4.1 Demographic information

General demographic information inclusive of age, gender, employment or educational status, religious and professional affiliations was recorded on a specifically designed and standardized questionnaire to reflect a basic profile of the pilot study population. From the findings, it is clear that there were youth, gender and ethnic imbalances in the demographic profiles which reflects that there may be no targeted recruitment in these municipalities since the entire population had been used in the study.

4.4.1.1 Age

Respondents partaking in the pilot study were found to be predominantly in the age group thirty and thirty-nine years of age (65%) in the population investigated. Respondents between the age of fifty to fifty-nine years of age and sixty and older were tied at (15%) of the population respectively whilst only 5% was in the forty to forty nine years of age category. As a result, it may be inferred that responders to the pilot research were mature, had a high likelihood of being responsible, and had adequate industry experience. It is clear that the sample was skewed with an overrepresentation of younger respondents, since the sample was based on the entire population, the results cannot be modified further but these will hopefully be more balanced during the main study.

The following information in Table 4-5 reflects the age frequencies for the pilot study.

Table 4-5: Age Frequency Table

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	30-39 years	13	65.0	65.0	65.0
	40 - 49 years	1	5.0	5.0	70.0
	50-59 years	3	15.0	15.0	85.0
	60 and older	3	15.0	15.0	100.0
	Total	20	100.0	100.0	

4.4.1.2 Gender

The respondents partaking in the study were predominantly male with 85% of the respondents being males and the remaining 15% being of the female gender. This came as no surprise due to the industry being investigated having historically been a male discipline, but it did reflect that significant progress was being made though it cannot be confirmed whether this was a result of targeted practices. The gender distribution (as can be seen in Table 4-6) was however not consistent with the demographic profile of both municipalities which seemed to be predominantly female (52.9% for Ingquza Hill and 60, 9% for Elundini). This is captured in Table 4-6 below. As can be seen, the gender distribution is skewed towards males which is also consistent with the general notion that engineering is a male dominated fraternity. According to a recent report tabled by ECSA less than a quarter of candidate engineers in South Africa are women. More worryingly, when it comes to professional engineers in South Africa, only 6% are women. ECSA had revealed previously that nearly 70% of these women engineering degree holders left the engineering profession because of the workplace climate. Specifically, the recent women engineering graduates “felt isolated in their jobs” (SAICE 2021).

Table 4-6: Gender Frequency Table

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	17	85.0	85.0	85.0
	Female	3	15.0	15.0	100.0
	Total	20	100.0	100.0	

The distribution of males to females in both municipalities was comparative as reflected in Table 4-7 below.

Table 4-7: Gender cross-tabulation

Gender * municipality Cross tabulation

Count

		Name of municipality		
		Ingquza Hill	Elundini	Total
Gender	Male	9	8	17
	Female	2	1	3
Total		11	9	20

4.4.1.3 Employment equity status

The employment equity status of the respondents partaking study was primarily black African, with respondents in this group sitting at 95% of the population whilst the remaining 5% was white. This was reflective of the population data of both sampled case study municipalities. The demographic profile from Ingquza Hill municipality is racially homogeneous, with more than 99 percent of the population being black African. Coloured, White, and Indian racial groupings make up the remaining 1% of

the population (Elundini Municipality 2020). According to the Statistics South Africa (2016) Community Survey, Black Africans make up a significant portion of Elundini's population (135 593), accounting for 98.01 percent of the total population. 1 323 Coloureds (1%) and 172 Asians make up the remaining 1.09 percent (2 580). (0.01 percent) In the other group, 903 Whites make up 0.07 percent of the population, while 183 people make up 0.01 percent (Statistics SA 2011). A reflection the actual racial distribution of study participants is given in Table 4-8 below and it is in stark contrast of the demographical data of the municipalities, indicating that targeted recruitment may not be present in the case study environment.

Table 4-8: Employment Frequency Table

Employment equity status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	African Black	19	95.0	95.0	95.0
	White	1	5.0	5.0	100.0
	Total	20	100.0	100.0	

4.4.1.4 Religion

Five percent of the respondents in the pilot study reflected that they had no adherence to any religion which corresponded to the 5% of respondents that showed that religion had no importance to them. The remainder of the respondents who showed the affiliation to religion were classified according to their religious groups which fell largely within the Christian denominations. Demographic analysis in terms of religion is given in Tables 4-9 to 4-11.

Table 4-9: Religion Frequency Table

Religion

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Catholic	6	30.0	30.0	30.0
	Protestant	5	25.0	25.0	55.0
	Evangelical	1	5.0	5.0	60.0
	Other	7	35.0	35.0	95.0
	Non Adherent to any religion	1	5.0	5.0	100.0
	Total	20	100.0	100.0	

Table 4-10: Importance of religion

Importance of religion

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very High importance	5	25.0	25.0	25.0
	High importance	5	25.0	25.0	50.0
	Moderate importance	9	45.0	45.0	95.0
	No importance	1	5.0	5.0	100.0
	Total	20	100.0	100.0	

Religion can help people establish an ethical framework and manage their values in everyday life. This method assists in the development of a person's personality. To put it another way, religion serves as a catalyst for socialization (Iyer 2018). The respondents in the study seemed to echo these sentiments in that 30% of the

respondents reflected that religion had very high or high importance to them. Sixty-five percent of the respondents indicated that religion held moderate importance to them, with only 5% of the respondents who indicated that religion had no importance to them as captured .

Table 4-11: Mean importance of religion

Report

Importance of religion

Religion	Mean	N	Std. Deviation
Catholic	2.00	6	1.095
Protestant	2.60	5	1.517
Evangelical	3.00	1	.
Other	2.29	7	.756
Non Adherent to any religion	3.00	1	.
Total	2.35	20	1.040

4.4.1.5 Position within the organization

The population for the pilot study was limited to employees of the two case study municipalities who were employed in senior and middle management. For the study, the senior manager were the heads of departments for infrastructure or technical services wherein civil engineering works were being carried out for the municipality. Further to this, middle managers held various positions such as managers reporting directly to the head of the department as well as other supervisory employees who had various positions within the department such as technicians, project managers, and foremen. The respondents of the study were predominantly permanent employees, with only 10% of the population being on a fixed contract. Table 4-12 gives a reflection on the period of participants within the organisation.

Table 4-12: Position in the organization Frequency Table

Position

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Permanent Position	18	90.0	90.0	90.0
	Contract Position	2	10.0	10.0	100.0
	Total	20	100.0	100.0	

Staff turnover can have both beneficial and negative effects on a business. Positive worker turnover is important for an organization's growth. When a non-productive employee leaves a company, this occurs. Staff turnover, on the other hand, can be costly to an organization if it results in a loss of human capital investment, intellectual capital, replacement expenses, and productivity loss (Ongori 2007). This frequency is eexpressed in Table 4-13 below.

Table 4-13: Years of experience Frequency Table

Years of experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 1 year	5	25.0	25.0	25.0
	Between 1 and 5 years	5	25.0	25.0	50.0
	Between 6 and 10 years	6	30.0	30.0	80.0

	More than 10 years	4	20.0	20.0	100.0
	Total	20	100.0	100.0	

The results on levels of experience within the organization varied from 1 to 5 years with the predominant respondents being in the categories of one to five years and those with more than ten years within the organization. The statistics for these groups were tied at 25% respectively. Other categories were six to ten years (30%) and the category which had more than ten years within the organization responding at (20%) of the population. These results displayed an adequate spread of experience within the organization which could contribute to retention of institutional knowledge as well as entry of skilled workforce. Figure 4-6 captures the demographics in terms of work experience.

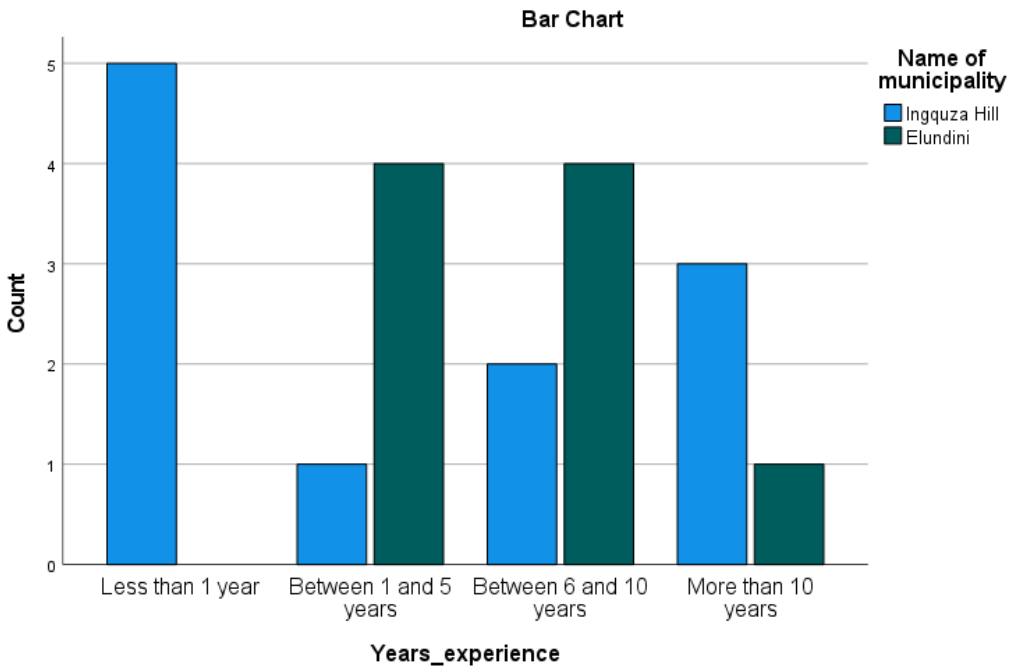


Figure 4-6: Years of experiences

In comparison, Ingquza Hill municipality had a higher proportion of newly appointed staff as opposed to Elundini municipality with a workforce whose experience was more uniformly distributed.

4.4.1.6 Qualification

The respondents in the study had varying levels of education in the Civil Engineering and Built environment. ECSA emphasizes the importance of being suitably qualified and competent to practice in the field and also to perform work at a suitable level of responsibility complementing one's competency. The respondents of the study were found to predominantly (65%) possess a diploma or a degree in the built environment whilst in the remainder of the population 25% had a certificate (TVET qualification). Respondents for lower than matric and a post-graduate diploma were tied at (5%). A tabulation of qualifications for the study participants is given in Table 4-14.

Table 4-14: Qualifications

Qualification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Lower than matric	1	5	5	5
	Certificate	5	25	30	30.0
	Diploma	5	25	25	55
	Btech	8	40	40	95
	Degree (BSc/ BEng)	0	0	0	95
	Post graduate Diploma	1	5	5	100
	Total	20	100.0	100.0	

The regulatory body ECSA has specific educational requirements for admission into registration as a candidate or a professional. These ordinarily require an accredited qualification.

The ECSA policy on registration (2018b) recognizes four methods for meeting the educational requirements before applying for a candidate or professional registration in the applicable category. For people without accredited or recognized qualifications, the procedure for satisfying the educational requirements for registration as a candidate or a professional is defined.

The criteria for acceptable educational requirements to make one eligible for registration with ECSA are as follows:

a. National Diploma
b. Diploma in Engineering
c. Diploma in Engineering Technology
d. Advanced Certificate in Engineering
e. Advanced Certificate in Engineering Technology
f. Bachelor of Technology
g. Bachelor of Engineering Technology
h. Advanced Diploma in Engineering
i. Bachelor of Engineering Technology (Honours)

From the above, it can thus be deduced that 30% of the respondents may not directly hold a relevant qualification making them eligible for registration with the regulatory body but would need to venture into the route for recognition of prior learning to be able to register in any of the recognised categories of registration.

On a municipal level, the Elundini municipality employed more staff with less than the required minimum education competency levels by the regulatory body. Competency to do engineering work is regarded as a crucial element in the ECSA code of conduct and undertaking work that one is not qualified or trained for is regarded as a violation with regards to the conduct of engineering personnel, but the code of conduct is however only enforced to registered persons. A bar chart indicating qualifications for the study participants is given in Figure 4-7.

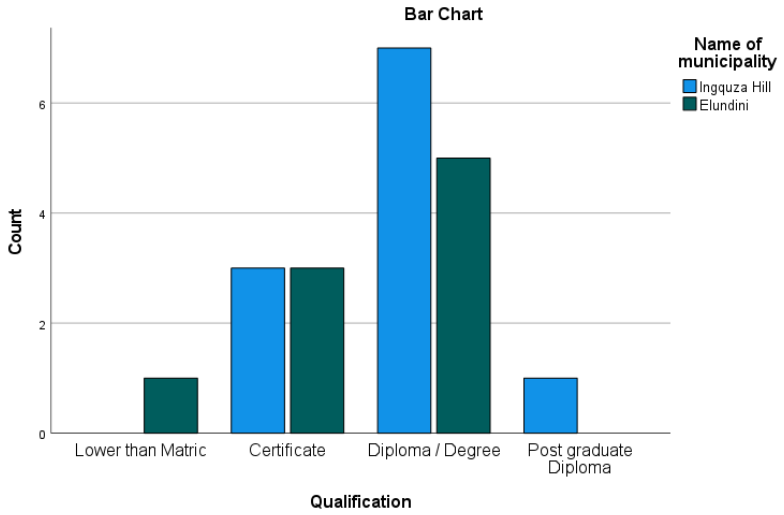


Figure 4-7: Qualifications

4.4.1.7 Professional Affiliation

On a local, regional, and global level, joining a professional association is vital for remaining up to date on the latest knowledge and practices. It assists the professional in staying up to date on current issues and opportunities, as well as assisting the member who becomes active in personal progress (Alibama Board for Registered Interior Designers (ABRID) 2018). The Engineering Profession Act, 2000 (Act No. 46 of 2000) not only does it emphasize mandatory registration, but it also has the full support of a government that insists on protecting the public from unprofessional acts by persons who are not held accountable for their actions (ECSA 2000). 35% of the population for the study population were registered with a professional body. Eleven respondents (55%) respondents did not indicate any affiliation and these can easily be categorised under “No affiliation”. 20% of the respondents indicated that they were registered with ECSA only whilst another 15% indicated they registered with both ECSA as well as with the voluntary association SAICE. The remaining 10% of the respondents reflected that they were registered with SAICE only (5%) and another professional body (reflected as SACPCMP- 5%). No other affiliations were recorded even though the questionnaire made allowance for such. The detailed reflection of Professional Affiliation is given in Table 4-15 below.

Table 4-15: Professional affiliation

Professional Affiliation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	ECSA	4	20.0	44.4	44.4
	SAICE	1	5.0	11.1	55.6
	Both ECSA and SAICE	3	15.0	33.3	88.9
	Other	1	5.0	11.1	100.0
	Total	9	45.0	100.0	
Missing	System	11	55.0		
Total		20	100.0		

In addition to the above, data was collected on the specific registration categories with the regulatory body ECSA. It was deduced that those who had not selected a category of registration fell in the category of no registration, which further increased this category to 70% of the respondents. Candidate technicians were recorded at 20% of the respondents whilst the remaining 10% was comprised of Professional Engineering Technologists. These results are illustrated in Table 4-16.

Table 4-16: ECSA Category of registration

ECSA category of registration

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	14	70.0	70.0	70.0
	Candidate technician	4	20.0	20.0	90.0
	Professional Engineering Technologist	2	10.0	10.0	100.0
	Professional Engineer	0	0	0	100.0
	Total	20	100.0	100.0	

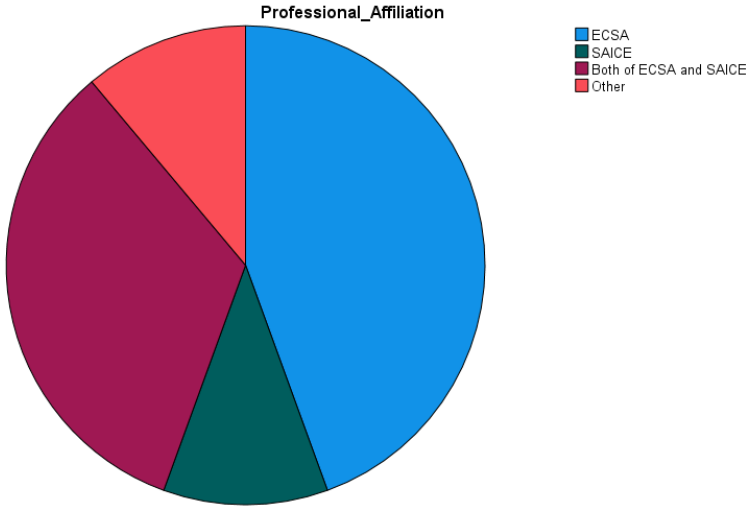


Figure 4-8: Professional affiliation

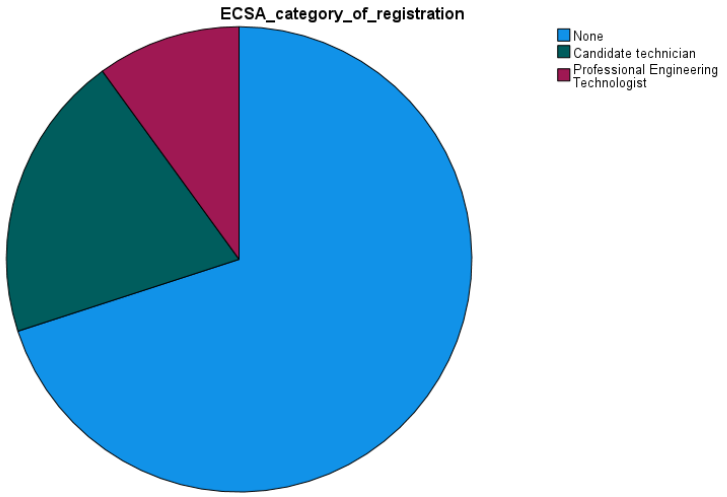


Figure 4-9: ECSA Category of registration

The above Figures 4-8 to 4-9 reflect ratios for registration categories and the regulatory bodies for those who indicated professional affiliations.

In comparison, both municipalities seemed to employ a comparative amount of staff who were similarly registered with a professional body. Ingquza Hill had a higher average of registered personnel than the population since 6 out of 11 (55%) respondents were registered when compared with Elundini where only 3 out of 9 (33%) respondents were registered with a professional body. A reflection of professional affiliation per municipality is captured in Figure 4-10 followed by a cross tabulation of ECSA registration per municipality in Table 4-17.

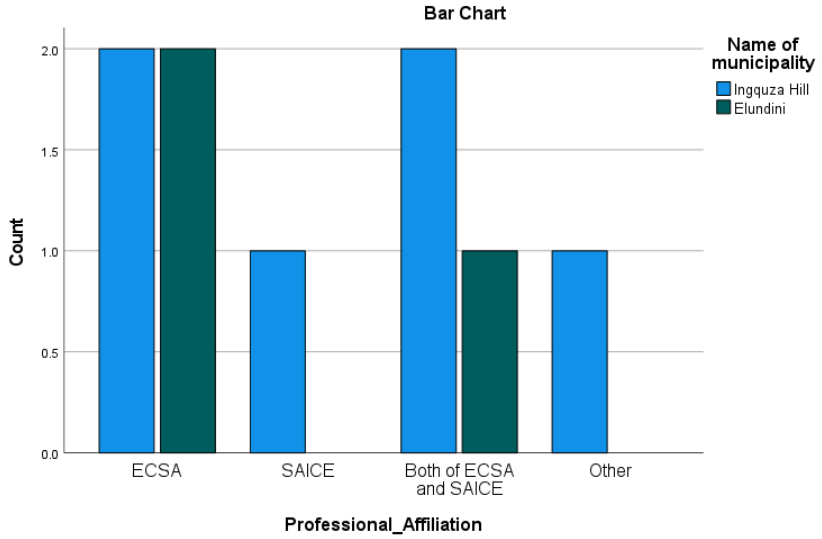


Figure 4-10: Professional affiliation per municipality

Table 4-17: ECSA category of registration per municipality cross-tabulation

ECSA category of registration * Municipality Cross tabulation

Count

		Name of municipality		
		Ingquza Hill	Elundini	Total
ECSA category of registration	None	8	6	14
	Candidate technician	2	2	4
	Professional Engineering Technologist	1	1	2
	Professional Engineer	0	0	0
Total		11	9	20

4.4.2 Analysis of Likert scale questions in the questionnaire

The primary element of the questionnaire consisted of 42 items that were assessed on a five-point Likert scale with alternatives such as "Unsure (U)" and "Does not (DN)" to assess the participants' perceptions. The alternatives (U) and (DN) were given a 0 rating. Participants were asked to rate their agreement or disagreement on a scale of 1 to 5, where 1 indicated the least agreement. The items of the questionnaire are reflected in the appendix.

The information was then analysed using the measures of central tendencies. There are three kinds of measures of central tendency, these being modes, medians, and means. The Mode denotes the most common response given to a question. Modes are particularly suitable for nominal-level variables. A Median is a midpoint in the distribution of responses. The Median is a suitable measure of central tendency for ordinal-level variables. Lastly, the measure of central tendency used for the interval- and ratio-level variables is referred to as the Mean. To obtain a Mean, one must add the value of all responses on a given variable and then divide that number

of the total number of responses. The Mean can also be commonly referred to as the average response for a variable.

4.4.3 Factor analysis

Goodwin and Leech (2006) describe factor analysis as a statistical strategy for expressing variability among observed, correlated variables in terms of a smaller number of unseen variables known as factors. It's feasible, for example, that changes in six seen variables are primarily due to changes in two unobserved variables. The basic premise of factor analysis is that there is a set of underlying variables called factors (smaller than the observed variables) that may explain the interrelationships among those variables for a set of observed variables.

Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) are two types of factor analysis. A factor analysis' goal is to reduce the number of variables needed to explain and interpret the results. Factor extraction and factor rotation are commonly used to accomplish this. Factor extraction entails deciding on a model type and the number of components to extract. After the components have been identified, factor rotation is performed to obtain a simple structure and increase interpretability. Principal components analysis and common factor analysis are two approaches to factor extraction that arise from differing approaches to variance partitioning. Orthogonal and oblique rotations are the two most common forms of rotations. In orthogonal rotation, factors are assumed to be independent or uncorrelated, but in oblique rotation, factors are assumed to be coupled. Factor rotations make it easier to understand factor loadings. The purpose of factor rotation is to make the factor solution more interpretable by reducing it to a simple structure.

4.4.4 Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO)

The Kaiser-Meyer-Olkin (KMO) Test is used to determine whether a sample is suitable for a Factor Analysis. The test determines whether each model variable, as well as the entire model, is sampled appropriately. The KMO test determines whether the data we have is appropriate for a Factor Analysis and, as a result, whether we have defined what we wish to assess. The calculated statistic is on a 0 to 1 scale. The following is the recognized method of interpreting the statistic:

- KMO values between 0.8 and 1 indicate the sampling is adequate.

- KMO values less than 0.6 indicate the sampling is not adequate and that remedial action should be taken. Some authors put this value at 0.5, so use your judgment for values between 0.5 and 0.6.
- KMO Values close to zero means that there are large partial correlations compared to the sum of correlations. In other words, there are widespread correlations which are a large problem for factor analysis.

4.4.5 Bartlett's test of sphericity

According to IBM® SPSS® Statistics, the hypothesis that the correlation matrix is an identity matrix, which would imply that variables are unrelated and thus unsuitable for structure discovery, is tested by Bartlett's test of sphericity. Small significance levels (less than 0.05) imply that factor analysis might be effective with your data.

i. Reliability

The main questionnaire was first assessed for reliability using the responses from participants. Before this could be done, the unsure responses were first coded as 3 on the Linkert scale to enable an analysis of the data. According to one study, respondents with a low level of education are more likely to select this response choice, implying that people are more likely to select "no opinion" responses when they view the processes of producing an appropriate response to be time consuming (Krosnick et al. 2002).

For this purpose, the Cronbach’s Alpha coefficient was used. Cronbach’s Alpha coefficient is used to determine the internal consistency of the responses from the participants. Before the computation of Cronbach’s Alpha coefficient, all questions were analysed to ensure they were positively worded. No variables were re - coded during this assessment. The norm for an acceptable Cronbach’s Alpha coefficient needs to be above 0.7 for it to be acceptable. The reliability statistics are caputed in Table 4-18 below.

Table 4-18: Reliability statistics

Reliability Statistics

Factor	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
Concept of ethics	.810	.814	13
Foundation values or guides for conduct	.338	.612	10*
Application of engineering ethics and implementation of service delivery	.501	.634	19**

*When questions 2.20 and 2.23 were removed from the foundational guides, Cronbach's coefficient was significantly improved to 0.704 which was within the acceptable value.

** When questions 2.31, 2.39 and 2.41 from the application of engineering ethics section were removed, Cronbach's coefficient was significantly improved to 0.735 which was within the acceptable value.

The revision on the questions significantly improved the questionnaire's reliability, as such, the omitted questions were not considered in the factor analysis. The remaining questions that were used to proceed further are 37 out of the original 42 questions in the questionnaire. The reliability statistics were revised are reflected in Table 4-19 as follows:

Table 4-19: Revised reliability statistics

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items

Concept of ethics	.810	.814	13
Foundation values or guides for conduct	.758	.803	8
Application of engineering ethics and implementation of service delivery	.708	.724	16

ii. Factor Analysis

Factor Analysis identifies fundamental variables that describe the pattern of correlation or variance within a set of observed variables. This technique is utilized to decrease the overall number of variables in a data set, but equally can be utilized to explore the latent structure of the variables contained in the data file. Factor analysis using the Principle Component Analysis (PCA) was conducted for the Likert scale items.

A factor analysis can yield a Non-Positive Definite (NPD) for the correlation matrix, meaning that some of the eigenvalues of the correlation matrix are not positive numbers. A matrix can also yield an NPD as a result of various other properties, such as when there are linear dependencies among the variables, as reflected by one or more eigenvalues of 0 or negative. To overcome this, a bivariate analysis can be conducted to identify correlating variables and allow for grouping of these variables.

For the factor analysis, a determinant of 0.332 was determined from the correlation matrix, which is higher than the recommended determinant of 0.001. The correlation matrix is captured in Table 4-20 on the next page.

Table 4-20: Correlation matrix

Correlation Matrix[a]

		Concept of ethics	Foundation values or guides for conduct	Application of engineering ethics and implementation of service delivery
Correlation	Concept of ethics	1.000	.781	.364
	Foundation values or guides for conduct	.781	1.000	.359
	Application of engineering ethics and implementation of service delivery	.364	.359	1.000
Sig. (1-tailed)	Concept of ethics		.000	.058
	Foundation values or guides for conduct	.000		.060
	Application of engineering ethics and implementation of service delivery	.058	.060	

a. Determinant = .332

A Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) of 0.593 and a Bartlett's test of sphericity of 0.001 were obtained after all of the prerequisites for factor analysis were met. The KMO value should be larger than 0.500, and the value

of Bartlett's Test of Sphericity sig. should be less than 0.05, indicating that the results were acceptable. The KMO is reflected in Table 4-21 on the next page.

Table 4-21: KMO

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.593
Bartlett's Test of Sphericity	Approx. Chi-Square	18.915
	df	3
	Sig.	.000

Further analysis on correlation of the variables can be determined through communalities. Extraction communalities are approximations of variance in each variable accounted for by the factors in the factor solution. Small values indicate variables that do not fit well with the factor solution, and should possibly be dropped from the analysis whilst variables with high values are well represented in the common factor solution. The values from this analysis were found acceptable and are captured in Table 4-22 below.

Table 4-22: Communalities

Communalities

	Initial	Extraction
Concept of ethics	1.000	.819
Foundation values or guides for conduct	1.000	.816
Application of engineering ethics and implementation of service delivery	1.000	.399

Extraction Method: Principal Component Analysis.

From the total of three factors used in the factor analysis, only one of the factors can be retained as reflected in the variance table below. The result of only one factor

being retained then suggests that all of the items fit onto a single theoretical construct, i.e. there is indeed one underlying factor.

The scree plot also confirms this limitation invariance, in that the line is almost flat from the second factor indicative of smaller and smaller variance for the second, third and fourth factors. The scree plot is reflected in Figure 4-11 below. Generally speaking, factor analysis is effective when there are more than 5 constructions, allowing for a clear view of the scree plot's curve. One could argue that Figure 4-11 is now a straight line that has not yet flattened with growing component numbers.

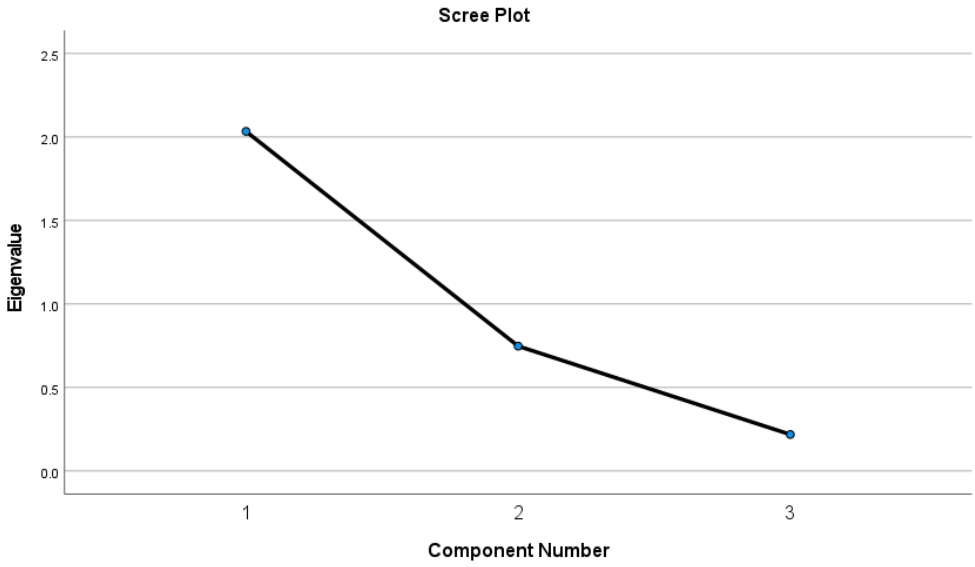


Figure 4-11: Scree plot

iii. Mean Analysis

For questions in the pilot survey, mean scores were considered in order to interpret percentages in relation to each point on the response scale.

The Likert scale had allowance for five points. The neutral group of respondents who chose the middle option or the unsure option in a Likert scale is not Homogeneous. It is important to segregate them to formulate policies by avoiding biases in measurement. The unsure group was thus denoted with a 0 on the scale to indicate neutrality. As Maness et al. (2018) put it, these respondents are not all truly opinion neutral and thus do not act as a transition group between these extremes. They fall into two groups:

a. Opinion Neutrality - Those individuals who possess true opinion neutrality on the issue

b. No Opinion - Those individuals have no opinion and are without adequate knowledge.

As a result, the Likert scale was calculated as 5 – 1 = 4. The ranges were calculated by multiplying 4 by 5, which equals 0.8. The unsure option received a score of zero. The following are the ranges and their definitions derived from this:

a. >4.20 ≤ 5.00 between a near major to major/major applicability or agreement;
b. 3.40 ≤ 4.20 between moderate influence to a near major/near major applicability or agreement;
c. 2.60 ≤ 3.40 between a near moderate influence / moderate applicability or agreement;
d. 1.80 ≤ 2.60 between a minor to near moderate influence / near minor applicability or agreement, and
e. 1.00 ≤ 1.80 between a near minor to minor applicability or agreement.

Descriptive statistics for the concept of ethics are given in Table 4-23 below.

Table 4-173: Concept of ethics

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Does your organization have a written code of ethics?	20	2	5	81	4.05	1.191
How relevant is your organizational code of conduct to the ECSA Code of Conduct for Registered persons?	20	1	5	78	3.90	1.252
Does your organization require ethics training?	20	1	5	77	3.85	1.309

Does your organization have procedures for reporting unethical behaviour?	20	3	5	88	4.40	.821
Are penalties for unethical behaviour strictly enforced in your organization?	20	1	5	72	3.60	1.314
Is ethical behaviour the norm in your organization?	20	1	5	66	3.30	1.129
Is unethical behaviour punished in your organization?	20	0	5	76	3.80	1.542
Are people of integrity rewarded in your organization?	20	1	5	47	2.35	1.137
Do the managers in your organization show that they care about ethics?	20	1	5	75	3.75	.967
Is ethical behaviour rewarded in your organization?	20	1	5	48	2.40	1.095
The main purpose of a code of ethics is to conform to the tradition established by the technical societies.	20	1	5	77	3.85	1.387

The Codes of Ethics for Registered Persons state the engineer's duties to society, to employers, to clients, to colleagues, to subordinates, and the profession. However, when these duties conflict, society (public interest) should take precedence	20	2	5	88	4.40	.995
The Code of Ethics for Registered Professionals is a voluntary guide, but strongly recommended by the Engineering Council of South Africa	20	1	5	80	4.00	1.257
Valid N (listwise)	20					

On question 1, majority (4.05) of the respondents confirmed that their organizations had a code of conduct regulating ethics, confirming that the case study municipalities indeed had a written code of ethics they abided by. When asked for further information on this, varied responses were received. On question 2 “How relevant is your organizational code of conduct to the ECSA Code of Conduct for Registered persons?” a mean of 3.90 was established indicating a moderate to major relevance between the code of ethics for the institution and that of the ECSA code of conduct. Respondents were asked whether their organization required ethics training, to which 3.85 indicated a requirement for ethics training. When asked whether their organization had procedures for reporting ethical conduct, 4.40 registered major agreement to this statement. When asked whether their organization strictly enforced penalties for ethical behaviour, 3.60 registered moderate to a major agreement to

this statement which agreed to question 7 (Is unethical behaviour punished in your organization?) which was rated at 3.80. On question 6 when respondents were asked if ethical behaviour was a norm in their institutions, they responded indicating moderate agreement at 3.30 which was contrary to the ratings of question 8 asking whether people of integrity were rewarded in their organization. The rating for this question was 2.35 which was like question 10 (rating of 2.40) which asked if people of integrity were rewarded within their organizations. Respondents indicated that managers within their organizations cared about ethics when responding to question 9 (rating 3.75). Respondents showed understanding of basic questions of ethics posed about a code of ethics in the answers provided in question 11 (rated 3.85) and question 12 (4.40) but seemed to agree that a code of conduct for registered persons as issued by the regulatory body ECSA was only voluntary. This would be aligned to the fact that most of the respondents were not affiliated with ECSA and therefore the code of conduct bore no significance to them as opposed to the code of ethics of their institutions which they may see as more superior and mandatory. Descriptive statistics for foundation values are reflected in Table 4-24 below.

Table 4-184: Foundational values or guides for conduct

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Treat others as you would have them treat you.	20	1	5	91	4.55	.945
Follow the moral values common to all major religions.	20	2	5	90	4.50	.946
Adhere to the moral standards in my faith or religion above all other considerations.	20	2	5	85	4.25	1.070
Compassion for those who are suffering or disadvantaged is the most crucial virtue.	20	3	5	89	4.45	.826

Justice, fairness, and equality are the most important requirements for society.	20	3	5	91	4.55	.759
Loyalty to one's group is more important than one's concerns.	20	1	5	60	3.00	1.589
Respect for authority is something everyone needs to learn.	20	3	5	89	4.45	.759
People should not do things that are revolting to others, even if no one is harmed.	20	2	5	85	4.25	1.070
Valid N (listwise)	20					

On the first question in this section, respondents indicated major applicability (4.55) to the question that they treated others in a manner they also preferred to be treated. Respondents also expressed major applicability (4.50) to following moral values as found in major regions which were congruent to the demographics that had indicated that a majority of the respondents held religion in high regard. When asked further information on this on whether they followed the moral standards of their faith amongst all considerations, a majority (4.25) of the respondents affirmed this. When asked detailed questions on how they treated others, major applicability on compassion (4.45) and justice (4.55) was indicated by the respondents. Respondents had mixed views on putting the interests of their group above other considerations with the moderate agreement being expressed when asked “Loyalty to one's group is more important than one's concerns?” with only a mean of 3.00 being established for the question. Respondents also seemed to have major regard for authority (4.45) but were opposed to doing things that may be revolting to other (4.25) meaning that this could be held in equal regard with their reverence for authority leading to constrained ethical decision making when balancing the two.

Notably, all variables in the category have MSs > 3 ≤ 4.55, which indicates that the variables have between a near moderate to major applicability. Descriptive statistics showing Engineering ethics and service delivery are given in Table 4-25 below.

Table 4-25: Engineering ethics and service delivery

Descriptive Statistics

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Engineering Ethics is a set of behavioural standards that all engineers are expected to follow.	20	3	5	94	4.70	.571
The application of engineering ethics is to ensure the safety of the public first and foremost	20	3	5	93	4.65	.587
By making use of engineering ethics, engineers can improve public perception of the engineering profession	20	2	5	89	4.45	.999
Negligence is a basis for disciplinary action under the Professional Engineering Act	20	2	5	89	4.45	.945
Failing to correct or report a situation that may endanger the public is against engineering practice	20	2	5	91	4.55	.759

Occasionally, a conflict of interest may occur accidentally or unavoidably. In such cases, the best course of action is to keep the conflict of interest secret, but try not to let it affect your decision	20	1	5	39	1.95	1.395
Making public statements that are not based on firm knowledge and conviction can be attributed to vast and unquestionable experience	20	1	5	75	3.75	1.446
Accepting commission for approving work is part of how engineers make their remuneration	20	1	5	37	1.85	1.496
There is a link on the application of engineering ethics and service delivery	20	1	5	87	4.35	1.182
Engineers are there to offer technical expertise and guidance and should not be distracted by soft skills such as ethics	20	1	5	38	1.90	1.447

If engineering ethics are not followed, the result may be compromised service delivery	20	2	5	92	4.60	.821
Do you think engineering ethics are currently being ignored within public service?	20	1	5	59	2.95	1.572
A project is running behind programme and a contractor delivers defective material on-site and re-ordering new supplies may delay project completion with chances of losing funding, It would be best to abandon the project as it was a lost cause, alternative funding can be sourced at a later stage	20	1	5	48	2.40	1.603
Most people do not really understand the technical aspects of a project, its best to involve the community when the project is completed and it is at the handover stage	20	1	5	65	3.25	1.943

When faced with conflicting test results, Ignore the failed samples as they may not be representative. It is best to try to finish the project on time and not add unnecessary investigations	20	1	5	39	1.95	1.468
Public service engineers are contributing towards improving the quality of life for communities	20	3	5	87	4.35	.875
Valid N (listwise)	20					

When asked ethical questions applicable to engineers (question one to five of the section), respondents responded with a mean of > 4.45 ≤ 4.70, which indicates that respondents had a major agreement with the variables in question. When participants were asked how they would treat an unexpected conflict of interest, they had minor agreement (1.95) to keep the conflict of interest to themselves and seemed to favour disclosing the conflict of interest. Respondents had a major agreement (3.75) that making public statements that were not based on firm knowledge displayed vast and unquestionable experience which signified a lack of understanding responsible communication. When asked if the accepting commission was part of an engineer's remuneration, respondents majorly disagreed with this statement. It could be interpreted that respondents were agreeable that engineers should not be remunerated on a commission basis but instead on a structured remuneration which is consistent with the guide for compensation of professional services. Respondents indicated linkage between engineering ethics (4.35) and this was confirmed by major agreement (4.60) that if engineering ethics were not followed there could be compromised service delivery. They were also disagreeable that engineering ethics were soft skills that did not warrant much technical expertise from engineers. There was moderate agreement that engineering ethics were being ignored in the public service. When asked practical questions from scenarios that

occur during the carrying out of engineering works, practical application of ethics seemed to be contrary to previous theoretical understanding previously noted in the responses from respondents. When asked how they would treat a project that was running behind that had defective work, respondents showed minor to the near minor agreement (2.40) to delaying a project to source additional funds to ensure good quality was achieved. Respondents showed moderate to the major agreement (3.25) that communities did not necessarily understand engineering work and should only be consulted at project completion.

Respondents showed minor disagreement (1.95) towards completing a project that had failed test results indicating that a requirement for further investigation may be warranted. The majority (4.35) of the respondents agreed that public service engineers were contributed to improving quality of life. The section on the application of engineering ethics has MSs of > 1.85 ≤ 4.70 which showed differing opinions on the application of engineering ethics when it came to practical scenarios.

iv. Descriptive statistics

Measures of kurtosis and skewness were used to determine if factors met normality assumptions. The results fell within the acceptable values of skewness range (− 3 and + 3) and appropriate kurtosis range (− 10 to + 10).

The factors showed a high mean of above 4 for the questions posed, meaning that respondents showed moderate to major applicability to questions posed.

The original sample is less than 30, the threshold needed before starting to examine normalcy, one should see the analysis in Tables 4-26 to 4-28 as having limited value. Some scholars even recommend a sample as large as 60 for the test. Rochon (2012) echoes this sentiment citing that normal distribution proved problematic in smaller samples.

Table 4-26:Descriptive statistics

Descriptive Statistics

	N	Minimum	Maximum	Sum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Concept of ethics	20	2.46	4.54	73.31	3.6654	.66138	-.214	.512	-1.039	.992
Foundation values or guides for conduct	20	2.88	5.00	85.00	4.2500	.62566	-.543	.512	-.752	.992
Application of engineering ethics and implementation of service delivery	20	2.94	5.00	70.13	3.5063	.54256	1.571	.512	2.575	.992
Valid N (listwise)	20									

v. Descriptive statistics to test normality

The Skewness and Kurtosis was calculated. For small samples (n < 50), if absolute z-scores for either skewness or kurtosis are larger than 1.96, which corresponds with an alpha level 0.05, then reject the null hypothesis and conclude the distribution of the sample is non-normal (Kim 2013).

All z- values apart from those in the foundational guide section indicated conformance within the acceptable range. Though the t-test (assuming equal

variances) and analysis of variance (ANOVA) with balanced sample sizes are stated to be "robust" in detecting moderate deviations from normality, it is not recommended to depend just on the feature and skip the data evaluation step. To determine whether or not assumption of normality is appropriate, a mix of eye inspection, skewness and kurtosis assessments, and formal normality tests can be applied (Kim 2013). Desciptive statistics are populated in Table 4-27 below.

Table 4-27: Descriptives

Descriptives

	Name of municipality			Statistic	Std. Error
Concept of ethics	Ingquza Hill	Mean		3.3961	.27998
		95% Confidence Interval for Mean	Lower Bound	2.7723	
			Upper Bound	4.0200	
		5% Trimmed Mean		3.3661	
		Median		3.2857	
		Variance		.862	
		Std. Deviation		.92858	
		Minimum		2.33	
		Maximum		5.00	
		Range		2.67	
		Interquartile Range		1.28	
		Skewness		.785	.661
		Kurtosis		-.126	1.279
	Elundini	Mean		3.5519	.32953
		95% Confidence Interval for Mean	Lower Bound	2.7919	

			Upper Bound	4.3118	
		5% Trimmed Mean		3.5734	
		Median		4.0000	
		Variance		.977	
		Std. Deviation		.98860	
		Minimum		1.92	
		Maximum		4.80	
		Range		2.88	
		Interquartile Range		1.46	
		Skewness		-.939	.717
		Kurtosis		-.178	1.400
Foundation values or guides for conduct	Ingquza Hill	Mean		3.9789	.22676
		95% Confidence Interval for Mean	Lower Bound	3.4736	
			Upper Bound	4.4841	
		5% Trimmed Mean		4.0182	
		Median		4.1250	
		Variance		.566	
		Std. Deviation		.75207	
		Minimum		2.25	
		Maximum		5.00	
		Range		2.75	
		Interquartile Range		.50	
		Skewness		-1.359	.661
		Kurtosis		2.191	1.279

	Elundini	Mean		4.4306	.20530
		95% Confidence Interval for Mean	Lower Bound	3.9571	
			Upper Bound	4.9040	
		5% Trimmed Mean		4.4715	
		Median		4.7500	
		Variance		.379	
		Std. Deviation		.61591	
		Minimum		3.13	
		Maximum		5.00	
		Range		1.88	
		Interquartile Range		.88	
		Skewness		-1.319	.717
		Kurtosis		1.414	1.400
Application of engineering ethics and implementation of service delivery	Ingquza Hill	Mean		3.7636	.20799
		95% Confidence Interval for Mean	Lower Bound	3.3002	
			Upper Bound	4.2271	
		5% Trimmed Mean		3.7781	
		Median		3.9333	
		Variance		.476	
		Std. Deviation		.68984	
		Minimum		2.60	
		Maximum		4.67	
		Range		2.07	

		Interquartile Range		1.33	
		Skewness		-.286	.661
		Kurtosis		-1.318	1.279
	Elundini	Mean		3.7217	.17329
		95% Confidence Interval for Mean	Lower Bound	3.3221	
			Upper Bound	4.1213	
		5% Trimmed Mean		3.7484	
		Median		3.8000	
		Variance		.270	
		Std. Deviation		.51987	
		Minimum		2.53	
		Maximum		4.43	
		Range		1.90	
		Interquartile Range		.43	
		Skewness		-1.483	.717
		Kurtosis		3.704	1.400

vi. Tests for normality using Shapiro Wilk

If Sig. value (or p-value) in the normality test table is less than 0.05, which implies that data may not be from a normally distributed population. The normality test was undertaken and signified a lower bound of the true significance, indicating that the distribution which the data was sampled from may not statistically significantly different from normal. The Shapiro-Wilk statistics were read from the normality table and some of the p-values were below 0.05 meaning that the null hypothesis that the data is normally distributed can be dismissed. A representation of the test for normality is reflected in table 4-28 on the next page.

Table 4-28: Test for normality

Tests for Normality

	Name of municipality	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Concept_of_ethics	Ingquza Hill	.179	11	.200*	.883	11	.112
	Elundini	.246	9	.123	.845	9	.065
Foundational_guide	Ingquza Hill	.329	11	.002	.853	11	.046
	Elundini	.254	9	.099	.844	9	.064
Engineering_ethics_section	Ingquza Hill	.183	11	.200*	.923	11	.342
	Elundini	.247	9	.119	.854	9	.083

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Further to this, upon visual inspection of the histograms, it was established that they did not have any approximate shape of a normal curve. The dots from the normal QQ plot also deviated significantly from the normality line. These are captured in Figure 4-12 to 4-23 below

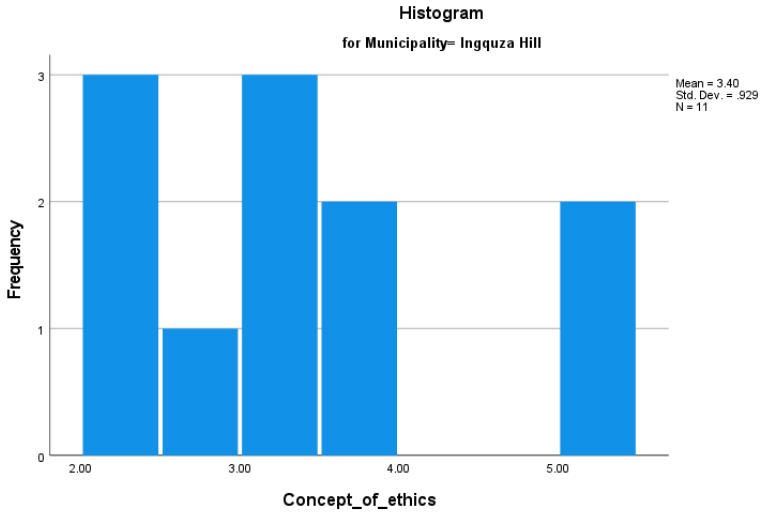


Figure 4-12: Concept of ethics Histogram IHLM

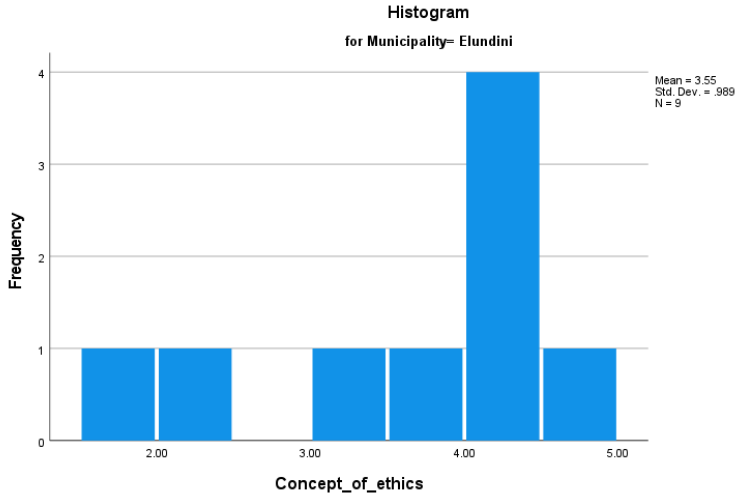


Figure 4-13: Concept of ethics Histogram ELM

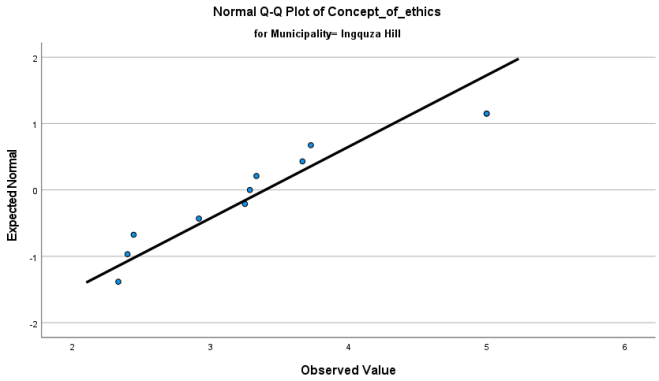


Figure 4-14: Q-Q Plot Concept of ethics IHLM

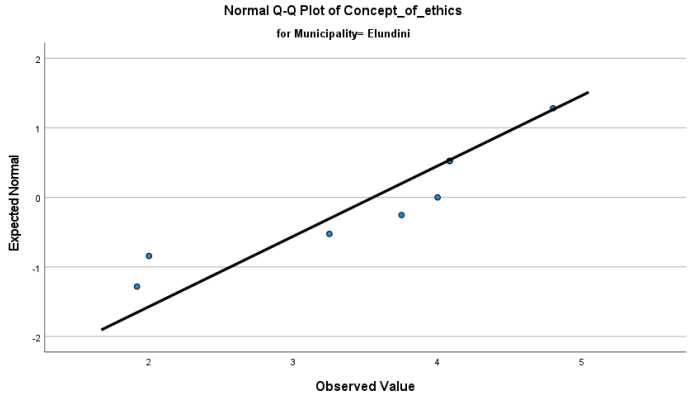


Figure 4-15: Q-Q Plot Concept of ethics ELM

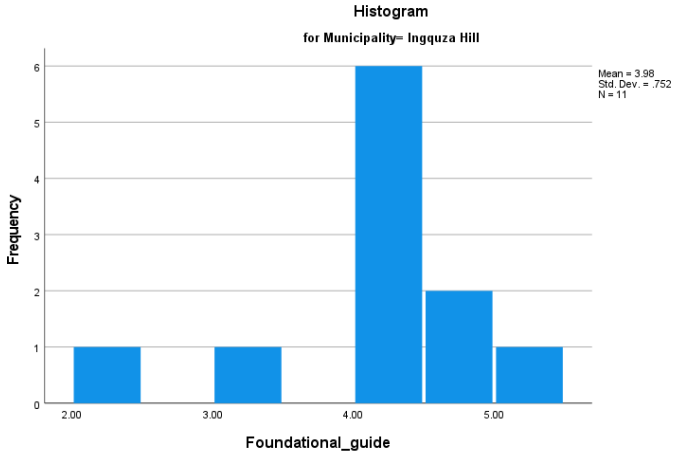


Figure 4-16: Foundational guide Histogram IHLM

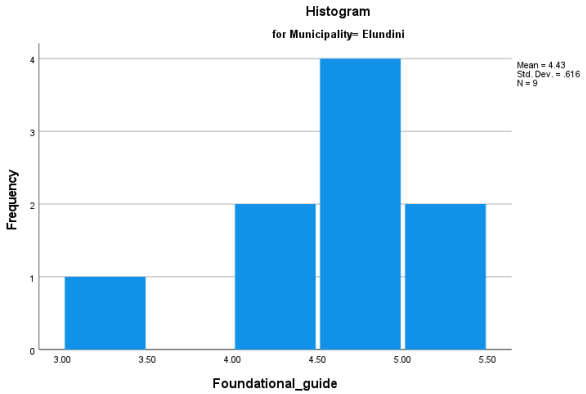


Figure 4-17: Foundational guide Histogram ELM

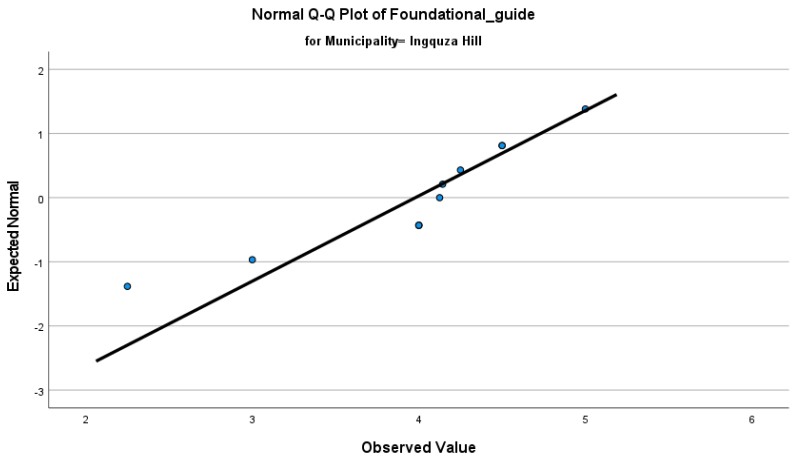


Figure 4-18: Q-Q Plot Foundational guide IHLM

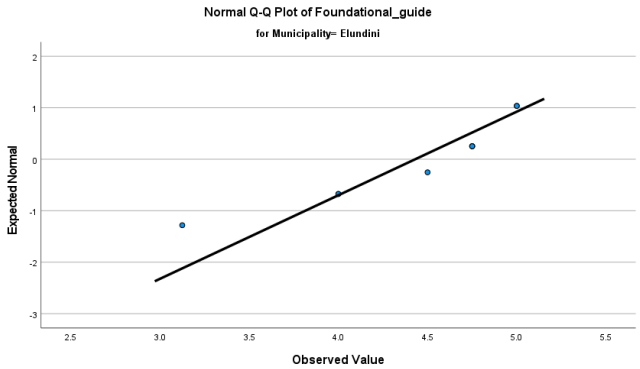


Figure 4-19: Q-Q plot Foundational Guide ELM

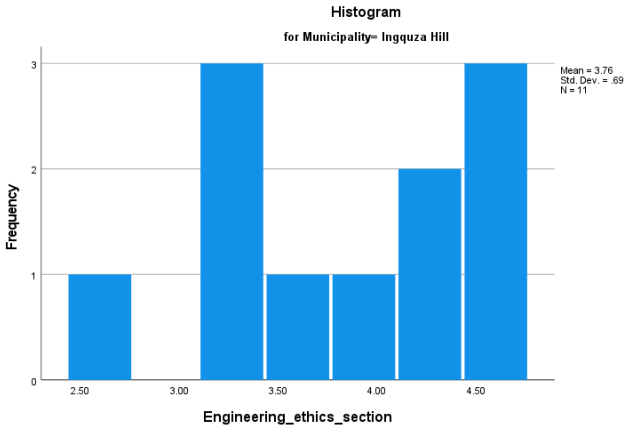


Figure 4-20: Histogram Engineering Ethics IHLM

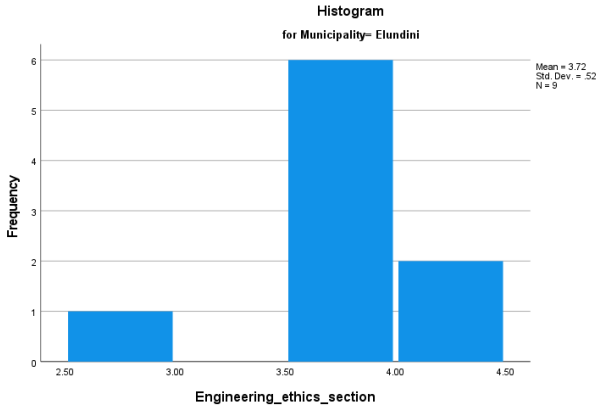


Figure 4-21: Engineering Ethics ELM

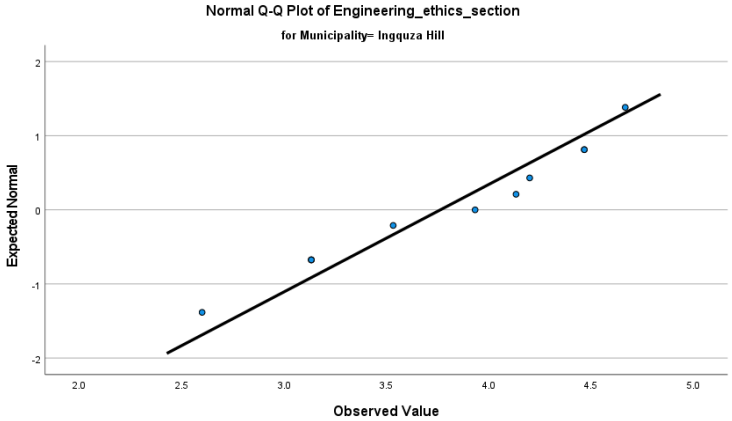


Figure 4-22: Q-Q Plot Engineering Ethics IHLM

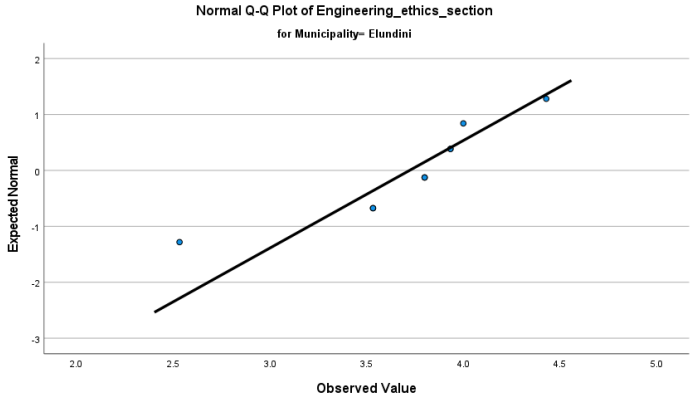


Figure 4-23:Q-Q Plot Ethics ELM

The box plots for the data were not symmetrical which showed a deviation from normality, meaning that non-parametric methods used in further analysis. This is captured in Figure 4-24 to Figure 4-26 on the next page.

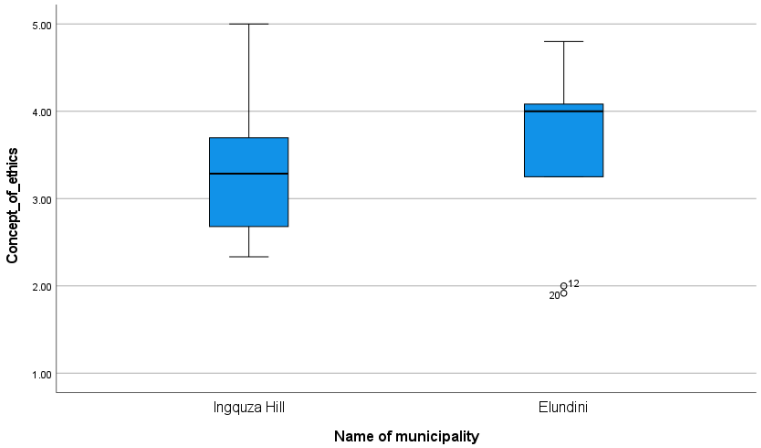


Figure 4-24: Box plot Concept of Ethics IHLM

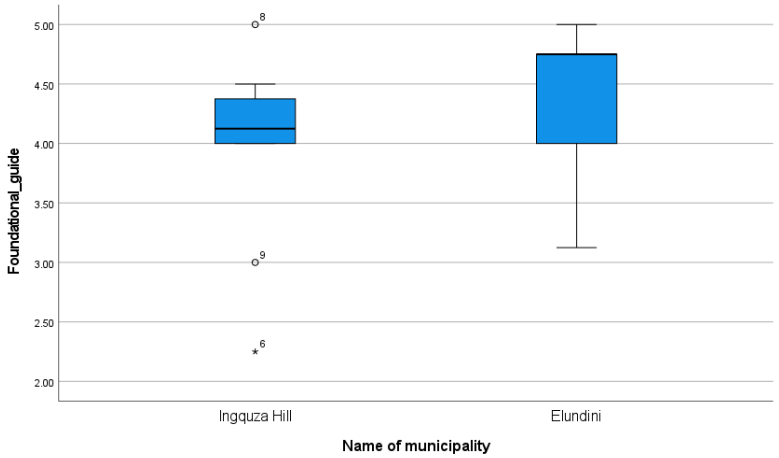


Figure 4-25: Foundational guide ELM

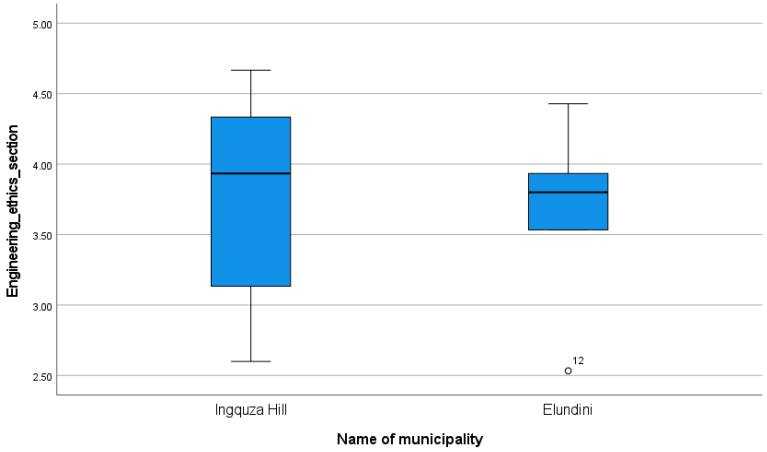


Figure 4-26: Histogram Engineering Ethics IHLM

4.4.6 Section 3 analysis

Section three contained seven open-ended questions that were posed to participants to find factors that they considered could impact service delivery. Some questions with open-ended probes were administered to respondents to clarify their answers to establish the validity of closed questions. Singer and Couper (2017) identified seven primarily methodological uses of open-ended questions for defining the range of alternatives to employ in closed-ended questions; evaluating how effectively questions operate; testing methodological theories and hypotheses; checking for errors (as a sign of response quality); encouraging more truthful replies; and offering an opportunity for feedback.

Open-ended questions provide a problem in analysis since they are difficult to answer.

a. Why Respondents do not always enjoy them (it takes effort on their part), which leads to short, unsatisfying responses.
b. They increase the time it takes to complete a survey, thereby lowering the response rate when used in a self-administered questionnaire; and
c. If there are a lot of open-ended responses, reading through all the verbatim remarks to find any insights can be laborious.

i. Section 3: Question 1

The answers received from respondents on question 1 of the questionnaire “How can engineers use engineering ethics to improve service delivery?” were categorized into seven categories. The responses indicated the need to improve engineering processes and values such as honesty, integrity, transparency, and accountability. Detailed results are reflected in Table 4-29 below.

Table 4-29: Results question 1

How can engineers use engineering ethics to improve service delivery?	Total respondents who answered X	% of respondents who answered X
Categories	**No of respondents**	**Percentage**
No answer	2	10%
Virtues such as honesty, integrity, transparency, and accountability	5	25%
Training/ Skills development	1	5%
Quality control and management	3	15%
Engineering processes - planning, design, and execution	5	25%
Procedure for ethics/code of conduct	2	10%
Health and Safety	2	10%

ii. Section 3: Question 2

Respondents were asked “How could the use of engineering ethics better empower public service engineers to provide improved service delivery?”. Engineering competency and decision-making were cited as a leading (40%) area which could be used to better empower public service engineers. This was consistent with data established earlier wherein it was identified that a majority of current personnel within the case study environment did not possess the required minimum competency for practicing in engineering work, which inherently lead to a majority of them not being registered with the regulatory body. Improvement in the enforcement of regulation particularly in line with the requirements set out by ECSA was identified as the second leading (25%) solution for how engineering ethics could be used to improve service delivery in public service, but enforcement becomes a challenge when the responsible person is not affiliated to the regulatory body. Improvement on quality control was cited as the third area of improvement, with 20% of responses indicating such. Detailed results are reflected in Figure 4-27 below.

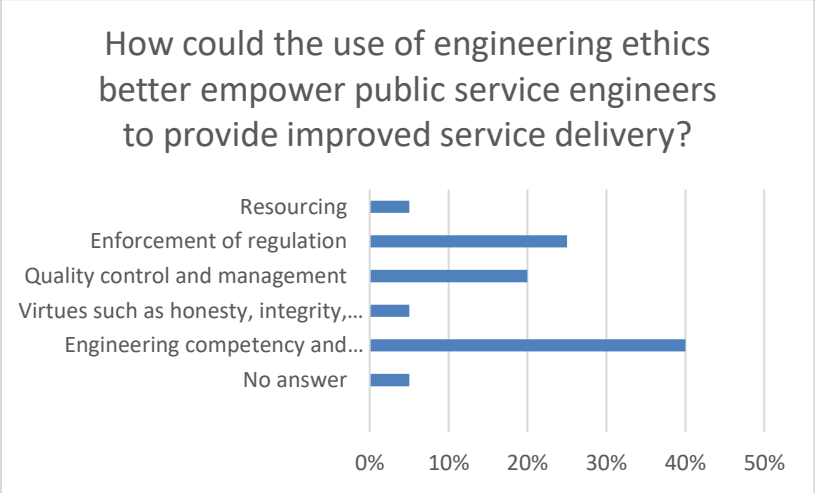


Figure 4-27: Bar chart question 2

iii. Section 3: Question 3

In the answers received from respondents on question 3 of the questionnaire "Which areas of ethical compromise are people within your designation most exposed as they carry out their duties?" most of the respondents indicated that administrative causes (20%) as well as quality constraints (20%). Though political interference is usually perceived as a leading cause of ethical compromise, it was recorded at 15%. This was tied with bribery and corruption and tender and procurement which also recorded responses of 15% each. Detailed results are reflected in Figure 4-28 below.

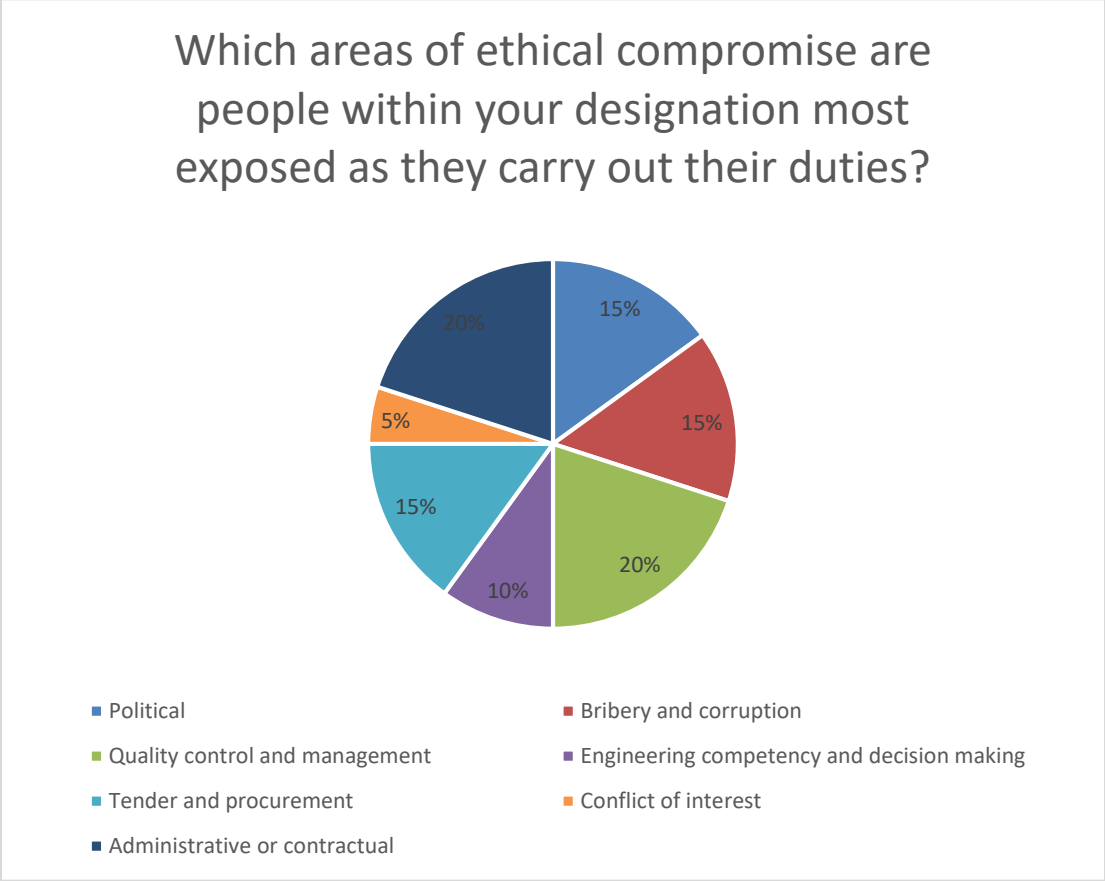


Figure 4-28: Pie chart question 3

iv. Section 3: Question 4

Respondents on question 3 of the questionnaire “List 3 ethical values stated in your organization’s code of conduct” identified Honesty, integrity, confidentiality, and trustworthiness as the leading (35%) ethics identified in the organization codes of conduct for the case study municipalities with administrative conduct and fairness and justice being highlighted as number 2 with a response average of 20%. Detailed results are reflected in Figure 4-29 below.

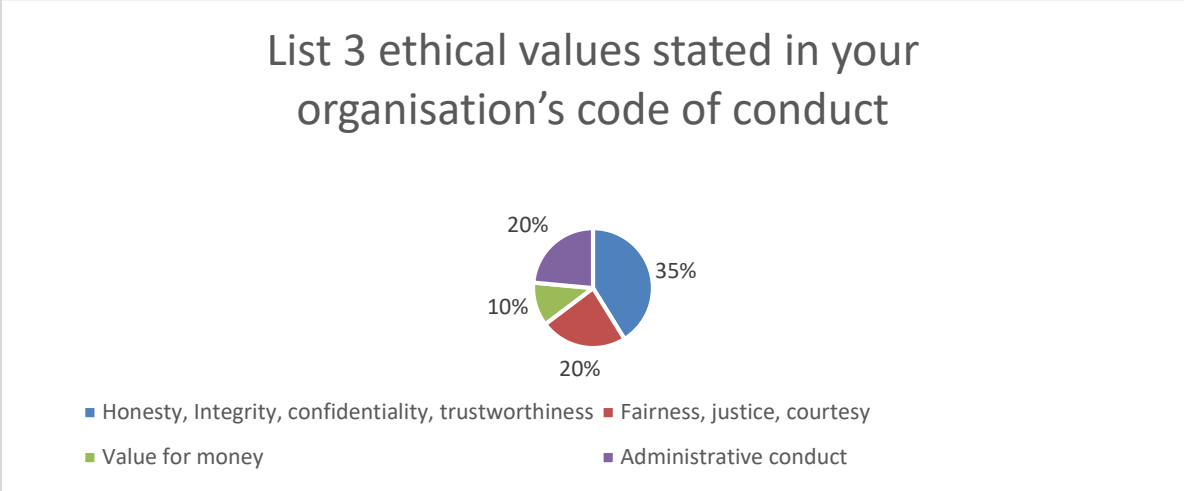


Figure 4-29: Pie chart question 4

v. Section 3: Question 5

The answers received from respondents on question 5 of the questionnaire "List 3 ethical values stated in your organization's code of conduct that is relevant to the ethics as contained in the ECSA Code of Conduct for Registered Persons." indicated that 30% identified fairness and justice as the leading common ethical value in their organization's code of conduct which was like the ECSA code of conduct. Honesty, integrity, confidentiality, and trustworthiness were identified as the second common (20%) ethics identified in their organizational codes of conduct that were like the ethics as provided for in the ECSA Code of Conduct.

The values identified seemed consistent with those highlighted in the code of conduct, though some respondents seemed to be entirely unaware of the composition of the code of conduct for registered persons and relied on their knowledge of other codes of conduct that may bear similarity. Detailed results are reflected in Figure 4-30 below.

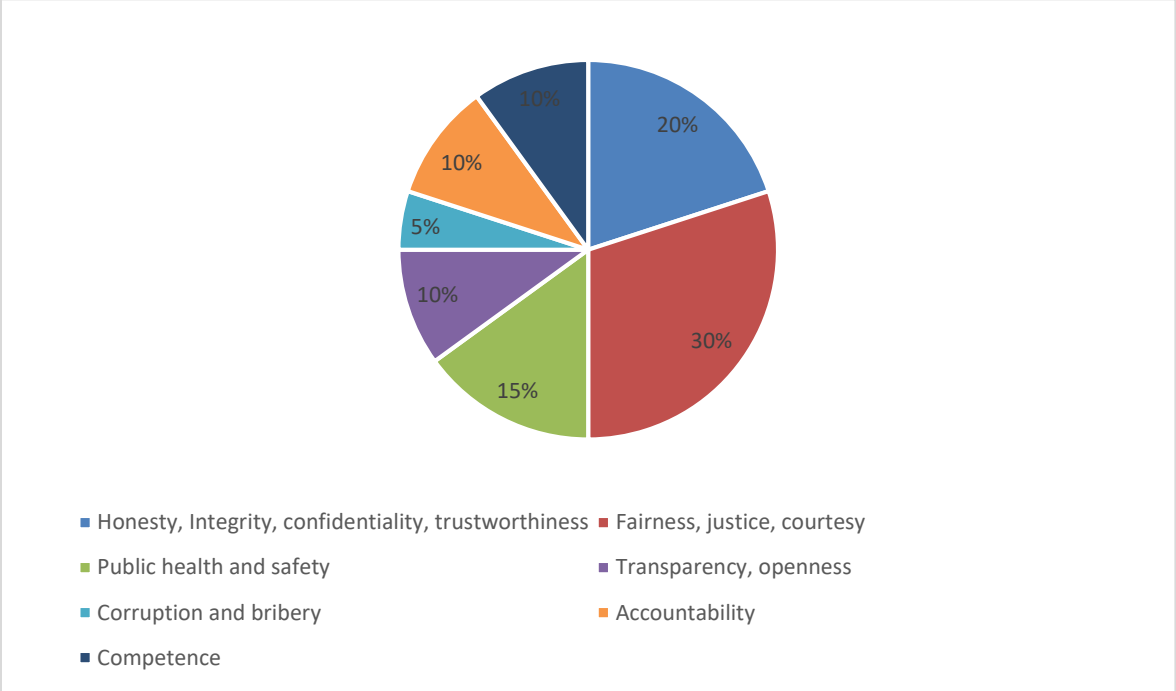


Figure 4-30: Pie chart question 5

vi. Section 3: Question 6

Engineering decision-making came was tied at number 1 with quality control wherein each of these categories recorded 25%. This accounted for 50% of the responses, indicating that some of the respondents did not feel that they were able to exercise ethical engineering decision-making in their environments. Detailed results are reflected in Figure 4-31 below.

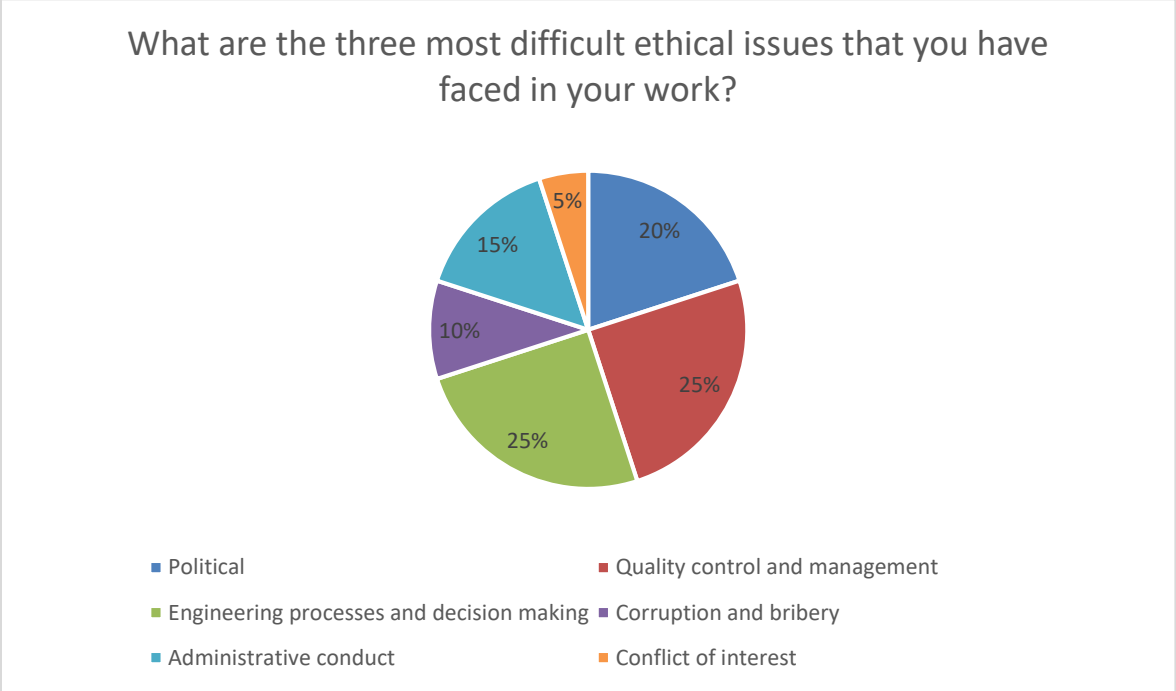


Figure 4-31: Pie chart question 6

vii. Section 3: Question 7

In the last question, participants were asked to provide general inputs regarding the use of engineering ethics and how it can be utilized for the betterment of service delivery.

The following inputs were received:

a. The employment of young engineers and their salaries by contractors must be regulated by the government.
b. There must be a strict criterion in the employment of the contractors that are doing engineering work for example the owner of the company must have a relevant qualification has to improve the quality of service delivery.
c. Major special training must be conducted for the companies who deal with the engineering project to enforce the ethics so that it does not become a burden to one individual.
d. If all young growing engineers can first prioritize the engineering ethics to their field of practice, lawfully compliance to statutory bodies for all engineering practices like any other field of study e.g. doctors and lawyers

e. Presentation on short courses on engineering ethics must be made as the understanding may differ
f. Engineers using engineering ethics can sometimes be seen as a setback to service delivery so this understanding would need to be shared with managers and political leadership
g. A simplified version of ethics taking into consideration even societal norms would assist because those are not always aligned.
h. The greediness of politicians is affecting how engineers are getting hired so the municipality needs to have its qualified engineers.

4.5 CONCLUSION

By conducting the pilot study, the researcher has been able to meet key objectives that will go a long way in assisting the main study.

The analysis conducted in the pilot study has assisted with a refinement of the questions contained in the questionnaire and has achieved the reduction of questions in the main section of the questionnaire from 42 to 37. It has also confirmed that indeed the questionnaire sort to establish a single theoretical construct.

a. Data Collection Method:

The pilot study sought to test the appropriateness of the data collection method by deciding between two competing study methods, that is the selected interview technique (face-to-face) or to establish whether a self-completed questionnaire would be appropriate. During the completion process of the questionnaires, participants did not experience many challenges which required clarity from the researcher and the questionnaire was relatively simple to complete meaning that self-completion could be facilitated during the main study. This will be beneficial due to the increase that is expected in the number of participants for the main study.

b. Data Collection Process

As part of the objectives of the pilot study, the researcher sought to test the data collection method, which includes the time it takes to complete the questionnaire, as well as the individuals' willingness to engage in the study. Participants took on average 20 minutes to complete the questionnaire whilst the researcher took 15 minutes explaining the research process and how the processing of data would be analyzed. The data analysis process and treatment of confidential information are already contained in the consent agreement for the study and if the questionnaire is self-completed, participants could still have access to information on granting and withdrawal of consent. Collection of data through a self-completed questionnaire allows for the use of computerized data handling and processing, thus minimizing errors during capturing and minimizes processing time and is thus preferred. There is various open software for this purpose that offer ease of transmission of data as well as security to maintain participant confidentiality and these will be explored in the main study.

c. Preliminary Outcome Measure

The pilot sought to collect preliminary information for the major outcome measure which would inform the main study. The data collection tool has been refined for the main study and preliminary findings have been made based on the information obtained. Lack of training on engineering ethics as well as the competency of engineering personnel have been highlighted as key factors in the pilot study. In addition to this, there is also rising concern regarding political influences which may affect ethical decision-making amongst personnel practicing in the case study municipalities, and the development of a mechanism to enable ethical decision-making could provide much-needed relief to the personnel within these municipalities.

The original questionnaire covered 13, 10, and 19 items for each construct respectively. This was done to provide "to provide minimum coverage of the construct's theoretical domain" (Hair et al. 2010). Ho and So (2016) argue that too many items in the questionnaire and fatigue effect can affect the reliability of items near the end of the survey. The questionnaire was thus refined to leave only 13, 7, and 15 items on each construct respectively. The overall reduction should improve usability of the questionnaire.

d. Sample Size

The secondary objective of the pilot was to help calculate the sample size for the main study. From the contract registers of both municipalities, it was established that one municipality had enlisted the use of 16 professional service providers whilst the other had 13 professional service providers. These participants did not form part of the pilot study and would be vital for testing out the tool that will be developed in the main study. Due to the small size of the population, there is no need for sampling.

Considering the above results, the pilot study is deemed successful, thus allowing the researcher to go on to the main research.

CHAPTER 5: MAIN STUDY - RELATIONSHIP BETWEEN ENGINEERING ETHICS AND VALUE OF SERVICE DELIVERY PROVIDED

5.1 INTRODUCTION

This Chapter contains findings made from the main study which was carried out using the list of eligible service providers within the case study municipalities. Participants for the main study did not participate in the pilot study. The refined study questionnaire from the pilot study was used for data collection and was distributed to 77 participants from the provided municipal contracts register. Use of BMI SPSS Statistics was made for statistical analysis of the questionnaire data and responses received. Thematic analysis was undertaken to analyse the open-ended questions that formed part of the questionnaire.

5.1.1 Participants

The intended population of the study was determined by making use of the municipal contracts register of serviced providers. The direct respondents in these municipalities who took part in the pilot study would not participate in the full study to limit influence from having previously participated as the completion of the previous questionnaire may have triggered them to research further on the subject matter. A total population of 77 was identified from the municipal contracts register. Of these participants, only 61 respondents gave consent to participate in the study. The final study participants are reflected in Table 5-1 below.

Table 5-1: Municipal Study participants

Municipality

		Frequency	Percent
Valid	Ingquza	34	55.7
	Elundini	27	44.3
	Total	61	100.0

The entire population from the contracts register was invited to participate in the main survey. The number of completed responses received from the survey was then used to determine the sample size. The sample size was determined from a total population size of 77. The following formula was used to determine an appropriate sample size:

$$\text{Sample size} = \frac{\frac{z^2 \times p\,(1-p)}{e^2}}{1 + \left(\frac{z^2 \times p\,(1-p)}{e^2 N}\right)}$$

Figure 5-1: Sample size formula (Cloud Research 2015)

In the above formula, the following inputs were used:

N – the population size

e – acceptable sampling error / margin of error

z – z-score based on desired confidence level

p – confidence level

A suitable sample size of 65 was established using a 95% confidence interval and a 5% margin of error are used. This, therefore, means that the results expressed from

the main study are given at a 95% certainty for the given population in the study environment.

By dividing the number of completed questionnaires received by the number of people that viewed or started the questionnaires, the questionnaire success rate can be computed. To convert this to a percentage, this number can be multiplied by 100. From the above, the study questionnaire success rate can be determined making use of the formula:

(61 / 77) * 100 = 79.2%

The questionnaire response rate for the main survey is 79.2%. The response rate can be considered adequate for the statistical analysis based on the number of questionnaires received.

5.1.2 Data Collection

The main study was conducted using the final research questionnaire as refined during the pilot study. This questionnaire was self-completed by participants using Google Forms online questionnaire system. Daily reminders were issued to study participants and the questionnaire collection period was 45 days. Some respondents returned the questionnaire whilst others delayed in submitting the questionnaire. This can be attributed to general fatigue to undertake questionnaires since the pilot study showed that the completion process required no more than 20 minutes. After numerous reminders were sent and no further questionnaires were received after 45 days, the researcher proceeded to analyse the questionnaire data with 61 responses.

Before participating in the study, each participant was asked to indicate their consent to participate in the study. If consent was declined, the questionnaire terminated automatically and such response was recorded as declined voluntary consent.

The questionnaire comprised of three sections, detailed as follows:

Section 1 – questions on demographic data

Section 2 – 37 questions on the concept of ethics ranked on a Likert scale

Section 3 – contained open-ended questions on service delivery and ethics

5.1.3 Data Analysis

The use of IBM SPSS was made to analyze sections 1 and 2 of the questionnaire. Thematic analysis using Microsoft Excel was undertaken on the open-ended section of the questionnaire.

The following tests were undertaken as part of the data analysis:

e. Where applicable, descriptive data such as means, and standard deviations are included. Tables or graphs are used to indicate frequency.

f. Chi-square goodness-of-fit test: A univariate test that is used on a categorical variable to see if any of the response alternatives is chosen significantly more or less frequently than the others. Under the null hypothesis, all responses are supposed to be equally chosen.

g. Wilcoxon Signed Ranks Test: A non-parametric test used to determine whether the average value differs substantially from a value of 3 in this study (the central score). This is used with questions that use a Likert scale.

h. Spearman's correlation: Spearman's correlations measure how ordinal variables or rank orders are related.

i. One-sample t-test: Determines whether a mean score differs from a scalar value.

j. Independent samples t-test: A test that compares two sets of instances that are not related.

k. Factor analysis

l. Cronbach's alpha

5.2 RESPONSES TO THE QUESTIONNAIRE

5.2.1 Section 1: Demographics

Table 5-2 summarises the demographic data of the respondents:

Table 5-2: Demographics

Demographics			Frequency	Percent
Gender	Valid	Female	8	13.1
		Male	53	86.9
		Total	61	100.0
Years in current role	Valid	<1 year	8	13.1
		1-5 years	36	59.0
		6-10 years	12	19.7
		>10 years	5	8.2
		Total	61	100.0
Age	Valid	21-29	9	14.8
		30-39	28	45.9
		40-49	16	26.2
		50-59	6	9.8
		60+	2	3.3
		Total	61	100.0
Race	Valid	African	52	85.2
		Coloured	2	3.3
		White	7	11.5
		Total	61	100.0
Qualification	Valid	TVET	1	1,6
		National diploma	19	31,2
		B-Tech	30	49,2
		Degree(BSc/ BEng)	5	8,2
		Postgraduate diploma	5	8,2
		Postgraduate degree	1	1,6
	Valid	Not registered	28	45.9

Professional Affiliation	Candidate	9	14.8
	Professional engineering technician	4	6.6
	Professional engineering technologist	15	24.6
	Professional engineer	5	8.2
	Total	61	100.0

Over 86% of respondents were male, with females coming in at a ratio of 1:7 males. The predominant age group was 30 – 39 years of age with a majority (59%) having been contracted to the institution for 1-5 years. The majority (85%) of respondents were African, which was consistent with the demographics of the area.

In as much as 31% and 57% of the respondents held either a National Diploma or a Bachelor's degree, it was surprising that over 45% of the respondents were not registered with ECSA. The role of the survey participants was that of Professional Service providers who were meant to be providing technical support to the case study municipalities, so it was unexpected to have a majority presenting as candidates (14.8%) or unregistered (45%).

A majority of the respondents indicated that they were Christian (52.5) and regarded religion of high importance (21%) or very high importance (37%).

5.2.2 Section 2: Likert scale items on Concept of Ethics

a. Organisational ethics:

For the first question in this section (Does your organization have a written code of ethics?) the chi-square goodness-of-fit test is applied to test if any response option is selected significantly more than others. A significant 67.2% indicated that their organization has a written code of ethics, $p<.001$.

All the remaining questions have scales that are 5-point Likert scales and the Mean and Standard Deviation for these questions have been calculated. There is significant agreement that the organizations which the respondents work for require ethics training. There is significant relatively strict enforcement of penalties for unethical behaviour.

These variables all deviated slightly from normality and so the Wilcoxon signed ranks test was applied to test if the median differed significantly from ‘3’. The interpretation depends on the scale. The median and IQR (interquartile range) are given in the following summary Table 5-3.

Table 5-3: Responses from the questionnaire on organizational ethics

Item		Responses as Frequency (%)						Mean (SD)	Median [IQR]	p-value
		1	2	3	4	5				
1 How relevant is your organizational code of conduct to the ECSA Code of Conduct for Registered persons?	Minor relevance	15 (24.6)	2 (3.3)	11 (18.0)	8 (13.1)	25 (41.0)	Major relevance	3.43 (1.627)	4 [1.5; 5]	.082
2 Does your organization require ethics training?	Disagree	3 (4.9)	5 (8.2)	16 (26.2)	12 (19.7)	25 (41.0)	Agree	3.84 (1.200)	4 [3; 5]	<.001*
3 Does your organization have procedures for reporting unethical behaviour?	Disagree	6 (9.8)	3 (4.9)	17 (27.9)	7 (11.5)	28 (45.9)	Agree	3.79 (1.343)	4 [3; 5]	<.001*
4 Are penalties for unethical behaviour strictly enforced in your organization?	Lightly enforced	8 (13.1)	6 (9.8)	14 (23.0)	10 (16.4)	23 (37.7)	Strictly enforced	3.56 (1.420)	4 [3; 5]	.004*
5 Is ethical behaviour the norm in your organization?	Rarely	5 (8.2)	2 (3.3)	11 (18.0)	12 (19.7)	31 (50.8)	Always	4.02 (1.258)	5 (3; 5)	<.001*
6 Is unethical behaviour punished in your organization?	Rarely	5 (8.2)	5 (8.2)	20 (32.8)	6 (9.8)	25 (41.0)	Always	3.67 (1.313)	4 [3; 5]	<.001*
7 Are people of integrity rewarded in your organization?	Rarely	9 (14.8)	4 (6.6)	20 (32.8)	3 (4.9)	25 (41.0)	Always	3.51 (1.456)	3 [3; 5]	0.08

8 Do the managers in your organization show that they care about ethics	Rarely	3 (4.9)	2 (3.3)	5 (8.2)	13 (21.3)	38 (62.3)	Always	4.33 (1.091)	5 [4; 5]	<.001*
9 Is ethical behaviour rewarded in your organization?	Rarely	8 (13.1)	4 (6.6)	22 (36.1)	5 (8.2)	22 (36.1)	Always	3.48 (1.386)	3 [3; 5]	0.011
10 The main purpose of a code of ethics is to conform to the tradition established by the technical societies.	Rarely	1 (1.6)	3 (4.9)	12 (19.7)	8 (13.1)	37 (60.7)	Always	4.26 (1.047)	5 [3; 5]	<.001*
11 The Codes of Ethics for Registered Persons state the engineer's duties to society, to employers, to clients, to colleagues, to subordinates, and the profession. However, when these duties conflict, society (public interest) should take precedence	Rarely	0 (0)	2 (3.3)	9 (14.8)	10 (16.4)	40 (65.1)	Always	4.44 (0.866)	5 [4; 5]	<.001*
12 The Code of Ethics for Registered Professionals is a voluntary guide, but strongly recommended by the Engineering Council of South Africa	Disagree	8 (13.1)	2 (3.3)	9 (14.8)	6 (9.8)	36 (59.0)	Agree	3.98 (1.433)	5 [3; 5]	<.001*

Further analysis was undertaken to get a single reliable measure for organizational promotion of ethical behaviour. Reliability is achieved if Cronbach's alpha coefficient >.7. Results are summarised in the table below. Some items were excluded because they were not consistently measuring this single construct:

Table 5-4: Reliability for organizational promotion of ethical behaviour

Construct	Label	Items included	Cronbach's alpha
Organizational promotion of ethical behaviour	OE	1 3 4 5 6 7 8 9	.918

Given that all the items use a scale of 1 = does not promote ethical behaviour to 5 = does promote ethical behaviour, this composite scale can be thought of as measuring how much ethical behaviour is promoted in the organizations.

The analysis is done on this composite measure (OE) to determine if there is a significant promotion of ethical behaviour or not.

Test –one-sample t-test, tests the average score against the central score of '3'. The one-sample test statistics for organisational promotion of ethical behaviour are reflected below in Table 5-5.

Table 5-5: One-Sample Statistics for organizational promotion of ethical behaviour

One-Sample Statistics

	N	Mean	Std. Deviation
OE	61	3.7213	1.09101

Table 5-6: **Analysis of the organizational promotion of ethical behaviour**

Item	n	Mean (SD)	t	Df	p-value
OE – Organisational promotion of ethical behaviour	61	3.72 (1.091)	5.164	60	<.001*

The analysis in Table 5-6 shows that there is a significant promotion of ethical behaviour in organizations, p<.001.

b. Personal ethical behaviour

The same analysis is done for these items. This time, all items are measured on a scale of 1 = not applicable to 5 = applicable, are measuring the personal ethical beliefs/behaviours of the respondents/employees. These responses are captured in Table 5-7 below.

Table 5-7: Responses from the questionnaire on personal ethical behaviour

Item		Responses as Frequency (%)						Mean (SD)	Median [IQR]	p-value
		1	2	3	4	5				
1 Treat others as you would have them treat you.	Not applicable	0 (0)	0 (0)	1 (1.6)	5 (8.2)	55 (90.2)	Applicable	4.89 (0.370)	5 [5; 5]	<.001*
2 Follow the moral values common to all major religions	Not applicable	3 (4.9)	1 (1.6)	7 (11.5)	5 (8.2)	45 (73.8)	Applicable	4.44 (1.088)	5 [4; 5]	<.001*
3 Adhere to the moral standards in my faith or religion above all other considerations	Not applicable	6 (9.8)	1 (1.6)	8 (13.1)	8 (13.1)	38 (62.3)	Applicable	4.16 (1.306)	5 [3.5; 5]	<.001*
4 Compassion for those who are suffering or disadvantaged is the most crucial virtue.	Not applicable	0 (0)	0 (0)	4 (6.6)	11 (18.0)	46 (75.4)	Applicable	4.69 (0.593)	5 [5; 5]	<.001*
5 Justice, fairness, and equality are the most important requirements for a society	Not applicable	0 (0)	0 (0)	2 (3.3)	10 (16.4)	49 (80.3)	Applicable	4.77 (0.496)	5 (5; 5)	<.001*
6 Loyalty to one's group is more	Not applicable	9 (14.8)	4 (6.6)	8 (13.1)	8 (13.1)	32 (52.5)	Applicable	3.82	5 [3; 5]	<.001*

important than one's concerns.								(1.500)		
7 Respect for authority is something everyone needs to learn	Not applicable	1 (1.6)	1 (1.6)	8 (13.1)	10 (16.4)	41 (67.2)	Applicable	4.46 (0.905)	5 [4; 5]	<.001*
8 People should not do things that are revolting to others, even if no one is harmed	Not applicable	1 (1.6)	1 (1.6)	2 (3.3)	4 (6.6)	53 (86.9)	Applicable	4.75 (0.745)	5 [5; 5]	<.001*

A single reliable measure is found for ‘personal ethics’ and summarised as follows:

These items above are numbered 1 to 8. Table 5-8 below shows a reflection of reliability for personal values.

Table 5-8: Reliability for personal values

Construct	Label	Items included	Cronbach’s alpha
Personal values	PV	2 3 4 5 6 8	.737

Once again analysis is done on this single construct to determine if the overall personal values are poor or good. From Tables 5-9 and 5-10, it can be seen that very good personal values are evident.

Table 5-9: **One-Sample Statistics for personal values**

One-Sample Statistics

	N	Mean	Std. Deviation
PV	61	4.4399	.67291

Table 5-10: **Analysis of personal values**

Item	n	Mean (SD)	T	df	p-value
Personal values (PV)	61	4.44 (.673)	16.712	60	<.001*

Analysis shows that there are significant personal values, p<.001.

c. Application of engineering ethics

The same analysis is done for these items. This time the scale is 1- disagree to 5 = agree, are measuring the application of engineering ethics using given scenarios.

Table 5-11: Responses from the questionnaire on the application of engineering ethics

Item		Responses as Frequency (%)						Mean (SD)	Median [IQR]	p-value
		1	2	3	4	5				
Engineering Ethics is a set of behavioural standards that all engineers are expected to follow.	Disagree	0 (0)	0 (0)	3 (4.9)	6 (9.8)	52 (85.2)	Agree	4.80 (0.511)	5 [5; 5]	<.001*
The application of engineering ethics is to ensure the safety of the public first and foremost	Disagree	0 (0)	0 (0)	4 (6.6)	10 (16.4)	47 (77)	Agree	4.70 (0.587)	5 [5; 5]	<.001*
By making use of engineering ethics, engineers can improve public perception of the engineering profession	Disagree	0 (0)	0 (0)	4 (6.6)	9 (14.8)	48 (78.7)	Agree	4.72 (0.581)	5 [5; 5]	<.001*
Negligence is a basis for disciplinary action under the Professional Engineering Act	Disagree	0 (0)	0 (0)	16 (26.2)	12 (19.7)	25 (41.0)	Agree	4.46 (0.905)	5 [5; 5]	<.001*
Failing to correct or report a situation that may endanger the	Disagree	1 (1.6)	1 (1.6)	8 (13.1)	10 (16.4)	41 (67.2)	Agree	4.75 (0.537)	5 (5; 5)	<.001*

public is against engineering practice										
Occasionally, a conflict of interest may occur accidentally or unavoidably. In such cases, the best course of action is to keep the conflict of interest secret, but try not to let it affect your decision	Disagree	0 (0)	0 (0)	3 (4.9)	9 (14.8)	49 (80.3)	Agree	2.51 (1.556)	3 [1; 4]	.013
Making public statements that are not based on firm knowledge and conviction can be attributed to vast and unquestionable experience	Disagree	27 (44.3)	3 (4.9)	15 (24.6)	5 (8.2)	11 (18.0)	Agree	3.02 (1.628)	3 [1; 5]	.997
Accepting commission for approving work is part of how engineers make their remuneration	Disagree	37 (60.7)	3 (4.9)	3 (4.9)	7 (11.5)	11 (18)	Agree	2.21 (1.654)	1 [1; 4]	<.001*
There is a link on the application of engineering ethics and service delivery	Disagree	1 (1.6)	0 (0)	5 (8.2)	12 (19.7)	43 (70.5)	Agree	4.57 (0.784)	5 [4; 5]	<.001*
Engineers are there to offer technical expertise and	Disagree	28	3 (4.9)	12 (19.7)	6 (9.8)	12 (19.7)	Agree	2.52	2 [1; 4]	.016

guidance and should not be distracted by soft skills such as ethics		(45.9)						(1.608)		
If engineering ethics are not followed, the result may be compromised service delivery	Disagree	0 (0)	0 (0)	5 (8.2)	10 (16.4)	46 (75.4)	Agree	4.67 (0.1.155)	5 [4.5; 5]	<.001*
Engineering ethics are currently being ignored within public service?	Disagree	3 (4.9)	3 (4.9)	13 (21.3)	14 (23.0)	28 (45.9)	Agree	4.00 (1.155)	4 [3; 5]	<.001*
A project is running behind the d program and a contractor delivers defective material on-site and re-ordering new supplies may delay project completion with chances of losing funding, It would be best to abandon the project	Disagree	27 (44.3)	8 (13.1)	10 (16.4)	7 (11.5)	9 (14.8)	Agree	2.39 (1.509)	2 [1; 4)	<.001*
Most people do not understand the technical aspects of a project, its best to involve the community	Disagree	28 (45.9)	8 (13.1)	10 (16.4)	3 (4.9)	12 (19.7)	Agree	2.39 (1.574)	2 [1; 3.5]	.003

when the project is completed and it is at the handover stage										
When faced with conflicting test results, Ignore the failed samples as they may not be representative. It is best to try to finish the project on time and not add unnecessary investigations	Disagree	41 (67.2)	5 (8.2)	10 (16.4)	4 (6.6)	1 (1.6)	Agree	1.67 (1.076)	1 [1; 2.5]	.007
Public service engineers are contributing towards improving the quality of life for communities	Disagree	4 (6.6)	0 (0)	9 (14.8)	10 (16.4)	38 (62.3)	Agree	4.28 (1.142)	5 [4; 5]	<.001*

These items were further analysed. Factor analysis with promax rotation was applied to explore the structure of the data and determine specific groupings (latent factors) that apply to the items. A Kaiser-Meyer-Olkin Measure of Sampling Adequacy KMO) of .784 and a significant Bartlett's test indicate that successful and reliable factor extraction was achieved. Three factors were extracted which account for 58.99% of the variance in the data. Rotation converged in 4 iterations. During this process, several items were dropped because they either did not load strongly enough onto a single factor or they cross-loaded on several factors. The factor loadings are summarised in Table 5-12.

Table 5-12: Factor loadings

	Factor		
	1	2	3
1 Engineering Ethics is a set of behavioural standards that all engineers are expected to follow.	.944		
2 The application of engineering ethics is to ensure the safety of the public first and foremost	.844		
3 By making use of engineering ethics, engineers can improve public perception of the engineering profession	.733		
5 Failing to correct or report a situation that may endanger the public is against engineering practice	.675		
4 Negligence is a basis for disciplinary action under the Professional Engineering Act	.613		
8 Accepting commission for approving work is part of how the engineers make their remuneration		.900	
15 When faced with conflicting test results, Ignore the failed samples as they may not be representative. It is best to try to finish the project on time and not add unnecessary investigations		.670	
10 Engineers are there to offer technical expertise and guidance and should not be distracted by soft skills such as ethics		.545	
6 Occasionally, a conflict of interest may occur accidentally or unavoidably. In such cases, the best course of action is to keep the conflict of interest secret, but try not to let it affect your decision		.492	
11 If engineering ethics are not followed, the result may be compromised service delivery			.889
9 There is a link on the application of engineering ethics and service delivery			.794

Details of these factors are summarised in Table 5-13 below..

Table 5-13: Details of the factors extracted

Factor	Construct	Label	Items included	Variance extracted (%)	Cronbach's alpha
1	Application of engineering ethics	AEE	1 2 3 4 5	36.24	.838
2	Unethical practices	UP	6 8 10 15	15.13	.731
3	Perceived effect on service delivery	PESD	9 11	7.63	.784

The results confirm that these three constructs are reliable. In addition, construct validity – both convergent and discriminant – is shown to be achieved from the structure in the factor loadings table.

Once again analysis is done to determine whether there is significant agreement or disagreement to these constructs. There is significant agreement that Engineering ethics are applied and that there is a perception that poor ethics affect service delivery. There is however a significant disagreement that unethical practices are found.

This is displayed in Table 5-14 on the next page.

Table 5-14: One-Sample Statistics for factors extracted

One-Sample Statistics

	N	Mean	Std. Deviation
AEE	61	4.6885	.49870
UP	61	2.2295	1.10989
PESD	61	4.6230	.64327

Further analysis was undertaken and shown in Table 5-15. This was done to test if these 5 composite measures differ significantly across municipality and gender (test = independent samples t-test). Also, if there is a correlation (Spearman's correlation) between age, experience, religious importance, and these 5 constructs.

Table 5-15: Analysis of composite measures and gender per municipality

Group Statistics

	Municipality	N	Mean	Std. Deviation	Gender	N	t	df	Sig. (2-tailed)	Analysis
OE	Ingquza	34	3.2537	1.12668	Female	8	-4.486	56.057	.000	Organisational promotion of ethical behaviour occurs significantly more at Elundini than at Ingquza, p<.001.
	Elundini	27	4.3102	.69973	Male	53				
UP	Ingquza	34	2.6250	1.06467	Female	8	3.384	59	.001	Unethical practices are perceived to occur sig more at Ingquza than at Elundini, p=.001.
	Elundini	27	1.7315	.97054	Male	53				

Table 5-16: Spearman's correlation

			OE	PV	AEE	UP	PESD
Spearman's rho	Age	Correlation Coefficient	.392**	-.041	-.063	-.440**	-.124
		Sig. (2-tailed)	.002	.755	.632	.000	.341
		N	61	61	61	61	61
	Year in current role	Correlation Coefficient	.030	.109	.100	-.028	-.025
		Sig. (2-tailed)	.819	.403	.441	.829	.846
		N	61	61	61	61	61
	Religion Importance	Correlation Coefficient	.216	.239	.126	-.162	.339**
		Sig. (2-tailed)	.095	.064	.333	.211	.008
		N	61	61	61	61	61

OE and age

The perception of organizational promotion of ethical behaviour is positively correlated with age, rho = .392, p=.002. This is perception stronger for those of greater age.

UP and age

The perception of unethical practice is negatively correlated with age, rho = -.440, p<.001. This perception is stronger for younger employees.

PESD and Religion

The perceived effect on service delivery had a positive correlation to the importance of religion, rho = -.339, p =.0.08. This perception is stronger for those greater in age.

5.2.3 Section 3: Open-ended questions on the use of engineering ethics to improve service delivery

Thematic analysis was chosen a suitable method of examining the data from the open-ended questions to gain a meaningful understanding of participant perspectives. The analysis identified patterns within the qualitative data enabling the researcher a detailed understanding of the research data.

This information from participants proved a valuable tool of communication as it was not constrained by any limitations to the responses. Microsoft Excel provided a valuable method for examining the content of responses from data collected.

Creswell (2012) has advocated that thematic analysis enables the researcher to organize and analyse and interpret them to determine common perspectives among participants. It is important to however highlight that as with any qualitative data, personal views and biases on the topic being explored are quite common in open-ended responses (Sutton and Austin 2015).

a. How can engineers use engineering ethics to improve service delivery?

Responses received were categorized into 5 categories, including those who chose not to answer the question. Results are noted in the table below. Personal virtues such as honesty and integrity, transparency and accountability, and technical competency were cited as the leading ways (tied at 15% respectively) in which engineers could use engineering ethics to improve service delivery. Detailed results are reflected in Table 5-17 below.

Table 5-17: Results for question: How can engineers use engineering ethics to improve service delivery

Categories	Percentage	No of respondents
No answer	51%	31
Virtues such as honesty, integrity, transparency, and accountability	15%	9
Technical Competency in Engineering processes - planning, design, and execution	15%	9
Regulation	13%	8
Tendering, costing, and estimation	7%	4

b. How could the use of engineering ethics better empower public service engineers to provide improved service delivery?

Responses were again classified into five categories according to answers received from respondents including the “No answer” category. 19% of the respondents identified improving technical competency and capacity as the leading way in which public service engineers could be empowered to improve service delivery. Detailed results are reflected in Figure 5-2 below.

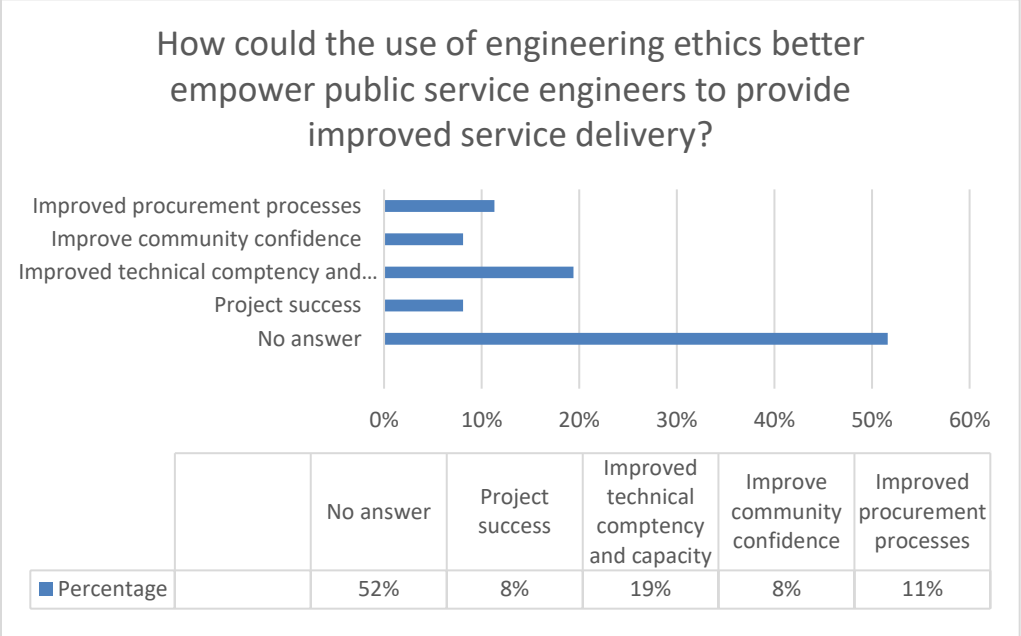


Figure 5-2: Representation of answers to questions "How could the use of engineering ethics better empower public service engineers to provide improved service delivery?"

c. Which areas of ethical compromise are people within your designation most exposed as they carry out their duties?

Responses received were categorized into 4 categories, including the "No answer" category. The leading area (21%) of ethical compromise was identified as non-compliance with project specifications. Detailed results are reflected in Figure 5-3 below.

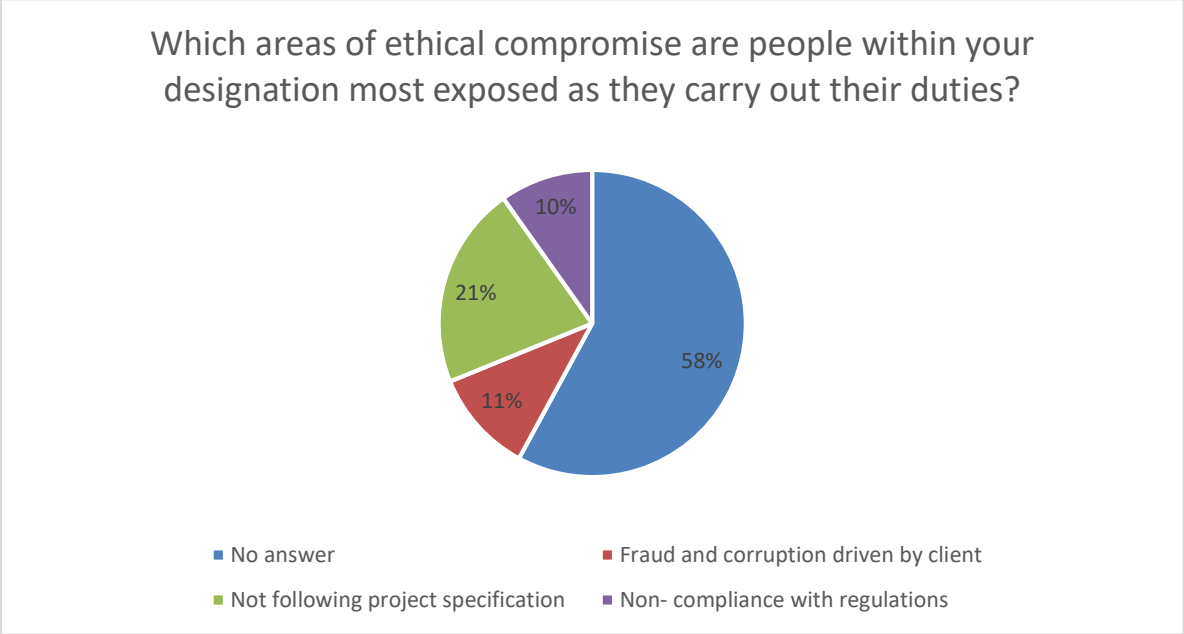


Figure 5-3: Representation on the question "Which areas of ethical compromise are people within your designation most exposed as they carry out their duties?"

d. List 3 ethical values stated in your organization's code of conduct

Responses were grouped into 5 categories, including the "No answer" category for respondents who did not complete the section. Most respondents (20%) identified values such as honesty, fairness, integrity, and transparency as the common ethical values cited in their organizational code of conduct. Detailed results are reflected in Table 5-18 below.

Table 5-18: List 3 ethical values stated in your organization's code of conduct

Categories	Percentage	No of respondents
No answer	67%	41
Competency	7%	4
Honesty, fairness, integrity, transparency	20%	12
Public Interest	5%	3
Compliance with regulations	2%	1

e. List 3 ethical values stated in your organization's code of conduct that are relevant to the ethics as contained in the ECSA Code of Conduct for Registered persons.

Responses were categorised into similar categories to the previous question. Honesty, fairness, integrity, and transparency were once again identified as the leading (11%) ethical value contained in the respondents' code of conduct, closely followed by public health, safety, and environment (9%). Detailed results are reflected in Table 5-19 below.

Table 5-19: List 3 ethical values stated in your organization's code of conduct that is relevant to the ethics as contained in the ECSA Code of Conduct for Registered persons

List 3 ethical values stated in your organisation's code of conduct that is relevant to the ethics as contained in the ECSA Code of Conduct for Registered persons.	Total respondents who answered X	% of respondents who answered X
Categories	**Percentage**	**No of respondents**
No answer	42%	37
Competency	8%	5
Honesty, fairness, integrity, transparency	11%	7
Public health, safety and environment	9%	6
Compliance with regulations	6%	4

f. What are the three most difficult ethical issues that you have faced in your work? List the most difficult first.

Responses from this question were grouped into 7 categories, including the "No answer" and "No ethical compromise" categories. Fraud and corruption driven by the client were identified as the leading cause of ethical compromise. Non-compliance with project specification was ranked last at 3%, which was in stark contrast to a similar question phrased under c above wherein it had been identified as the leading area of ethical compromise at 21%. Detailed results are reflected in Figure 5-4 below.

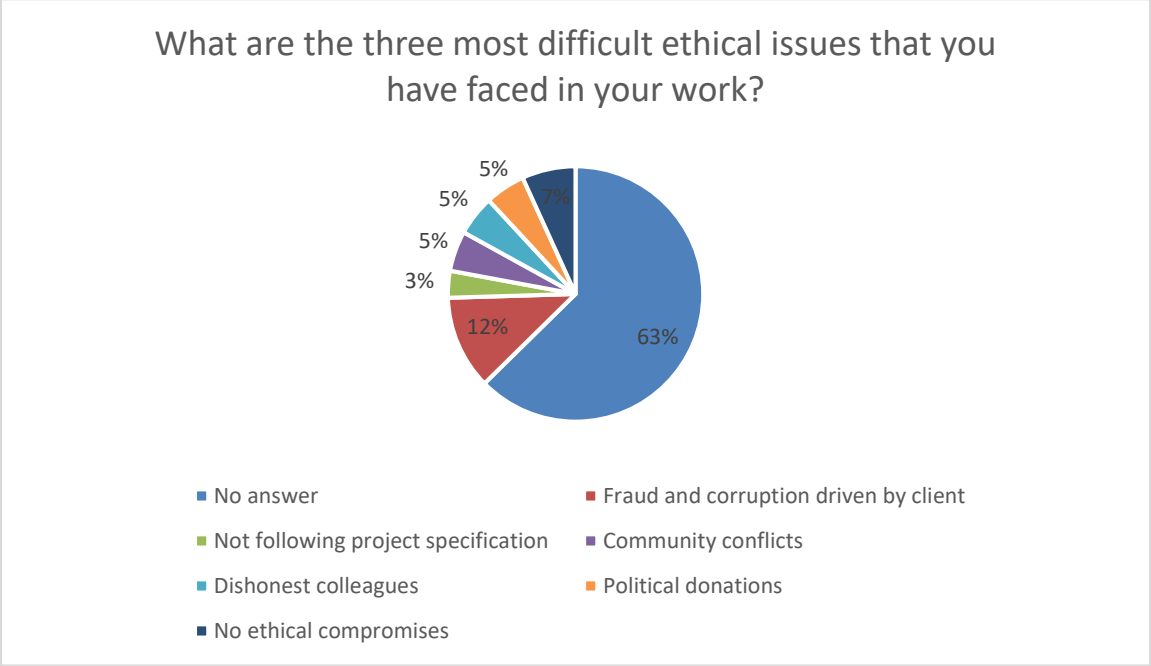


Figure 5-4: Representation of the question "What are the three most difficult ethical issues that you have faced in your work?"

g. Do you have any further comments in general regarding the use of engineering ethics for the betterment of service delivery?

When respondents were asked if they could provide any further comments on the use of engineering ethics for the betterment of service delivery, they provided the following responses:

a. It is essential to the industry and the public trust, especially in a developing country where there is a perception of corruption and collusion
b. Consequence management needs to be constantly and continuously instituted to improve and encourage ethical behaviour in the engineering industry
c. More honesty in the procurement of all work professionals and construction
d. Any unethical behaviour must be reported. Ethical people in the engineering industry must stop looking the other way as it has become the new norm. We must change the industry to align with our ethical beliefs.
e. Corruption, unethical behaviour, and the acceptance of substandard work from contractors and service providers must stop. It is killing our industry and

the economy in general. The taxpayers are becoming fewer and the public at large are the losers.

f. Proper monitoring of ethical behaviour in the industry may improve the quality-of-service delivery.

From the responses above, it is evident that there is a need to foster an environment favourable to ethical decision-making by engineers.

5.3 CONCLUSION

By conducting the main survey, the researcher has been able to meet the key objectives of the research.

a. To determine whether an engineer's ability to make complex moral decisions can be used to improve the overall performance of duties of engineers within public service, thus resulting in improved service delivery.

b. To determine the role played by engineering ethics in the identified case study municipalities.

c. To create a model for ethical decision-making that will assist the case study towns in making better engineering decisions.

From the results of the study, it is evident that there is agreement that an engineer's ability to make complex moral decisions can be used to improve the performance duties of engineers. The main study also went into great detail in determining the role played by engineering ethics in the identified case study municipalities, which will assist in the crafting of the ethical decision-making model which will be tackled in the next chapter.

CHAPTER 6: DEVELOPMENT OF AN ASSESSMENT TOOL FOR ETHICAL COMPLIANCE

6.1 INTRODUCTION

The development of the assessment tool made use of information collected from both the pilot and main studies.

The pilot study unearthed a variety of factors that hinder ethical decision-making in the case study environment. From the results of the pilot study, integrity was identified as the leading ethical concern whilst political overreach and the inability to make engineering decisions closely followed as part of the top three concerns. These findings are not out of the ordinary and have long since been a concern in the South African environment. Walsh (2020) ventures that these prolific challenges signal that the underlying threat lies in leadership.

From the main survey, it is evident from the areas of ethical compromises unearthed engineers need to be better equipped in making ethical decisions during their execution of engineering activities.

To address these, a framework for enabling effective ethical engineering decision-making would therefore need to be formulated to better aid the challenges identified in the case study municipalities. This chapter will therefore address this imperative.

6.2 ENGINEERING DECISION MAKING

According to Prahbat (2016), decision-making is commonly thought of as the cognitive process one undergoes before choosing a particular course of action. He further proclaims that engineers are trained to approach problems from a relatively more pragmatic and logical perspective. Engineers value efficiency, utility, and minimizing cost over aesthetics and flair. Teaching ethics in engineering is an important topic, yet typical approaches can often seem distant (Center for Engineering Learning & Teaching 2015). Thus, the professionals need to be trained in exploring the solution space of problems related to engineering ethics (Baligar and Joshi 2017).

Herrmann (2015) provides for two categories of decisions that engineers make

- What should the design be?

1) The National Research Council (2001) advocates that knowledge-based engineering tools can provide computational representations of engineering design rules, allowing engineers to execute modelling, analysis, and optimization thereby improving design decisions. Herrmann (2015) describes these types of decisions as straightforward and requiring an established approach to decision making, as the “right” answer can often be judged objectively.

- What should be done?

1) Herrmann (2015) classifies these as management decisions that define which activities should happen, their sequence, and who should perform them. This is an area where most predominant ethical dilemmas arise. He further describes these decisions as an “issue,” an undesirable situation that a person or an organization wishes to change and admits that solving this type of problem can be a messy process.

2) Engineering decision-making requires the application of engineering judgment. Engineering judgment may be described as a method or process used to resolve field problems when a tested design, system, or assembly is not available. Engineering judgment making involves generating and evaluating alternatives and selecting the most preferred one that satisfies given requirements

The following six step problem-solving process was established by Powell and Baker (2004) and can be used as a means for enabling engineering decision making:

a. Investigate the following facts: Look for issues and possibilities, embrace a challenge, and get to work on a solution.
b. Gather data and impressions, evaluate the situation from a variety of perspectives, and determine the most significant information.
c. Choose a working problem statement from a list of potential problem statements.
d. Search for solutions: Consider a variety of options before settling on one (or a few) that appear to be the most promising.
e. Form criteria for analysing and evaluating ideas and choose the most significant criterion, then evaluate and revise the idea(s), and finally choose a solution.
f. Implement a solution: first, determine the implementation processes and resources needed, and then put the solution into action.

A system reflection of the six step problem solving process is given in Figure 6-1 below.

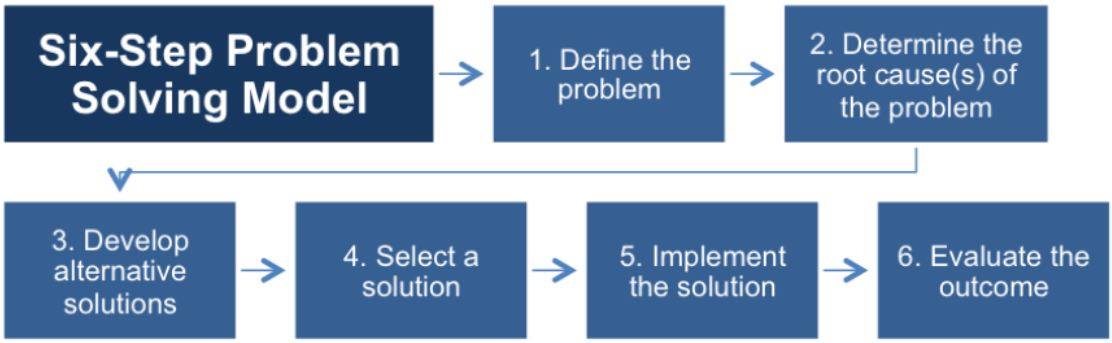


Figure 6-1: Six-Step Problem Solving Model

To understand the decision-making processes engineers undertake, it is critical to provide a context for the nature of problems that engineers face. Cheerangie (2019) provides the following categories for engineering problems:

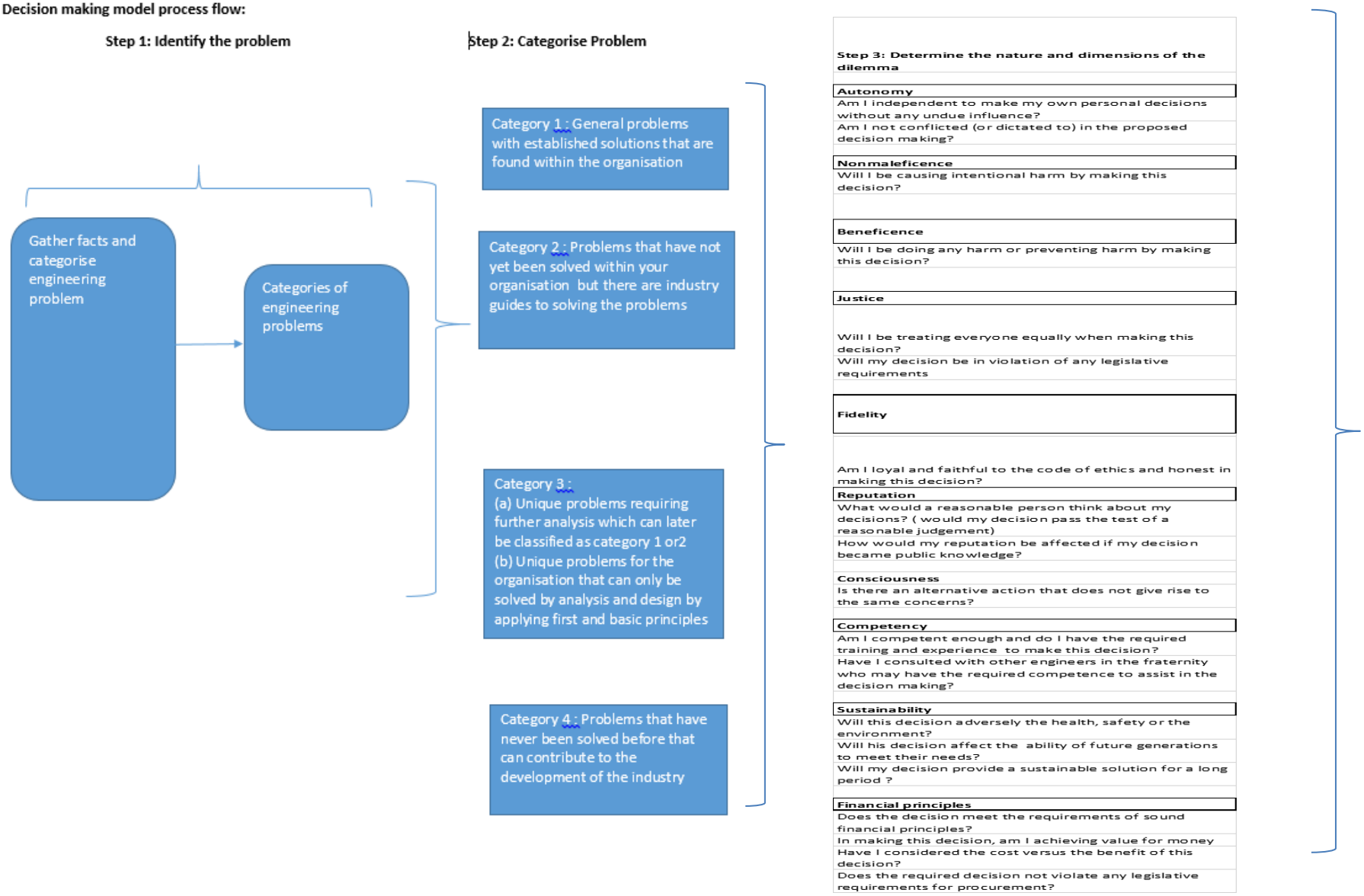
a. General problems that have already been solved by someone in the organization. These problems should have generic solutions
b. General problems that have not been solved by someone in the organization, but there are known ways for solving them throughout the industry. These problems should be solved in consultation with others in the fraternity
c. Problems that seem unique at first, but upon further investigation, fall under categories one or two. One can draw analogies between these problems and Category 2 problems, and in doing so, utilize the same problem-solving process for the first two categories.
d. Specific problems that neither the engineer nor the industry has solved which provide for opportunities for new approaches. These problems are career-changing and can impact the industry as a whole. It's the problems that can define a lifetime of work. These are the truly rare societal challenges

Municipal engineers more likely face the same nature of problems with the only change being the environment under which the decisions are undertaken

6.3 AN ENGINEERING AID FOR ETHICS IN DECISION MAKING

The following model has been formulated taking into account tested ethical decision-making aides and has been formulated to provide a sequential approach to ethical engineering decisions making. The model is reflected in Figure 6-5 below.

Decision making model process flow:



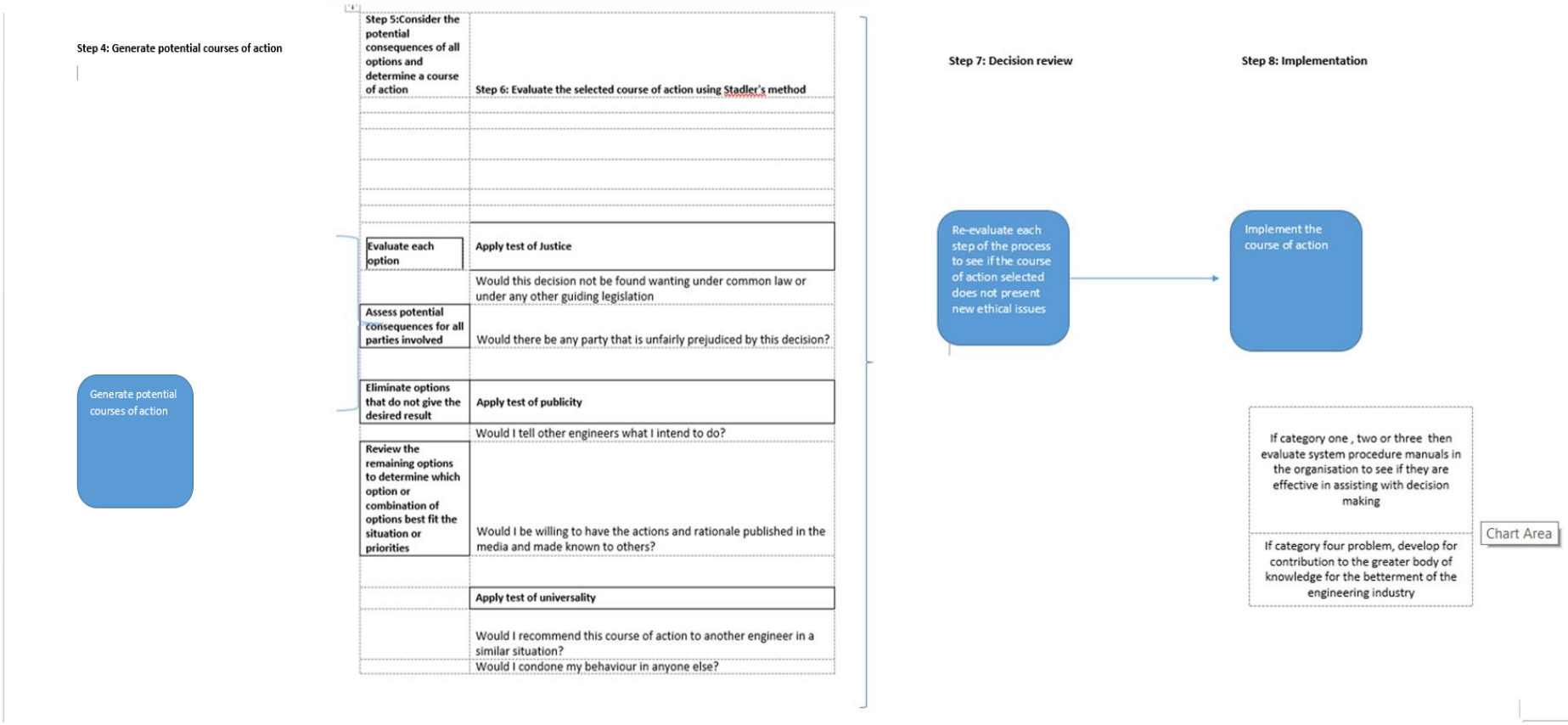


Figure 6-5: Engineering ethical decision-making model

6.3.1 Step 1: Identify the problem

This step comprises two key components, namely gathering the facts and categorizing the engineering problem.

6.3.1.1 Gathering the facts

This serves as a starting point for gathering information regarding the situation. The fact that most ethical conflicts are perceived is a hurdle, but it is critical to distinguish between assumptions and suspicions. Questions like who, what, where, when, how, and why can be asked. When there is a lack of information, it is critical to provide the foundation for any assertions. It is important to remember that ethical issues are frequently complex, therefore a good rule of thumb is to look at the situation from multiple angles and avoid looking for a simple solution.

Gathering of facts assist in establishing the following:

a. Who are the most important or immediate stakeholders?
b. Who are the indirect or secondary stakeholders?
c. Why are they involved in the problem as stakeholders?
d. Putting things into perspective - viewing things through the viewpoint of those who are affected.

6.3.1.2 Define nature of the problem

Problems can be simple or complex in nature involving set standards or needing one to decipher grey lines which may be easily crossed. This therefore requires an Engineer to be conscious of the nature of his problem.

6.3.2 Categorising the engineering problem

This is done in line with Cheerangie (2019) categories of problems established in paragraph 6.2 above. The following categories are included in the decision-making tool:

a. Category 1: General problems with established solutions that are found within the organization
b. Category 2: Problems that have not yet been solved within your organization but there are industry guides to solving the problems
c. Category 3: (i) Unique problems requiring further analysis which can later be classified as category 1 or 2

(ii) Unique problems for the organization that can only be solved by analysis and design by applying first and basic principles

d. Category 4: Problems that have never been solved before that can contribute to the development of the industry

6.3.3 Step 3: Determine the nature and dimensions of the dilemma

This model is centred on the premise that engineers are bounded by the ECSA code of ethics, thus decision-making needs to subscribe to this code of conduct. For this purpose, the model makes reliance on Clause 3 (Rules of Conduct: Ethics) as found in the ECSA code of conduct for registered persons. The following areas are emphasised as defined in the code of conduct:

a. Competency
b. Integrity
c. Public Interest
d. Environment
e. Dignity of the profession

The complexity of ethical challenges necessitates a thorough examination of the nature and dimensions of ethical issues. Looking at several factors such as moral ideals, professional obligations, and regulatory compliance might serve as a guide for this goal. Rudimentary questions based on Bowen (2005), Velasquez et al. (2021), and Blanchard and Peale (1988) are offered to aid the decision-maker in achieving the intended goal.

a. Autonomy - Am I independent to make my own decisions without any undue influence? Am I not conflicted (or dictated to) in the proposed decision-making?
b. Non-maleficence - Will I be causing intentional harm by making this decision?
c. Beneficence - Will I be doing or preventing any harm by making this decision?
d. Justice - Will I be treating everyone equally when making this decision? Will my decision violate any legislative requirements?
e. Fidelity - Am I loyal and faithful to the code of ethics and honesty in making this decision?
f. Reputation - What would a reasonable person think about my decisions? (Would my decision pass the test of a reasonable judgment). How would my reputation be affected if my decision became public knowledge?
g. Consciousness - Is there an alternative action that does not give rise to the same concerns?
h. Competency - Am I competent enough and do I have the required training and experience to make this decision? Have I consulted with other engineers in the fraternity who may have the required competence to assist in the decision-making?
i. Sustainability - Will this decision adversely the health, safety, or the environment? Will his decision affect the ability of future generations

to meet their needs? Will my decision provide a sustainable solution for a long period?

j. Financial principles - Does the decision meet the requirements of sound financial principles? In making this decision, am I achieving value for money? Have I considered the cost versus the benefit of this decision? Does the required decision not violate any legislative requirements for procurement?

6.3.4 Step 4: Generate potential courses of action

This entails coming up with a variety of options. It necessitates the decision maker's openness and creativity in evaluating all available options. You can also enlist the help of a co-worker or an outside party who can quickly find new ways to address the problem. The flexibility of investigation necessary in this step is based on Forester-Miller and Davis (2016)'s philosophy, which states that professionals confronted with similar situations may choose various actions.

6.3.5 Step 5: Consider the potential consequences of all options and determine a course of action

This stage asks the decision-maker to consider the decision's potential good and negative repercussions for those who may be affected. To make analysis easier, one might concentrate on the most important stakeholders. Examining the short-term vs. long-term effects might help you figure out whether your decision will hold up over time.

There are also wider systemic implications to consider, such as those related to symbolism and concealment.

Symbolic ramifications - Every decision conveys a message and might establish precedent.

Consequences of secrecy - What happens if a choice or action is made public?

Have any cognitive biases or impediments been considered?

Consider a situation in which the decision is only dependent on the consequences. The decision-maker must examine the size of the repercussions as well as the likelihood that they will occur, before moving on to check if the situation is comparable when other factors are considered.

The following considerations must be made to assist the decision-maker in doing so:

- Consider each possibility.

- Evaluate the potential ramifications for all parties involved - Rule out options that do not produce the desired result - Evaluate the remaining possibilities to identify which option or combination of options best fits the scenario or priorities.

6.3.6 Step 6: Evaluate the selected course of action using Stadler's method

This step borrows Stadler's (1986) philosophy outlined in paragraph 6.4 (f) above. The decision-maker is required to evaluate the decision taken according to three tests as outlined below:

a. Apply the test of Justice - Would this decision not be found wanting under common law or any other guiding legislation? Would there be any party that is unfairly prejudiced by this decision?
b. Apply the test of publicity - Would I tell other engineers what I intend to do? Would I be willing to have the actions and rationale published in the media and made known to others?
c. Apply the test of universality - Would I recommend this course of action to another engineer in a similar situation? Would I condone my behaviour in anyone else?

6.3.7 Step 7: Decision review

This step requires the decision-maker to re-evaluate each step of the process to see if the course of action selected does not present new ethical issues. If a new ethical dilemma is presented, then the decision-maker needs to re-start the process of decision making.

6.3.8 Step 8: Implementation

This is by far the most difficult step in ethical decision-making – taking the required action. This requires the decision-maker to act in resolving the identified ethical dilemma. This also allows the decision-maker to create an environment that can ease decision-makers for others in a similar situation. If the ethical dilemma was categorized under category one, two, or three in step 1 of the decision-making process, then it is important for the decision-maker to evaluate system procedure manuals in the organization to see if they are effective in assisting with decision making. If a category four problem has been established, the decision-maker can contribute to the greater body of knowledge for the betterment of the engineering industry.

6.4 PRACTICAL EXAMPLE FOR THE APPLICATION OF THE ETHICAL DECISION MAKING MODEL

The information below gives an illustration of a practical situation in which the decision making tool could be utilised.

Let's go back to the example highlighted in Chapter 2, section 2.7 of this dissertation. A detailed extract of the case study is attached as an appendix to this dissertation and has been further included in the references for information and ease of reference. The case study is that of the construction of a single residential unit in a standard designed development. The tool will now be utilised to show how engineering decision making could have been improved making use of the ethical decision making model.

6.4.1 Step 1

The Engineer in the problem needed to consider the following stakeholders

a. Who are the most important or immediate stakeholders? **His employer the contractor**

b. Who are the indirect or secondary stakeholders and why are they identified in the problem?

- **The purchaser - has to occupy the unit after completion**
- **The Architect – is responsible for ensuring design compliance and overall building approval**
- **The designer – responsible for concept formulation and modification of design**
- **The artisans – responsible for design execution and constructing the unit**

c. Putting things into perspective - viewing things through the viewpoint of those who are affected.

- The contractor stands to benefit financially from any decision that is made relating to savings in material. The benefit will be financial and may also be time related if the omission leads to less work being required.
- The purchaser will use the property for his own personal benefit, be it for occupancy or for re-sale and the overall quality will affect not only the market value but the overall acceptability of the end product.
- The Architect has to approve the works and deem them fit for occupancy upon completion.

- The designer has overall accountability for design suitability and usage and failures could be easily attributable to him risking reputational damage.
- The artisan is responsible for the overall presentation of the plan and its desirability to suit the intended purpose. Any deformations could easily be blamed on the artisan thus he needs to be meticulous in his execution and also make enquiry where clarity is required as he is not vested with authority to deviate from the design or make alterations.

d. The nature of the problem was simple regarding basic principles of wrong and right, however the decision is complicated by the nature of the relationship between the Engineer and the contractor. The contracting party in this case is the contractor and the Engineer seems inclined to act in the contractor's best interest as his employer.

6.4.2 Step 2

Category of the problem – the Engineer had to make a decision based on a design that is already approved meaning that the nature of the problem was well defined. This therefore classifies it as a category 1 problem making him suitably qualified to make the decisions independently making use of the facts at his disposal.

6.4.3 Step 3

The dimensions of the dilemma can be analysed as follows:

a. Compromised autonomy due to the financial relationship between the employer and the Engineer
b. The issue of maleficence comes into play when compromises in quality are made as they may have a structural bearing and cause unintended harm to users of the residency. The decision to reduce the height between the ground floor and the first floor had unintended consequences of the reduction in door height bringing it closer to a hazardous level. This in turn would affect the overall usage and aesthetics of the building making it harder for the owner to appropriate it for its intended purpose at completion.
c. The decision would be unjust and unfavourable to the owner as it would degrade the overall value of the property in comparison to the other residential units that had been constructed according to the specification.
d. The Engineer was not honest in making his decision in that he misled the other parties into thinking the reduction was due to the stairway being too steep. The independent investigation also showed that there was no justification to substantiate his reasoning in making the design

alteration which was worsened even more so that consultation with the architect had not been made.

e. The owner would not derive value for money from the Engineer's decision but instead would need to pay the same amount as the other residential units which did not have the defect in their execution. The contractor would therefore unduly benefit from this decision.

6.4.4 Step 4

If the Engineer was required to save costs for his employer, he could have identified other means that did not have an overall compromise in quality of the structure. This could have involved the exploration of equivalent but suitably tested brands in terms of materials which were required for construction. The engineer could consider in this regard investigating alternative suppliers for this purpose.

An accelerated construction period could have also lead to a decrease in running costs and this could have been easily achieved by sourcing a well skilled artisan – this is in reference to the note on the case study reflecting that the artisan was unskilled.

If the changes required were a direct request from his employer, the Engineer is then duty bound by the code of conduct to advise his employer of the ramifications of the decision and also highlight the reputation risk his employer may be faced with.

6.4.5 Step 5

The alternatives provided have an additional implication of time delays due to the period that it may take to get alternative suppliers or a suitably trained artisan, however they do not bring rise to new ethical constraints. The options still yield a positive outcome towards project completion but they require the Engineer to effectively analyse their value.

6.4.6 Step 6

When applying Steadler's method to the new alternatives, one may argue that the current artisan would be unfairly prejudiced through replacement with one who may be more suitably qualified, however this could be contracted by having the less skilled artisan work under strict supervision by the Engineer or under the new artisan. The old artisan could also be deployed on to a less sensitive project that would allow him opportunity for learning in the process to acquire the needed skills. This would therefore enable the decision to pass the test for justice, publicity and universality.

6.4.7 Step 7

When reviewing the decisions the Engineer can look at whether there are any further ethical compromises evident. At present it seems as though the needs of all stakeholders have been adequately addressed. This would then lead to successful project implementation yielding a fruitful relationship between the Engineer and his employer in that there is no risk of reputational damage.

6.4.8 Step 8

The Engineer is therefore required to execute his decision.

CHAPTER 7: CONCLUSION AND RECOMMENDATIONS

7.1 RESEARCH SUMMARY

The case study environment provided a fertile ground for the exploration of vital issues on engineering ethics. Perceptions from both the municipal employees and the professional service providers contracted to both municipalities showed that there were underlying ethical problems that needed decisive actions from the decision-makers within both municipalities.

7.2 CONCLUSIONS RELATIVE TO THE PILOT STUDY

From the pilot study, it was evident that constraints relating to engineering decision-making and the ability to exercise proper quality control during engineering processes were key frustrations for the interviewed municipal employees.

In addition to this, there is also rising concern regarding political influences which affect ethical decision-making amongst employees which is seen to limit the autonomy of personnel practicing in the case study municipalities. This is consistent with Reddy's (2013) findings that major challenges being experienced within local government include inter alla, poor service delivery ; corruption ; poor financial management and lack of compliance ; lack of political and management will ; increased politicization of the municipal service ; poor skills base ; lack of monitoring and evaluation and weak intergovernmental relations. The development of a mechanism to enable ethical decision-making could provide much-needed relief to the personnel within these municipalities.

Lack of training on engineering ethics as well as the competency of engineering personnel have been highlighted as key factors plaguing personnel in both municipalities, which is evidenced by lack of suitable qualified or registered employees in both employees. This in turn makes it harder to regulate engineering practices within the case study environment as most of the personnel had no professional affiliation.

7.3 CONCLUSIONS RELATIVE TO THE MAIN SURVEY

From the main survey, fraud and corruption driven by the client were identified as the leading cause of ethical compromise. Organizational promotion of ethical behaviour was found to occur significantly more at Elundini than at Ingquza Hill. Unethical practices are perceived to occur more at Ingquza Hill than at Elundini as evidenced from the responses received from each municipality's service providers.

The role of the main survey participants was that of Professional Service providers who were meant to be providing technical support to the case study municipalities, so it was unexpected to have a majority presenting as candidates (14.8%) or unregistered with ECSA (45%). The lack of professional registration of service providers can be attributed to a lack of enforcement of regulation when it comes to practicing within the suitable area of registration. It can therefore be concluded that the respective municipalities do not consistently verify suitable registration of personnel provided by contracted organizations.

Over 27% of the main survey participants had been contracted for more than 6 years which is worrisome when looking at the provisions of the MFMA and considering that term contracts are provisioned for three years. The lack of new skills being sourced can also lead to the laxity of ethical compliance, even more so in an environment that is perceived to be rife with unethical conduct.

There is overall agreement that engineering ethics were being applied in the organizations in which the respondents worked and there is a perception that poor ethics affect service delivery, which was consistent with the objectives of the study. There was significant agreement that the organizations which the respondents work for required ethics training.

Respondents also agreed that there was significant relatively strict enforcement of penalties for unethical behaviour within their organizations which could not be echoed for the municipalities in which they were practicing. It can therefore be concluded that there must be mechanisms established within these organizations to ensure the enforcement of ethical compliance, thus the case study municipalities could benefit from the sharing of such practices and the incorporation of these practices within their policies to ensure enforcement.

7.4 CONCLUSIONS RELATIVE TO THE ETHICAL DECISION-MAKING TOOL

The researcher had been authorized to design a model that the identified municipalities would consider implementation. Management will be responsible for implementing/testing the model. It is important to consider that situations will differ in both municipalities, and this may affect overall how the tool is implemented, but management's willingness to improve the decision-making environment is key to the successful application and implementation of the tool. The tool is overall arching in the problems it seeks to resolve, thus it should be suitable for use in both municipalities which have been seen to have similar challenges as far as engineering decision making is concerned.

7.5 RECOMMENDATIONS FOR MANAGEMENT

7.5.1 Ingquza Hill Municipality

To address the issue of engineering competency and accountability, it is advised that management explores a mentoring strategy that can be led by the professional service providers to ensure that employees are eligible for ECSA registration. Promotion of ECSA registration amongst employees will foster an environment of increased accountability and empower engineering decision-making within the identified areas of practice.

There was overall agreement that there was a need for training in engineering ethics. Personnel could benefit from the structuring a training program that will form part of their road to registration as part of the key outcomes required by ECSA.

The ethical decision-making model could serve as an interim solution to the limited ability in decision making, but management needs to address issues of political interference perceived to affect decision making. It is also recommended that decision-making autonomy be allowed during engineering decision making which can limit the fraud and corruption perpetrated by the client as perceived by service providers.

7.5.2 Elundini Municipality

There was agreement that overall, there were organizational ethics in place which created an environment that promoted ethical decision making. It was however noted that with both personnel and professional service providers practicing within the municipality, professional registration was absent with ECSA. This limits accountability in that engineering personnel are not bound by the regulator's code of conduct which can compromise engineering decision-making. It was also established that non-compliance with project specifications was a challenge that needed to be addressed. If left unattended, this could compromise the overall quality of engineering work. Management, therefore, needs to pay particular focus in ensuring understanding of engineering roles and scope of work to ensure enforcement of project specification.

7.6 SUGGESTIONS FOR FURTHER RESEARCH

It is recommended that the generated decision-making tool be examined and explored further for usage in other similar contexts as a decision-making help for engineers. Further analysis of how Engineers in municipalities are held accountable for decision making particularly considering the lack of registration and affiliation with the regulatory authority could be done as part

of future research. Another area of contribution would be looking at the recruitment and selection procedures for municipal engineers to compare it to the professional engineering capacity constraints that seem evident in the case study municipalities. Outside the scope of this dissertation, one may also investigate the relationship between professional registration and ethical conduct

REFERENCES

Abdul-Rahman, H. (2010). "How professional ethics impact construction quality." Scientific Research and Essays.

Abdul Rahman, H. Wang, C. and Saimon, M (2011). "Clients' Perspective of professional ethics for civil engineers."

Abdul-Rahman, H. Wang, C. and Yap, W. (2010). “How professional ethics impact construction quality: Perception and evidence in a fast developing economy." Scientific Research and Essays 5(23): 3742-3749.

Alibama Board for Registered Interior Designers. (2018). "Importance of Joining a Professional Organization." Retrieved 22 March 2020, from https://abrid.alabama.gov/about-interior-design/importance-of-joining-a-professional-organization.

Alzheimers Europe. (2009). The Four Main Approaches: Types of Research. Iyer, Luxemburg. Accessed at https://blogs.deakin.edu.au/devt-hum/2019/12/02/on-selecting-a-research-paradigm-and-why-pragmatism-worked-for-us/ on 21 March 2020.

American Society of Civil Engineers. (2008). Ethics: Guidelines for Professional Conduct for Civil Engineers.

Arthur, W. (2020). "Ethical Decision Making Models." Retrieved 11 January 2020, from https://pagecentertraining.psu.edu/public-relations-ethics/introduction-to-public-relations-ethics/lesson-2/ethical-decision-making-models/.

Athanassoulis, N. (2020). Virtue Ethics, Internet Encyclopedia of Philosophy.

Baligar, P. and G. Joshi (2017). Engineering ethics: decision-making using fundamental canons. International Conference in Engineering Education Transformations.

Baron, J. (2004). "Normative models of judgment and decision making." Blackwell Handbook of Judgment and Decision Making: 19–36.

Baron, J. (2012). The point of normative models in judgment and decision making Philadelphia, PA, USA, Department of Psychology, University of Pennsylvania.

Beauchamp, T.L. and Childress, J.F. (1979). Principles of biomedical ethics. New York : Oxford University Press.

Beauchamp, T. L. Childress, J. F. and Childress, U. P. H. P. E. J. F. (1979). Principles of Biomedical Ethics, Oxford University Press.

Beerbohm, E. and Davis, R. W. (2017). "The Common Good: A Buck-Passing Account*." Journal of Political Philosophy 00(00).

Beemsterboer, S., Baumann, H. and Wallbaum, H. (2020). Bridging the gap between assessment and action: recommendations for the effective use of LCA in the building process. IOP Conference Series Earth and Environmental Science 588(2) DOI:10.1088/1755-1315/588/2/022007

Bello, M., Martin, D. and R. Kasim (2017). "A Review of Effects of Quality Municipal Services on Citizen Satisfaction in Malaysian Municipal Council: A Content Analysis."

Belyh, A. (2020). "The Nadler-Tushman Congruence Model: Aligning The Drivers Of High Performance." Retrieved 03 January 2021, from https://www.cleverism.com/nadler-tushman-congruence-model.

Bekink, B. (2006). The powers and functions of municipal governments. University of Pretoria.

Bernstein, D. and Shaw, N. (2016). Anti-Corruption in South Africa Baker McKenzie South Africa.

Bero, B. N. and Kuhlman, A. (2011). "Teaching Ethics to Engineers: Ethical Decision Making Parallels the Engineering Design Process." Science and Engineering Ethics 17(3):597-605 17(3): 597-605.

Besterfield, D., Besterfield - Michna, C. Besterfield, G. H. and Besterfield – Sacre, M. (2003). Total Quality Management. Upper Saddle River, Prentice Hall.

Bhandari, P. (2020). "An introduction to quantitative research." Retrieved 03 March 2021, from https://www.scribbr.com/methodology/quantitative-research/.

Blanchard, K. and Peale, N. V. (1988). The Power of Ethical Management. London, Random House.

Bowen, P. (2007). "Professional ethics in the South African construction industry." Building Research and Information 35(2): 189-205.

Bowen, S. (2005). "A Practical Model for Ethical Decision Making in Issues Management and Public Relations." Journal of Public Relations Research 17(3): 191-216.

Brait, R. and Pollock, B. (2004). "Confidentiality, Intellectual Property and Competitive Risk in the employment relationship" THE CANADIAN BAR REVIEW 83: 585-632.

Brannen, J. (2004). "Mixing Methods: The Entry of Qualitative and Quantitative Approaches into the Research Process." International Journal of Social Research Methodology 8(3): 173-184.

Campbell, J. (2014). "South Africa: What Does "Service Delivery" Really Mean?" Africa in Transition.

Center for Engineering Learning & Teaching. (2015). Ethical Decision Making in Engineering. Highline College: Campus Reflection Field Guide – Reflective

Techniques to Encourage Student Learning: Background and Examples. Seattle, Washington.

Chandler, J. (2017). Descriptive Decision Theory. Stanford Encyclopedia of Philosophy, The Metaphysics Research Lab.

Cheerangie, K. K. (2019). "The Four Types of Problems Engineers Must Solve." https://engineeringmanagementinstitute.org/tag/four-types-of-problems/ Accessed 22 March 2020.

Chartered Institute of Building Construction Management Profession. (2020). "Quality Control for Construction Works." from https://www.designingbuildings.co.uk/wiki/Quality_control_for_construction_works, Chartered Institute of Building Construction Management Profession.

Cloud Research (2015). Determining Sample Size: How Many Survey Participants Do You Need? Accessed at www.cloudresearch.com./resources/guides/statistical-significance/determine-sample-size/ on 21 March 2020.

Construction Industry Development Board (2003). Code of conduct for all parties engaged in Construction Procurement, Construction Industry Development Board.

Construction Industry Development Board (2011) "Construction Quality in South Africa: A client perspective", Construction Industry Development Board.

Connor, K. (2006). "Assessing organizational ethics: measuring the gaps." Proquest 38(3): 148-155.

Corruption Watch (2014). Understanding tender corruption. J. Erasmus. South Africa, Media Club South Africa.

Cottone, R. and Tarvydas, V. (2007). Counseling ethics and decision making. Pearson/Merrill Prentice Hall.

Cottone, R. R. (2012). "Ethical decision making in mental health contexts: Representative models and an organizational framework." APA PsycBooks.

Creswell, J. (2012). Educational Research Planning, conducting, and evaluating quantitative and qualitative research Boston, MA Pearson.

Creswell, J. W. and Creswell, J. D. (2017). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. Newbury Park, SAGE Publications.

de Visser, J. (2010). The political-administrative interface in South African municipalities assessing the quality of local democracies..

Denzin, N. K. and Lincoln, Y. S. (2005). "Introduction: The Discipline and Practice of Qualitative Research." The Sage handbook of qualitative research 1-32.

Department of Planning Monitoring and Evaluation . (2016). Outcome 7: Vibrant, equitable, and sustainable rural communities and food security for all. Department of Planning Monitoring and Evaluation

Department of Provincial and Local Government. (2004). "MIG - Municipal Infrastructure Grant guideline document – National MIG management unit programme management processes and procedures."

Department of Provincial and Local Government (2007). Policy process on the System of Provincial and Local Government: Background: Policy Questions, Process, and Participation. Government Notice 936 Government Gazette No 30137 of 1 August 2007. South Africa, Department of Provincial and Local Government.

Dillon, S. M. (1998). Descriptive Decision Making: Comparing Theory with Practice. 33rd Annual Operational Research Society of New Zealand Conference. Auckland: 99-108.

Doherty, L. (2014). "Do engineers need ethics?" Engineering News Retrieved 13 March 2019, from https://www.engineeringnews.co.za/article/do-engineers-need-ethics-2014-08-01.

Dooty and Dooty, C. M. (2015). "Conducting a pilot study: case study of a novice researcher." British journal of nursing.

Dougherty, M. Thomas, R. and Lange, N. (2010). Psychology of Learning and Motivation, Science Direct. 52: 299-342.

Dudovskiy, J. (2018). The Ultimate Guide to Writing a Dissertation in Business Studies: A Step-by-Step Assistance, Research-methodology.net.

Engineering Council of South Africa (2006). Government Gazette No. 28605, 17 March 2006, Rules of Conduct for Registered Persons: Engineering Profession Act, 2000 (Act No. 46 of 2000). South Africa, Engineering Council of South Africa.

Engineering Council of South Africa (2012). Case Study No. 2012/5: Extreme implications, from contravention of ECSA's Rules of Conduct on a small project. South Africa, Engineering Council of South Africa.

Engineering Council of South Africa (2017). Code of Conduct for Registered Persons: Engineering Profession Act. South Africa, Engineering Council of South Africa.

Engineering Council of South Africa (2018a). Criteria and Processes for Recognition of Educational Qualifications for Professional Categories South Africa, Engineering Council of South Africa.

Engineering Council of South Africa (2018b). Guide to the Competency Standards for Registration as a Professional Engineer. South Africa, Engineering Council of South Africa.

Engineering Council of South Africa (2020). Overarching Code of Practice for Performance of Engineering Work. South Africa, Engineering Council of South Africa.

Eastern Cape Socio-Economic Consultative Council (2000). Rural Development Framework. Bhisho, South Africa, Eastern Cape Socio-Economic Consultative Council.

Eastern Cape Socio-Economic Consultative Council (2018). 2017 / 2018 ECSECC Annual Report. East London, South Africa, Eastern Cape Socio-Economic Consultative Council.

Edwards, W. (1968). "Conservatism in human information processing." Formal Representation of Human Judgment. 17(52).

Elundini Municipality (2019). -integrated Development Plan (IDP) 2019-20. Elundini Municipality.

Elundini Municipality (2020). -integrated Development Plan (IDP) 2020-21. Elundini Municipality.

Education and training unit for democracy and development. (2020). "Municipal Service Delivery." Retrieved 26 November 2020, from https://www.etu.org.za/toolbox/docs/localgov/munservice.html.

Evans, J. A. (2007) "An essay on divine command ethics." Texas A&M University.

Calhoun, C. (2015). "Phil 240a Hand-out #7 - varieties of non - consequentialist ethical theories." from http://faculty.washington.edu/wtalbott/phil240/hdnoncon.htm.

Fan, L. (2003). Decision-making models for handling ethical dilemmas. ICE Virtual Library.

Febrero, M. J. (2017). "Consequentialism - Ethical Egoism." Retrieved 19/03/2019, from https://www.slideshare.net/MaryFabrero/consequentialismethical-egoism.

Federation of Consulting Engineers (2016). Definition of services guidelines: Infrastructure Construction / Civil Works, Federation of Consulting Engineers.

Fieser, J. (2019). Ethics. Internet Encyclopedia of Philosophy. University of Tennessee, U. S. A., Encyclopedia of Philosophy.

Flew, A. (1979). A dictionary of philosophy. New York, St. Martin's.

Forester-Miller, H. and Davis, T. E. (2016). "Practitioner's Guide to Ethical Decision Making." The Center for Counseling Practice, Policy, and Research.

Forester-Miller, H. and Rubenstein, R. L. (1992). Group counseling: Ethics and professional issues. Denver, Colorado.

Frost, M. (2011). "Consequentialism." Retrieved 21/03/2019, from http://www.martinfrost.ws/htmlfiles/consequentialism.html.

Fu, E. (2013). "Why Public Service Needs Engineers and Scientists." from https://www.huffingtonpost.com/ernestine-fu/why-public-service-needs-engineers_b_3714313.html.

Gildenhuys, J. S. H. (2004). Ethics and professionalism are the battle against public corruption. Stellenbosch, Sun Press.

Gill, P. Stewart, K. Treasure, E. and Chadwick B. (2008). "Methods of data collection in qualitative research: interviews and focus groups " British dental journal 204(8): 291-296.

Goodwin, L.D and Leech, N.L. (2006). “Understanding Correlation: Factors That Affect the Size of r.” The Journal of Experimental Education 74, no. 3: 251–66. http://www.jstor.org/stable/20157427.

Haas, L. J. and Malouf, J. L. (1989). "Keeping up the good work: A practitioner’s guide to mental health ethics." Professional Resource Exchange.

Hair, J.F., Black, W.C., Babin, B.J. and Anderson, R.E. (2010) Multivariate Data Analysis pg.676. 7th Edition, Pearson, New York.

Hamzah, A., Wang, C. and Yap, X. (2010). "How professional ethics impact construction quality: perception and evidence in a fast developing economy, scientific research, and essays."

Handelsman, M. M. Knapp, S. and Gottlieb, M. C. (2009). Positive ethics: Themes and variations. , Oxford University Press.

Hare, R.M. (1981). Moral Thinking: Its Levels, Method, and Point. Oxford Scholarship Online. 10.1093/0198246609.001.0001

Hare,R.M. (1985). Comparison of procedures for the assessment of psychopathy. Journal of Consulting and Clinical Psychology, 53(1), 7–16. https://doi.org/10.1037/0022-006X.53.1.7

Hart, G. (2011). "Applying Utilitarianism: Are Insider Trading and the Bailout of GM Ethical?" Retrieved 21/03/2019, from https://sevenpillarsinstitute.org/ethics-101/applying-utilitarianism-are-insider-trading-and-the-bailout-of-gm-ethical/.

Potter, R.B. (2020) Potter's box for ethical decision making. Harvard Divinity School, Harvard University. (https://hds.harvard.edu/)

Hayes, A., James, M. and Beer, K. (2021). Stratified Random Sampling.

Herrmann, J. W. (2015) "Introduction to engineering Decision making." Engineering Decision Making and Risk Management.

Hess, J. (2013). Global Portrayals of Engineering Ethics Education: A Systematic Literature Review. 120th ASEE Annual Conference & Exposition, American Society for Engineering Education.

Ho, W.T and So, H.C.J (2016). Issues in Measuring Generic Skills Using Self-Administered Questionnaire in a Community College in Hong Kong. Open Access Library Journal, Volume 3 Issue No.7.

Ingquza Hill Local Municipality (2019). Integrated Development Plan (IDP) 2019-20. Ingquza Hill Local Municipality.

Institute of Directors. (2002). King of Code of Governance Principles. KING II.

Institute of Directors. (2016). King of Code of Governance Principles. KING IV.

Iyer, R. (2018). "What is the importance of religion in our lives?" Retrieved 31 March 2020, from https://www.tutorialspoint.com/what-is-the-importance-of-religion-in-our-lives#:~:text=Religion%20helps%20in%20creating%20an,empathy%2C%20respect%2C%20and%20harmony

Jacob-Timm, S. (1999). "Ethically challenging situations encountered by school psychologists." Psychology in the Schools 36(3): 205-217.

Johnson, E. J. and Ratcliff, R. (2014). "Computational and Process Models of Decision Making in Psychology and Behavioural Economics" Neuroeconomics.

Johnson, M. K. (2020). Making a Decision on Ethical Decision-Making Models. Utah State University, DigitalCommons@USU.

Jamaludin, SZHS. and Mohammed, M.F. Ahmad, K. (2014). Enhancing the Quality of Construction Environment by Minimizing the Cost Variance Social and Behavioural Sciences. AMER International Conference on Quality of Life. The Pacific Hotel, Sutera Habour, Malaysia: University of Technology MARA.

Kahlela, T. (2018). Ethics in construction industry: project managers' case study. Durban University Technology.

Kamm, F. M. (2007). "Intricate Ethics: Rights, Responsibilities, and Permissible Harm." Oxford Scholarship Online.

Kenton, W. (2019). McKinsey 7S Model. Investopedia. V. Velasquez, Dotdash Meredith Publishers.

Kim, H. Y. (2013). "Statistical notes for clinical researchers: assessing normal distribution (2) using skewness and kurtosis." Restorative dentistry & endodontics 38(1): 52-54.

Kitchener, K. S. (1984). "Intuition, critical evaluation and ethical principles: The foundation for ethical decisions in counseling psychology." Counseling Psychologist 12: 43-55.

Krosnick, J., Holbrook, A., Berent, M., Carson, R., Hanemann, M., Kopp, R.J., Mitchell, R., Presser, S., Ruud, P., Smith, V., Moody, W., Green, M.C., Conaway, M. (2002). The impact of "no opinion" response options on data

quality - Non-attitude reduction or an invitation to satisfice?. Public Opinion Quarterly. 66. 371-403.

Kruger, M. (2013). "Leading quality management for improved public service delivery." African Journal of Public Affairs. 5(3): 167-178.

Cushman, R.(2018). Ethics Terms and Terminology. Philadelphia, Pennsylvania: 2. La Salle University

Langer, G. (2003). "About Response Rates - Some Unresolved Questions" Public Perspective: 16-18.

Leedy, P. D. and Omrod, J. E. (2014). Practical Research: planning and design. Upper Saddle River, Merrill Prentice Hall.

Lerrick, A. (2005). Aid to Africa at Risk: Covering Up Corruption. International Economics Report, Gailliot Center for Public Policy.

Lues, L. (2007). "Service delivery and ethical conduct in the public service: the missing links." Koers - Bulletin for Christian Scholarship.

Maness, M., Sheela, P., Balusu, S. and Pinjari, A. (2018). When neutral responses on a Likert scale do not mean opinion neutrality: Accounting for unsure responses in a hybrid choice modelling framework. 7th Innovations in Travel Modeling Conference, Atlanta, GA, USA. http://onlinepubs. trb. org/onlinepubs/Conferences/2018/ITM/MManess. pdf

Manyaka, R., K. and Sebola, M.P. (2013). Ethical training for effective anti-corruption systems in the South African public service. Journal

Martin, W. and Schinzinger, R. (2005). Ethics in Engineering. New York, United States of America, McGraw Hill.

Mathebula, N. and Makamu, V. (2014). Reflections on conceptions of corruption in South Africa: implications for service delivery. South African Association of Public Administration and Management Limpopo Chapter. The Park Hotel, Mokopane.

Mauro, P. (1995). "Corruption and Growth." The Quarterly Journal of Economics 110(3): 681-712.

McCartney, S. and Parent, R. (2015). Ethics in Law Enforcement. Burnaby, Canada, Simon Fraser University.

McKinsey Quartely. (2008). https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/enduring-ideas-the-7-s-framework. McKinsey and Company.

Middleton, F. (2019). "Reliability vs validity: what's the difference?" Retrieved 22 March 2020, from https://www.scribbr.com/methodology/reliability-vs-validity/.

Mind Tools. (2021). "McKinsey 7-S Framework - Making Every Part of Your Organization Work in Harmony." from https://www.mindtools.com/pages/article/newSTR_91.htm.

Mohamed, O. M. Nazihah, J. N. Bachok, S. and Izzaty-Bakri, N. (2012). "An Assessment of Local Authority Performance in Delivering Their Services: Case Study of Ipoh City Council." Journal of Architecture, Planning & Construction Management 4: 1-20.

Mokhlis, S. (2011). "Municipal Service Quality and Citizen Satisfaction in Southern Thailand ".

Mpehle, Z. (2012). "Are service delivery protests justifiable in democratic South Africa?" Journal of Public Administration 47: 213-227.

Municipal IQ. (2019). 2019 Service Delivery Uptick, Municipal Data, and Intelligence.

Muzhedzi, M. P. (2016). "Fostering public accountability in South Africa: A reflection on challenges and successes." Retrieved 14 April 2019, from https://td-sa.net/index.php/td/article/view/339/330.

Nadler, D. A. and Tushman, M. L. (1989). "Organizational Frame Bending: Principles for Managing Reorientation." Academy of Management Perspectives 3(3).

National Planning Commission. (2011). Diagnostic overview South Africa, Department: The Presidency of the Republic of South Africa.

National Research Council. (2001). Approaches to Improve Engineering Design. Washington, DC: The National Academies Press. https://doi.org/10.17226/10502.

Ngcaweni, B. (2020). National School of Government vote 10a Annual Report 2019/20. South Africa, Department of National School of Government.

National Treasury. (2015). Standard for Infrastructure Procurement and Delivery Management: Annexure B. South Africa, Department of National Treasury: 66.

National Treasury. (2018). MFMA Circular 92 - Municipal Finance Management Act No. 56 of 2003. Municipal Public Accounts Committee. South Africa, Department of National Treasury: 1.

Ncube, M. (2014). "Improving the Performance of Municipalities Through Performance-Based Grants." Retrieved 03 June 2019, from

http://www.ffc.co.za/docman-menu-item/reports/610-2014-2015-tr-chapter-12-improving-the-performance-of-municipalities-through-performance-based-grants.

Nigro, O. (2012). "Citizens Satisfaction with Local Governments in Argentine: Key Predictors." Journal of Public Administration and Governance 2: 35-56.

Ojasalo, J. (2001). "Managing customer expectations in professional services." Managing Service Quality: An International Journal 11: 200-212.

Oluwaseun, T. (2013). "Corruption and Economic Development: Africa and East Asia in Comparative Perspective " Ubuntu: Journal of Conflict and Social Transformation 2: 47-67.

Ongori, H. (2007). "A review of the literature on employee turnover." African Journal of Business Management: 49-54.

Organisation for Standardisation (2006). ISO 26000 Guidance on social responsibility, International Organisation for Standardization.

Organisation for Standardisation (2011). ISO 10845-3:2011 Construction procurement — Part 3: Standard conditions of tender, International Organisation for Standardization.

Organisation for Standardisation (2021). ISO 10845-3:2021 Construction procurement — Part 3: Standard conditions of tender, International Organisation for Standardization.

Paul, R. Sen, A. and Wyatt, E. (2018). What is Engineering Leadership? A Proposed Definition. 2018 ASEE Annual Conference & Exposition. Salt Lake, Utah, American Society for Engineering Education.

Powell, S. G. and Baker, K. R. (2004) "The Art of Modeling with Spreadsheets."

Prahbat, J. (2016). "The Importance of Ethics in the Engineering Sector." Retrieved 20 February 2019, from https://medium.com/@PrabhatJoshi/the-importance-of-ethics-in-the-engineering-sector-cba24b1eba26

Public Service Coordinating Bargaining Council. (2013). Public Service Charter. South Africa, Public Service Coordinating Bargaining Council.

Reddy, P. S. (2018). "Evolving local government in post-conflict South Africa: Where to?" Sage Publications.

Reddy, P.S. and de Vries, M.S. (2013). Ethical training for effective anti-corruption systems in the South African public service. Cabinet, Journal of Public Administration.

Reddy, P. S. and de Vries, M. S. (2016). Quo Vadis? Local Governance and Development in South Africa post-1994. Johannesburg, South Africa, Palgrave.

Republic of South Africa (1996). Constitution. South Africa, Republic of South Africa.

Republic of South Africa (1998 a). Local Government: Municipal Structures Act 117 of 1998. South Africa, Office of the President, Republic of South Africa.

Republic of South Africa (1998 b). White Paper on Local Government South Africa, Department of Co-operative Governance and Traditional Affairs.

Republic of South Africa (2000). Local Government: Municipal Systems Act, 2000 (Act NO. 32 OF 2000), Republic of South Africa.

Republic of South Africa (2003). Local Government: Municipal Finance Management Act, 2003 (Act NO. 56 OF 2003), Republic of South Africa.

Republic of South Africa (2004). Prevention and Combating of Corrupt Activities Act, 12 of 2004 Republic of South Africa.

Rochon, J. Gondan, M. and Kieser, M. (2012). To test or not to test: Preliminary assessment of normality when comparing two independent samples. BMC Medical Research Methodology. Volume 12, Article numbe: 81.

Runciman, W. (1972). "Explaining Social Stratification." Imagination and Precision in the Social Sciences.

Sabir, A. (2018). "The Congruence Management -a Diagnostic Tool to Identify Problem Areas in a Company." Journal of Political Science and International Relations 1(2): 34.

South African Customer Satisfaction Index. (2019). "South Africans not happy with Service Delivery - survey." Retrieved 03 June 2019, from https://www.fin24.com/Economy/south-africans-not-happy-with-municipalities-survey-20160727, South African Customer Satisfaction Index.

South African Institution of Civil Engineering. (2017). "Code of Ethics for Members." from https://saice.org.za/wp-content/uploads/2017/09/SAICE-Code-of-Ethics.pdf, South African Institution of Civil Engineering.

South African Institution of Civil Engineering. (2021). Civil Engineering Journal. Volume 29, Issue 1, page 10. Pursuing inspirational and transformational leadership in civil engineering.

South African Institution of Mechanical Engineering (2018). The South African Institution of Mechanical Engineering Standard of Professional Competency. South Africa, The South African Institution of Mechanical Engineering.

Salkind, N. (2010). Pragmatic Study. Encyclopedia of Research Design, SAGE.

Scalza, A. A. (2011). "Ethics in the Construction Industry. Teaching Students Ethics in this 21st Century Global Market." Academia.

Schwartz, A. E. (2014). "Key Concepts in Engineering Ethics: Protecting the Public Health and Safety & Demonstrating Professional Competence." Retrieved 18 February 2019, from https://www.nspe.org/sites/default/files/resources/pdfs/091814EthicsWebinar.pdf

Sebake, B. and Sebola, M. (2013). "Growing trends and tendencies of corruption in the South African public service: negative contribution to service delivery." Journal of Public Administration.

Shantikumar, S. (2018). "Research Methods Appropriate to Public Health Practice, including Epidemiology, Statistical Methods and other methods of inquiry including Qualitative Research Methods." Retrieved 22 March 2020, from https://www.healthknowledge.org.uk/public-health-textbook/research-methods.

Shasha, Z. (2012). An assessment of service delivery challenges: Intsika Yethu Municipality. Master of Public Administration, Nelson Mandela Metropolitan University.

Shaver, R. (2002). Egoism, Stanford Encyclopedia of Philosophy. Accessed at https://plato.stanford.edu/entries/egoism/ on 23 March 2019

Shin, D. (1977). "The quality of municipal service: Concept, measure and results".

Sileo, F. J. and Kopala, M. (1993). "An A-B-C-D-E worksheet for promoting beneficence when considering ethical issues." Counseling and Values 37(2): 89-95.

Singer, E. and Couper, M. P. (2017). "Some Methodological Uses of Responses to Open Questions and Other Verbatim Comments in Quantitative Surveys." Methods, data, analyses: a journal for quantitative methods and survey methodology (mda), 11(2): 115-134.

Slote, M. (2001). Morals from Motives, Oxford University Press.

Hasan, K. (2009). "Unit One: Introduction to Ethics." Retrieved 21/03/2019, from https://www.soas.ac.uk/cedep-demos/000_P563_EED_K3736-Demo/module/pdfs/p563_unit_01.pdf. School of Oriental African Studies.

Stadler, H. A. (1986). "Making hard choices: Clarifying controversial ethical issues." Counseling and Human Development 19(1): 1-10.

Stanford Encyclopedia of Philosophy (2007). Deontological Ethics. Accessed at https://plato.stanford.edu/entries/ethics-deontological/ on 31 March 2020.

Stats SA. (2011). Census 2011 Statistical release (Revised) P0301.4 South Africa, Statistics South Africa.

Stats SA. (2016). Community Survey Statistical release P0301. South Africa, Statistics South Africa.

Steers, R. M., Mowday R. T. and Shapiro, D. L. (2004). "Introduction to special topic forum: The future of work motivation theory." Academy of Management Review 29(3): 379-387.

Strong, K. C. and Meyer, D. G. (1992). "An Integrative Descriptive Model of Ethical Decision Making " Journal of Business Ethics 11(2): 89-94.

Sullivan, R. J. (1994). An introduction to Kant's ethics. New York, Cambridge University Press.

Sutton, J. and Austin, Z. (2015). "Qualitative Research: Data Collection, Analysis, and Management." The Canadian journal of hospital pharmacy 68(3): 226-231.

The Royal Academy of Engineering. (2011). Engineering ethics in practice: a guide for engineers. Carlton House Terrace, London, The Royal Academy of Engineering

Uff, J. (2003). The engineer's public duty: The role of the institutions. Ingenia. London, The Royal Academy of Engineering: 49-55.

UN General Assembly (1948). Universal Declaration of Human Rights. 217 A (III), available at: https://www.refworld.org/docid/3ae6b3712c.html

UN Global Compact. (2016). Ten Principles of the United Nations Global Compact, United Nations Global Compact.

Van Hoose, W. H. and L. V. Paradise (1979). Ethics in counseling and psychotherapy: Perspectives in issues and decision making. Cranston, Rhode Island, Carroll.

Velasquez, M., Moberg, D. Meyer, M. J. Shanks, T. McLean, M. R. DeCosse, D. André, C. and Hanson, K. O. (2021). "A Framework for Ethical Decision Making." Accessed at https://www.scu.edu/ethics/ethics-resources/a-framework-for-ethical-decision-making/ on 21/11/2021.

Walsh, B. (2020). The Challenge of Ethics and Governance in South Africa's Crisis. The People Factor Magazine.

Waterman, R. H. J. and Peters, T. J. (2004). In Search of Excellence, Haper Collins.

Weber, E. U. (2001). "Personality and Risk Taking" International Encyclopedia of the Social & Behavioural Sciences.

Whittemore, R. and Melkus, G. D. E. (2008). "Designing a Research Study." The Diabetes Educator 34(2).

Whittier, N. C., Dewett, T. C. and Williams, S. (2006). "Evaluating ethical decision-making models: a review and application." Society and Business Review 1(3): 235-247.

Williams, G. (2017). Kant's Account of Reason. Stanford Encyclopedia of Philosophy, The Metaphysics Research Lab.

Wisniewski, M. (2001). "Using SERVQUAL to Assess Customer Satisfaction with Public Sector Services." Managing Service Quality: An International Journal 11: 380-388.

Wisniewski, M. and de Visser, J. (2010). The political-administrative interface in South African municipalities assessing the quality of local democracies. Commonwealth Local Government Conference Freeport, Bahamas, Commonwealth Journal of Local Governance.

Yadav, A. and Barry, B. (2009). "Using case-based instruction to increase ethical understanding in engineering: what do we know? what do we need?" International Journal of Engineering Education

Yadav R.S. Shrestha, I.N and Mishra, A.J. 2016. Assessment Of Ethical Behavior Among Professionals At Procurement And After Tendering Process With Its Impacts And Drivers In Nepalese Construction Industry. International Journal of Scientific and Technology Research. Volume 5(11). Available at www.ijstr.org. (Accessed on 14 April 2019)

Yu, Y.M. (2015). "Comparative Analysis of Jones' and Kelley's Ethical Decision-Making Models." Journal of Business Ethics 130(3): 573-583.

Zitha, H. and N. Mathebula (2015). "Ethical conduct of procurement officials and implications on service delivery: a case study of Limpopo provincial treasury." Public and Municipal Finance 4(3): 16-24.

Živković, N. and Glogovac. M (2019). Determining the quality of municipal services using SERVQUAL model 5th IPMA SENET Project Management Conference Atlantis Press. 108.

APPENDICES

Appendix 1: Ethics certificate

CERTIFICATE

OF COMPLETION

PHRP Online Training, LLC certifies that

Sisekho Sako

has successfully completed the web-based course
"Protecting Human Research Participants Online Training".

Date Completed: **04/07/2019**
Certification Number: **2821927**

PHRP
Protecting Human
Research Participants
Online Training

Appendix 2: Letter of information and consent form

LETTER OF INFORMATION

I **Sisekho Sako**, a Post-Graduate student at the Durban University of Technology– am undertaking research on "The use of Engineering Ethics for the betterment of service delivery: The case of Public Service", with a specific focus on "engineers within local municipalities" as part of my Master of Engineering research.

Title of the Research Study:

The use of Engineering Ethics for the betterment of service delivery: The case of Ingquza Hill and Elundini Local Municipalities

Principal Investigator/s/researcher: (Name, qualifications)

Sisekho Sako (B-Tech Civil Engineering : Construction Management)

Co-Investigator/s/supervisor/s: (Name, qualifications)

Brief Introduction and Purpose of the Study:

The aim of the research is to explore how the application of ethical engineering principles can be utilised to improve service delivery.

It seeks to determine the linkage between engineering ethics and the quality of service delivery provided, thus determining whether the use of engineering ethics can be a driver for better service delivery.

Outline of the Procedures:

The research methodology will incorporate a desktop review as well as make use of interviews to provide an analytical experience of the concept under investigation as well as to provide a more practical outcome to the research question. Engagements with the participants will take the form of structured interviews in the form of a questionnaires. The findings of the research will then be conveyed back to the research environment in the hope that they can be applied to provide improved service delivery.

Risks or Discomforts to the Participant: Not applicable

Benefits:

The research is intended to contribute to the improvement of service delivery which is the primary job of the participant who are in public service. The findings of the research will also be published for wider impact

Reason/s why the Participant May Be Withdrawn from the Study: (Non-compliance, illness, adverse reactions, etc. Need to state that there will be no adverse consequences for the participant should they choose to withdraw)

Participants are free to withdraw participation at any point during the study. Information obtained from interviews with the participant will not be used as part of the final submission should they withdraw consent. Participants are under no obligation to participate for the entire duration of the study and do so at their own free will.

Remuneration: Not Applicable

Costs of the Study: Not Applicable

Confidentiality: (Description of the extent to which confidentiality will be maintained and how will this be maintained)

All participants will be advised during the introductory stages that data will be held securely and kept confidential, and that the final data will stored, analysed and reported in a completely anonymised format. The details of each interview case will be fully anonymised so that anyone analysing that data will not be able to trace the participant.
All data will be kept private, both from other participants and when reporting findings.
The project will adhere to the requirements of data protection rules in terms of data labelling, storage and security as detailed in the DUT Research Ethics Policy.
Notes from the research session and accompanying data (inclusive of recordings where applicable) will be stored in locked filing cabinets and on a password protected computer.
Participants' names and individual positions will not be referenced once fieldwork is complete so it will not be possible to link responses to individual participants once the final submission has been consolidated and are only for statistical purposes.

Research-related Injury: None expected

Persons to Contact in the Event of Any Problems or Queries:

(Supervisor and details) Please contact the researcher (Sisekho Sako 073 011 9908), my supervisor (tel no.) or the Institutional Research Ethics Administrator on 031 373 2900. Complaints can be reported to the Director: Research and Postgraduate Support, Prof S Moyo on 031 373 2577 or moyos@dut.ac.za

General:

The research primary language is English.

CONSENT

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Sisekho Sako about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: _____,
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

_____	_____	_____	_____
Full Name of Participant	**Date**	**Time**	**Signature / Right Thumbprint**

I, Sisekho Sako herewith confirm that the above participant has been fully

informed about the nature, conduct and risks of the above study.

Sisekho Sako	03/06/2019	
Full Name of Researcher	**Date**	**Signature**
Full Name of Witness (If applicable)	**Date**	**Signature**
Full Name of Legal Guardian (If applicable)	**Date**	**Signature**

Please note the following:

Research details must be provided in a clear, simple and culturally appropriate manner and prospective participants should be helped to arrive at an informed decision by use of appropriate language (grade 10 level

- use Flesch Reading Ease Scores on Microsoft Word), selecting of a non-threatening environment for interaction and the availability of peer counselling (Department of Health, 2004)

If the potential participant is unable to read/illiterate, then a right thumb print is required and an impartial witness, who is literate and knows the participant e.g. parent, sibling, friend, pastor, etc. should verify in writing, duly signed that informed verbal consent was obtained (Department of Health, 2004).

If anyone makes a mistake completing this document e.g. a wrong date or spelling mistake, a new document has to be completed. The incomplete original document has to be kept in the participant's file and not thrown away, and copies thereof must be issued to the participant.

References:

Department of Health: 2004. *Ethics in Health Research: Principles, Structures and Processes*

http://www.doh.gov.za/docs/factsheets/guidelines/ethnics/

Department of Health. 2006. *South African Good Clinical Practice Guidelines*. 2nd Ed. Available at:

http://www.nhrec.org.za/?page_id=1

Appendix 3: Gate Keeping Authorisation

To	**:**	***The Municipal Manager Ingquza Hill Local Municipality***
From	**:**	***Sisekho Sako***
Date	**:**	***14 March 2019***
Subject	**:**	***Request for authorization to undertake Master of Engineering research***

gineering programme with the Durban University of Technology

2. The research topic is "The use of Engineering Ethics for the betterment of service delivery: The case of Public Service"

3. The aim of the research is to explore how the application of ethical engineering principles can be better utilized to improve service delivery. It is anticipated that the findings of the research will contribute to a larger body of knowledge within the engineering fraternity and thus boosting service delivery within Ingquza Hill LM

4. I am writing this memorandum to request the following in respect of the above:

    a. Authorization to undertake the intended research within Ingquza Hill LM interacting with engineering professionals as employed and contracted by the municipality.
    b. To request support of the institution while undertaking this research and to be afforded an opportunity to table the findings of this research as a means of contributing towards service delivery and later on to avail the information upon consent for publishing in engineering and construction journals as required by the Durban University of Technology

5. I have attached a sample of my research proposal, accompanied by the proposed research questionnaire for data collection to be submitted to the Institutional Research Ethics Committee at DUT on the 31 March 2019 as well as a letter of information relating to the research.

6. It is therefore against this background that I make this submission to your good office for consideration
7. Trusting that the above is in order.

Yours in service delivery,

Mrs S Sako

Approved / ~~Not Approved~~

M. Gqadd
Acting Municipal Manger

ELUNDINI LOCAL MUNICIPALITY

INTERNAL MEMORANDUM

To	:	***The Municipal Manager***
From	:	***Director Infrastructure Planning and Development***
Date	:	***14 March 2019***
Subject	:	***Request for authorization to undertake Master of Engineering research***

Dear Municipal Manager

1. I have applied for enrollment for the Master of Engineering programme with the Durban University of Technology

2. The research topic is "The use of Engineering Ethics for the betterment of service delivery: The case of Public Service"

3. The aim of the research is to explore how the application of ethical engineering principles can be better utilized to improve service delivery. It is anticipated that the findings of the research will contribute to a larger body of knowledge within the engineering fraternity and thus boosting service delivery within Elunidni LM

4. I am writing this memorandum to request the following in respect of the above:

    a. Authorization to undertake the intended research within Elunidni LM interacting with engineering professionals as employed and contracted by the municipality.
    b. To request support of the institution while undertaking this research and to be afforded an opportunity to table the findings of this research as a means of contributing towards service delivery and later on to avail the information upon consent for publishing in engineering and construction journals as required by the Durban University of Technology

5. I have attached a sample of my research proposal, accompanied by the proposed research questionnaire for data collection to be submitted to the Institutional Research Ethics Committee at DUT on the 31 March 2019 as well as a letter of information relating to the research.

6. It is therefore against this background that I make this submission to your good office for consideration
7. Trusting that the above is in order.

Yours in service delivery,

.....

Mrs S Sako

Approved / Not Approved

.....

K. Gashi
Municipal Manger

Appendix 4: Pilot Study Questionnaire

Faculty of Engineering and Built Environment

Department of Civil Engineering and Geomatics

Research Questionnaire

Instructional Programme : **Master of Engineering**

Applicant Details

Name: **Sisekho Sako nee Makunga**

Contact number: **0730119908 / 065 951 6302**

Email: **sisekho.sako@gmail.com**

Topic:

The use of Engineering Ethics for the betterment of service delivery: The case of Ingquza Hill and Elundini Local Municipalities

Notes:

Research will be based on the local sphere of governance, with special focus on the municipal sector as the research environment

All participants will be advised during the introductory stages that data will be held securely and kept confidential, and that the final data will stored, analysed and reported in a completely anonymised format. The details of each interview case will be fully anonymised so that anyone analysing that data will not be able to trace the participant.

PROVINCE: …….

MUNICIPALITY: …….

Please answer the following questions as honestly and accurately as possible.

1. SECTION ONE: DEMOGRAPHIC PROFILE (PERSONAL INFORMATION REQUIRED)

1.1 Name and Surname

1.2 Job Title:

Please read each question carefully and clearly mark appropriate answer in the space provided.

1.3 Your age group:

21-29 years	
30-39 years	
40- 49 years	
50-59 years	

60 years and older	

1.4 Gender:

Male	
Female	

1.5 Your employment equity (EE) status:

African Black	
Coloured	
Indian	
White	
Other(please specify)	

1.6 Which religious faith, if any, do you adhere to? Select one.

Muslim Jewish Catholic Protestant Evangelical Hindu

Buddhism Orthodox Other Don't Know

Not an adherent to any religious faith

If other, please specify:

1.7 If you identified a religious faith, please indicate the importance of religious interests to you.

Very High Importance High Importance Moderate Importance

Low Importance No Importance

1.8 Your position in the organization:

Permanent position	
Part time position	
Contract position	
Professional Service provider	

1.9 Number of years in your current position:

Less than one year	
Between 1-5 years	
Between 6-10 years	
More than 10 years	

1.10 Your highest formal qualification/education

Lower than Matric	
Matric/Grade 12	
Certificate	
Diploma/Degree	
Postgraduate Diploma	
Other(please specify)	

1.11 Highest qualification

INSTITUTION	QUALIFICATION	FIELD OF STUDY	YEAR OF COMPLETION

1.12 Professional Affiliation

INSTITUTION	CATEGORY OF MEMBERSHIP	STATUS OF MEMBERSHIP (ACTIVE/ INACTIVE)	YEAR OF REGISTRATION

2. SECTION TWO: CONCEPT OF ETHICS

On a scale of 1 (minor) to 5 (major), rate the applicability of the following statements Indicate how these statements are relevant to your organization. Select one response. (If contracted service provider, respond in light of your assessment of the organisation you are contracted to)

Please note the 'unsure' (U) and 'Does not' (DN) options.

	Code of Conduct	U	DN	Minor……..Major				
				1	2	3	4	5
2.1.	Does your organization have a written code of ethics?	U	DN	1	2	3	4	5
2.2.	How relevant is your organisational code of conduct to the ECSA Code of Conduct for Registered persons?							
2.3.	Does your organization require ethics training?	U	DN	1	2	3	4	5

2.4.	Does your organization have procedures for reporting unethical behaviour?	U	DN	1	2	3	4	5
2.5.	Are penalties for unethical behaviour strictly enforced in your organization?	U	DN	1	2	3	4	5
2.6.	Is ethical behaviour the norm in your organization?	U	DN	1	2	3	4	5
2.7.	Is unethical behaviour punished in your organization?	U	DN	1	2	3	4	5
2.8.	Are people of integrity rewarded in your organization?	U	DN	1	2	3	4	5
2.9.	Do the managers in your organization show that they care about ethics?	U	DN	1	2	3	4	5
2.10.	Is ethical behaviour rewarded in your organization?	U	DN	1	2	3	4	5
2.11.	The main purpose of a code of ethics is to conform to the tradition established by the technical societies.	U	DN	1	2	3	4	5

2.12.	The Codes of Ethics for Registered Persons state the engineer's duties to society, to employers, to clients, to colleagues, to subordinates, and to the profession. However, when these duties conflict, society (public interest) should take precedence	U	DN	1	2	3	4	5
2.13.	The Code of Ethics for Registered Professionals is a voluntary guide, but strongly recommended by the Engineering Council of South Africa	U	DN	1	2	3	4	5

The following statements are possible FOUNDATIONAL VALUES or GUIDES FOR CONDUCT. Please select the appropriate number to indicate the applicability of each as a basis for your own ethical choices. On a scale of 1 (not applicable) to 5 (applicable), rate the applicability of the following statements Select one response. Please note the 'unsure' (U) and 'Does not' (DN) options.

	Ethical Conduct	**U**	**DN**	**Not Applicable……Applicable**				
				1	**2**	**3**	**4**	**5**
2.14.	Treat others as you would have them treat you.	U	DN	1	2	3	4	5
2.15.	Follow the moral values common to all major religions.	U	DN	1	2	3	4	5

2.16.	Adhere to the moral standards in my own faith or religion above all other considerations.	U	DN	1	2	3	4	5
2.17.	Compassion for those who are suffering or disadvantaged is the most crucial virtue.	U	DN	1	2	3	4	5
2.18.	Justice, fairness and equality are the most important requirements for a society.	U	DN	1	2	3	4	5
2.19.	Loyalty to one's group is more important than one's individual concerns.	U	DN	1	2	3	4	5
2.20.	How much pressure do you feel personally within your position to engage in what you perceive to be unethical behaviour?	U	DN	1	2	3	4	5
2.21.	Respect for authority is something everyone needs to learn.	U	DN	1	2	3	4	5
2.22.	People should not do things that are revolting to others, even if no one is harmed.	U	DN	1	2	3	4	5
2.23.	Honesty is only required when the truth will not hurt anyone.							

On a scale of 1 (Disagree) to 5 (Agree), rate your level of agreement with the following statements towards the application of engineering ethics. (Please note the 'unsure' (U) and 'Does not' (DN) options).

	Engineering Ethics	U	DN	Disagree……Agree				
				1	2	3	4	5
2.24.	Engineering Ethics are a set of behavioural standards that all engineers are expected to follow.	U	DN	1	2	3	4	5
2.25.	The application of engineering ethics is to ensure the safety of the public first and foremost							
2.26.	By making use of engineering ethics, engineers can improve public perception on the engineering profession	U	DN	1	2	3	4	5
2.27.	Negligence is a basis for disciplinary action under the Professional Engineering Act	U	DN	1	2	3	4	5
2.28.	Failing to correct or report a situation that may endanger the public is against engineering practice	U	DN	1	2	3	4	5
2.29.	Occasionally, a conflict of interest may occur accidentally or unavoidably. In such cases, the best course of action is to keep the conflict of interest secret,	U	DN	1	2	3	4	5

	but try not to let it affect your decision							
2.30.	Making public statements that are not based on firm knowledge and conviction can be attributed to vast and unquestionable experience	U	DN	1	2	3	4	5
2.31.	A person who has graduated from an engineering program at an accredited higher education institution, but has not registered with ECSA in any of the regulatory categories must not practise engineering, except under the supervision of a registered engineer	U	DN	1	2	3	4	5
2.32.	Accepting commission for approving work is part of how engineer's make their remuneration	U	DN	1	2	3	4	5
2.33.	There is a link on the application of engineering ethics and service delivery	U	DN	1	2	3	4	5
2.34.	Engineers are there to offer technical expertise and guidance and should							

	not be distracted by soft skills such as ethics							
2.35.	If engineering ethics are not followed, the result may be compromised service delivery							
2.36.	Do you think engineering ethics are currently being ignored within public service?							

On a scale of 1 (Disagree) to 5 (Agree), rate your level of agreement with the following statements towards the implementation of service delivery. (Please note the 'unsure' (U) and 'Does not' (DN) options).

	Service delivery implementation	**U**	**DN**	**Disagree……Agree**				
				1	**2**	**3**	**4**	**5**
2.37.	A project is running behind programme and a contractor delivers defective material on site and re-ordering new supplies may delay project completion with chances of losing funding, It would be best to abandon the project as it was a lost cause,	U	DN	1	2	3	4	5

	alternative funding can be sourced at a later stage							
2.38.	Most people do not really understand the technical aspects of a project, its best to involve the community when the project is completed and it is at handover stage							
2.39.	Social facilitators should be hired for the public participation function as it does not fall within the scope of engineering.	U	DN	1	2	3	4	5
2.40.	When faced with conflicting test results, Ignore the failed samples as they may not be representative. It is best to try to finish the project on time and not add unnecessary investigations	U	DN	1	2	3	4	5
2.41.	Communities who are better informed about a project easily own the final product when it is completed but their role must be limited to the correct structures such as Community Liaison	U	DN	1	2	3	4	5

	Officers and Project Steering Committee							
2.42.	Public service engineers are contributing towards improving the quality of life for communities	U	DN	1	2	3	4	5

3. SECTION THREE: IMPROVING SERVICE DELIVERY

3.1. How can engineers use engineering ethics to improve service delivery?

3.2. How could the use of engineering ethics better empower public service engineers to provide improved service delivery?

3.3. Which areas of ethical compromise are people within your designation most exposed as they carry out their duties?

3.4. List 3 ethical values stated in your organisation's code of conduct.

3.5. List 3 ethical values stated in your organisation’s code of conduct that are relevant to the ethics as contained in the ECSA Code of Conduct for Registered persons.

3.6. What are the three most **difficult ethical issues** that you have faced in your work? List the most difficult first.

3.7. Do you have any comments in general regarding the use of engineering ethics for the betterment of service delivery?

……
……
……
……
……
……
……
……..

All data will be kept private, both from other participants and when reporting findings.

The project will adhere to the requirements of data protection rules in terms of data labelling, storage and security as detailed in the DUT Research Ethics Policy.

Notes from the research session and accompanying data (inclusive of recordings where applicable) will be stored in locked filing cabinets and on a password protected computer.

Participants' names and individual positions will not be referenced once fieldwork is complete so it will not be possible to link responses to individual participants once the final submission has been consolidated and are only for statistical purposes.

Thank you for your participation

Researcher ……

Ms Sisekho Sako

_____ _____

Signature of the participant **Date**

Appendix 5: Main Study Research Instrument

Statement of Agreement to Participate in the Research Study: • I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report and that I can withdraw my consent to participate at any stage • I hereby confirm that I have been informed by the researcher, Sisekho Sako about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: 2821927, • I have also received, read and understood the above written information (Participant Letter of Information) regarding the study. • I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report. • In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher. • I may, at any stage, without prejudice, withdraw my consent and participation in the study.• I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study. • I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

- ○ Yes
- ○ No

SECTION ONE: DEMOGRAPHIC PROFILE

Personal Information required

Name and Surname *

Municipality undertaking services for *

- ○ Ingquza Hill Municipality
- ○ Elundini Municipality

Gender *

- ○ Female
- ○ Male
- ○ Prefer not to say
- ○ Other:

Your role in the organization *

- ○ Permanent employee
- ○ Part time Employee
- ○ Fixed term contract employee
- ○ Professional Service Provider

Number of years in your current role to the municipality *

- ○ Less than one year
- ○ Between 1-5 years
- ○ Between 6-10 years
- ○ More than 10 years

Your age group *

- ○ 21-29 years
- ○ 30-39 years
- ○ 40- 49 years
- ○ 50-59 years
- ○ 60 years and older

Your employment equity (EE) status *

- ○ African
- ○ Coloured
- ○ Indian
- ○ White
- ○ Other:

Your highest formal qualification/education *

- ○ TVET Certification
- ○ National Diploma
- ○ Degree
- ○ Postgraduate Diploma
- ○ Other:

Regarding your highest qualification, please state the name of the qualification, year obtained and the institution obtained at *

Professional affiliation with ECSA as a regulatory body *

- ○ Not registered

- ○ Candidate
- ○ Professional Engineering Technician
- ○ Professional Engineering Technologist
- ○ Professional Engineer
- ○ International Professional Engineer

Which religious faith, if any, do you adhere to? Select one *

- ○ Muslim
- ○ Jewish
- ○ Catholic
- ○ Protestant
- ○ Evangelical
- ○ Buddhism
- ○ Orthodox
- ○ Don't Know
- ○ Not an adherent to any religious faith

Other:

If you identified a religious faith, please indicate the importance of religious interests to you. *

- ○ Very High Importance
- ○ High Importance
- ○ Moderate Importance
- ○ Low Importance
- ○ No Importance

SECTION TWO: CONCEPT OF ETHICS

Where required, On a scale of 1 to 5 please rate the applicability of the following statements Indicate how these statements are relevant to your organization. Select one response. (If contracted service provider, respond in light of your assessment of the organisation you are contracted to)

Does your organization have a written code of ethics? *

- ○ Yes
- ○ No
- ○ Unsure

How relevant is your organisational code of conduct to the ECSA Code of Conduct for Registered persons? *

Minor relevance

- ○ 1
- ○ 2
- ○ 3

- 4
- 5

Major relavance

Does your organization require ethics training? *

Disagree

- 1
- 2
- 3
- 4
- 5

Agree

Does your organization has procedures for reporting unethical behaviour *

Disagree

- 1
- 2
- 3
- 4
- 5

Agree

Are penalties for unethical behavior strictly enforced in your organization? *

Lightly enforced

- 1
- 2
- 3
- 4
- 5

Strictly enforced

Is ethical behaviour the norm in your organization? *

Rarely

- 1
- 2
- 3
- 4
- 5

Always

Is unethical behaviour punished in your organization? *

Rarely

- 1
- 2
- 3
- 4
- 5

Always

Are people of integrity rewarded in your organization?

Rarely

- 1
- 2
- 3
- 4
- 5

Always

Clear selection

Do the managers in your organization show that they care about ethics *

Rarely

- 1
- 2
- 3
- 4
- 5

Always

Is ethical behaviour rewarded in your organization? *

Rarely

- 1
- 2
- 3
- 4
- 5

Always

The main purpose of a code of ethics is to conform to the tradition established by the technical societies. *

Rarely

- 1

- 2
- 3
- 4
- 5

Always

The Codes of Ethics for Registered Persons state the engineer's duties to society, to employers, to clients, to colleagues, to subordinates, and to the profession. However, when these duties conflict, society (public interest) should take precedence *

Rarely

- 1
- 2
- 3
- 4
- 5

Always

The Code of Ethics for Registered Professionals is a voluntary guide, but strongly recommended by the Engineering Council of South Africa *

Disagree

- 1
- 2
- 3
- 4
- 5

Agree

FOUNDATIONAL VALUES or GUIDES FOR CONDUCT

Please select the appropriate number to indicate the applicability of each as a basis for your own ethical choices. On a scale of 1 (not applicable) to 5 (applicable), rate the applicability of the following statements

Treat others as you would have them treat you.

- 1
- 2
- 3
- 4
- 5

Follow the moral values common to all major religions. *

- 1
- 2

- 3
- 4
- 5

Adhere to the moral standards in my own faith or religion above all other considerations. *

- 1
- 2
- 3
- 4
- 5

Compassion for those who are suffering or disadvantaged is the most crucial virtue. *

- 1
- 2
- 3
- 4
- 5

Justice, fairness and equality are the most important requirements for a society. *

- 1
- 2
- 3
- 4
- 5

Loyalty to one's group is more important than one's individual concerns. *

- 1
- 2
- 3
- 4
- 5

Respect for authority is something everyone needs to learn. *

- 1
- 2
- 3
- 4
- 5

People should not do things that are revolting to others, even if no one is harmed. *

- 1
- 2

- 3
- 4
- 5

Application of engineering ethics

On a scale of 1 (Disagree) to 5 (Agree), rate your level of agreement with the following statements towards the application of engineering ethics.

Engineering Ethics are a set of behavioural standards that all engineers are expected to follow. *

- 1
- 2
- 3
- 4
- 5

The application of engineering ethics is to ensure the safety of the public first and foremost *

- 1
- 2
- 3
- 4
- 5

By making use of engineering ethics, engineers can improve public perception on the engineering profession *

- 1
- 2
- 3
- 4
- 5

Negligence is a basis for disciplinary action under the Professional Engineering Act *

- 1
- 2
- 3
- 4
- 5

Failing to correct or report a situation that may endanger the public is against engineering practice *

- 1
- 2

- 3
- 4
- 5

Occasionally, a conflict of interest may occur accidentally or unavoidably. In such cases, the best course of action is to keep the conflict of interest secret, but try not to let it affect your decision *

- 1
- 2
- 3
- 4
- 5

Making public statements that are not based on firm knowledge and conviction can be attributed to vast and unquestionable experience *

- 1
- 2
- 3
- 4
- 5

Accepting commission for approving work is part of how engineer's make their remuneration *

- 1
- 2
- 3
- 4
- 5

There is a link on the application of engineering ethics and service delivery *

- 1
- 2
- 3
- 4
- 5

Engineers are there to offer technical expertise and guidance and should not be distracted by soft skills such as ethics *

- 1
- 2
- 3
- 4
- 5

If engineering ethics are not followed, the result may be compromised service delivery *

- 1
- 2
- 3
- 4
- 5

Engineering ethics are currently being ignored within public service? *

- 1
- 2
- 3
- 4
- 5

A project is running behind programme and a contractor delivers defective material on site and re-ordering new supplies may delay project completion with chances of losing funding, It would be best to abandon the project as it was a lost cause, alternative funding can be sourced at a later stage *

- 1
- 2
- 3
- 4
- 5

Most people do not really understand the technical aspects of a project, its best to involve the community when the project is completed and it is at handover stage *

- 1
- 2
- 3
- 4
- 5

When faced with conflicting test results, Ignore the failed samples as they may not be representative. It is best to try to finish the project on time and not add unnecessary investigations *

- 1
- 2
- 3
- 4
- 5

Public service engineers are contributing towards improving the quality of life for communities *

- 1
- 2
- 3
- 4
- 5

IMPROVING SERVICE DELIVERY

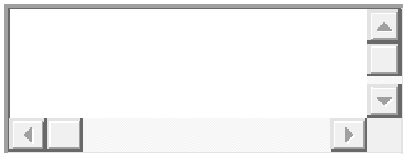
Please offer your opinion on how service delivery could be improved

How can engineers use engineering ethics to improve service delivery?

Your answer

How could the use of engineering ethics better empower public service engineers to provide improved service delivery?

Your answer



Which areas of ethical compromise are people within your designation most exposed as they carry out their duties?

Your answer

List 3 ethical values stated in your organisation’s code of conduct.

Your answer

List 3 ethical values stated in your organisation’s code of conduct that are relevant to the ethics as contained in the ECSA Code of Conduct for Registered persons.

Your answer

What are the three most difficult ethical issues that you have faced in your work? List the most difficult first.

Your answer

Do you have any further comments in general regarding the use of engineering ethics for the betterment of service delivery?

Your answer

Appendix 6: ECSA Case Study No. 2012/5: Extreme implications, from contravention of ECSA's Rules of Conduct on a small project

ENGINEERING COUNCIL OF SOUTH AFRICA

CASE STUDIES ARISING FROM CONTRAVENTION OF ECSA's RULES OF CONDUCT FOR REGISTERED PERSONS.

PUBLISHED BY ECSA TO MINIMISE THE RISK OF RECURRENCE

Case Study No. 2012/5 : Extreme implications, from contravention of ECSA's Rules of Conduct on a small project

THE PROJECT

A residential dwelling unit constructed with numerous faults and defects, arising in part from unprofessional performance by the Engineer.

BACKGROUND TO THE CASE

The dwelling was one of a number of similar units in a cluster development situated in a suburban area. The development was undertaken by a contractor. The unit in question was constructed under a direct contract between the purchaser (i.e. Employer) and the Contractor. The Contractor retained the services of the Engineer to provide the necessary professional engineering services.

The quality of materials and workmanship produced by the Contractor left much to be desired. The level of substandard building work gave rise to numerous defects and justified a complaint to the Architectural Council. This was aggravated by other faults and defects, apparently of an engineering nature.

On receipt of a complaint from the Employer after the dwelling unit was ostensibly completed, ECSA commissioned an expert to investigate the matter. This revealed that the dominant fault involving the Engineer concerned a reduction in the floor to floor height between ground and first floors. When this action was queried by the Employer the Engineer made a written misrepresentation to the Employer (now the Owner) to cover up for his client the Contractor. It was considered this transgressed Rule of Conduct 3(2)(h) of ECSA in that the Engineer had failed to give any decision, recommendation or opinion that was objective and based upon prevailing facts. The Engineer pleaded guilty to the charges by ECSA and in a settlement agreement agreed to pay a fine of R5000.

DETAILS OF THE PROBLEM

The units in the cluster development were designed to an architectural style from the Northern hemisphere, in the belief this gave the units a unique appeal and marketability. However this style was not suited to South African climatic conditions. The design was modified considerably, which resulted in a standard of finishes which was spartan and "cheap" compared with "normal" standards to which buyers were accustomed. This was aggravated by the Contractor's cost-cutting approach which included inferior materials and poor workmanship from employing unskilled artisans. This culminated in a dispute between Employer and Contractor over the extent of defects not remedied and failure to complete the contract. A detailed investigation report by an expert independent architect, which substantiated the Employer's allegations, was made available to ECSA.

Besides the very numerous architectural defects and alleged Contractor's defaults, the report noted various acts by the Contractor's Engineer, which were considered unprofessional and unacceptable. Chief among these was the Contractor's decision to reduce the vertical distance between ground and first floors of the unit by at least 300mm, thus saving a depth of brickwork not constructed of 360mm. (This saved not only brickwork, but also plaster, rhinolite and paint, in all the walls over the plan area of the unit) The reduction was queried by the Employer. The Contractor prevailed upon the unit's architectural designer and the Engineer to explain this was unavoidable – it was necessary to avoid a staircase that would be too steep if it were not to protrude into the ground floor area. The door to a walk-in pantry below the stairs, intended to be of standard height with a 2.10m door frame, now became 1.91m high instead of 2.03m - and this was an unavoidable consequence. The Engineer concurred with the designer. The independent architectural investigation determined that the reasons for reducing the floor height were not valid. The reduction was not necessary from a design viewpoint – it was a blatant cost-cutting exercise, taken without correctly informing the Employer.

It is relevant to note that the reduction could not be rectified as the unit was nearly complete. The effects of this would thus be permanent and have a lasting negative value:

- The hazard of a door height too low
- The value of the utility of the volume lost
- The aesthetic value of the volume lost
- The consequent loss in the market value of the unit.

It was clear these effects would have far-reaching implications, and that the Engineer had acted unprofessionally in his statements supporting the reduction decision. It was considered by ECSA's expert in his investigation that the Engineer contravened ECSA's Rules of Conduct 3(2)(a), whereby his actions did not constitute a discharge of his duty to his employer and the public with integrity, viability and honesty. The Engineer was charged accordingly.

The Engineer pleaded guilty to transgressing Rule 3(2)(h) of the Rules of Conduct of ECSA (Registered Persons must give engineering decisions, recommendations or opinions that are honest, objective and based on facts that are used in reaching recommendations or opinions given to clients or employers). In a settlement agreement he agreed to a fine of R5000, suspended for two years on condition he was not found guilty of transgressing the same rule during this period.

WHAT LESSONS CAN BE LEARNED ?
Some pertinent lessons can be learned :

1. In building or construction contracts such as the one above, where the Engineer is employed by his client (in this case the Contractor), his duties include administering the contract, not only in the interests of his employer, but also in a manner which is fair and impartial. As a professional therefore the Engineer may well give a decision which appears against the interests of his employer – here the Contractor – but if the Contractor is at fault the need to decide impartially becomes paramount and the Engineer cannot side with his employer.

2. Where claims for compensation could arise when work is omitted from a contract, the claimant would not only be entitled to a credit in respect of the labour and materials not utilised, but also for the downstream effects of the omission where these could harm the interests of the claimant – illustrated by the reduction in floor height in the case above.

-o0o-

Appendix 7: Editor's certificate

Professional Editors (South Africa)

To: Sisekho Sako
Contact: sisekho.makunga@gmail.com

From: Valentina Govender
Email: magnifyenter@gmail.com

07 May 2022

Please accept this letter in lieu of work completed.
Document: Research Dissertation
Title: "The use of Engineering Ethics for the betterment of service delivery: The case of Ingquza Hill and Elundini Local Municipalities"

The document has been improved with due effort. Editing was carried out according to the scope and criteria as per the candidate's instructions - language and grammar; cross checking references; line spacing. Suggestions for improvement have been made.

I trust that you may find the work satisfactory. I wish you all the best in your submissions.

Thank you kindly,
Valentina Govender
Professional Editor and Writer (South Africa)

Appendix 8: Statistician’s letter of confirmation

Gill Hendry B.Sc. (Hons), M.Sc. (Wits), PhD (UKZN)
Mathematical and Statistical Services

Cell: 083 300 9896
Email: gillhendrystats@gmail.com

25 March 2022

Re: Assistance with data analysis

Please be advised that I have assisted Sisekho Sako (Student number 20709183), who is currently studying for a Master of Engineering at DUT, with the statistical analysis of her data.

Yours sincerely

Appendix 9: Research outputs and publications

Interdisciplinary Journal of Applied and Basic Subjects (2021), 1(7), 54-63.

RESEARCH PAPER

The use of engineering ethics for the betterment of service delivery: The case of Ingquza hill and Elundini local municipalities

Sisekho Sako *, Dhiren Allopi

Department of Civil Engineering and Geomatics, Durban University of Technology, Durban, KwaZulu-Natal, South Africa

ABSTRACT

Service delivery is the core function of municipalities and the forefront of this function, are municipal engineers. Municipal engineers are not only tasked with providing services according to set standards but have to also balance this with public perception since this sector is highly publicized due to previous corrupt practices which have compromised the integrity of municipal engineering. It seeks to determine the linkage between engineering ethics and the quality of service delivery provided, thus determining whether the use of engineering ethics can be a driver for better service delivery. The research aims to establish how the application of the principles of ethics can impact services provided by the two municipalities that the study will be focusing on. The study was conducted in Ingquza Hill and Elundini Municipality as the case study environments. During the pilot study, personnel in the civil engineering discipline, identified in the organogram were interviewed. Findings established that honesty and integrity were the leading concerns for municipal engineers and political influence was a key concern that impacted decision making. The main study will be conducted using professional service providers working for the case study municipalities. The tool is aimed at easing decision making thus yielding better engineering judgment and improving service delivery.

Keywords: engineering ethics, code of conduct, service delivery, municipal engineering

1. INTRODUCTION

Communities perceive the quality of service delivery by municipalities to be poor, which leads to unrest and service delivery protests, however this can be improved through the proper application of engineering ethics. There has been public dissatisfaction over the quality of infrastructure services provided by municipalities [1]. The technical factors contributing to quality such as design, poor application of standards, procurement and construction factors have been explored without necessarily providing a solution to the quality issue, as evidenced by the CIDB (2009) study on

Table 1. Study participants

Site reference	Number of eligible participants	Number of participants who partook in study
Ingquza Hill LM	11	11
Elundini LM	10	9
Average Participants per site		10

Table 2. Age frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	30-39 years	13	65.0	65.0	65.0
	40 - 49 years	1	5.0	5.0	70.0
	50-59 years	3	15.0	15.0	85.0
	60 and older	3	15.0	15.0	100.0
	Total	20	100.0	100.0	

Table 3. Gender frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	17	85.0	85.0	85.0
	Female	3	15.0	15.0	100.0
	Total	20	100.0	100.0	

Table 4. Gender cross tabulation

		Name of municipality		Total
		Ingquza Hill	Elundini	
Gender	Male	9	8	17
	Female	2	1	3
Total		11	9	20

quality titled "Construction Quality in South Africa : A client perspective"[2].

The research seeks to determine whether there is a linkage between engineering ethics and the quality of service delivery provided, thus determining whether the use of engineering ethics can be a driver for better quality in service delivery. It also sought to distinguish between engineering judgment and moral judgment. The ECSA (2006) code of conduct for registered persons was used as a key document in defining key terms particularly in the South African Context [3].

Once the conceptual framework was established, the researcher then looked at various research conducted in the area of service delivery and the impact of corrupt practices in the South African public service [4]. The researcher then explored the legislative framework governing decision making in the local sphere of governance.

A review of ethical decision making models was undertaken. This was followed by a deeper look at ethical considerations as identified in the Guidelines for Professional Conduct for Civil Engineers issued by ASCE (2008) [5].

2. METHOD AND MATERIAL

The research is experimental in nature. The study made use of the pragmatic approach to research.

2.1. Research Environment

The setting of the research is within the local governance sphere, particularly focused on two local municipalities within the Eastern Cape which have been identified for the case study. It draws attention on experiences within the Ingquza Hill Local Municipality and Elundini Municipality as application environments for engineering ethics within public service.

2.2. Research Design

Table 5. Population frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	African Black	19	95.0	95.0	95.0
	White	1	5.0	5.0	100.0
	Total	20	100.0	100.0	

Table 6. Religion frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Catholic	6	30.0	30.0	30.0
	Protestant	5	25.0	25.0	55.0
	Evangelical	1	5.0	5.0	60.0
	Other	7	35.0	35.0	95.0
	Non Adherent to any religion	1	5.0	5.0	100.0
	Total	20	100.0	100.0	

Table 7. Importance of religion frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very High importance	5	25.0	25.0	25.0
	High importance	5	25.0	25.0	50.0
	Moderate importance	9	45.0	45.0	95.0
	No importance	1	5.0	5.0	100.0
	Total	20	100.0	100.0	

Table 8. Years of experience frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 1 year	5	25.0	25.0	25.0
	Between 1 and 5 years	5	25.0	25.0	50.0
	Between 6 and 10 years	6	30.0	30.0	80.0
	More than 10 years	4	20.0	20.0	100.0
	Total	20	100.0	100.0	

Table 9. Qualification frequency

	Frequency	Percent	Valid Percent	Cumulative Percent
Lower than matric	1	5	5	5
Certificate	5	25	25	30
Diploma / Degree	13	65	65	95
Post graduate Diploma	1	5	5	100
Total	20	100	100	

Table 10. Professional affiliation frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	ECSA	4	20.0	44.4	44.4
	SAICE	1	5.0	11.1	55.6
	Both of ECSA and SAICE	3	15.0	33.3	88.9
	Other	1	5.0	11.1	100.0
	Total	9	45.0	100.0	
Missing	System	11	55.0		
Total		20	100.0		

Table 11. ECSA Category of registration cross tabulation

		Name of municipality		Total
		Ingquza Hill	Elundini	
ECSA category of registration	None	8	6	14
	Candidate technician	2	2	4
	Professional Engineering Technologist	1	1	2
Total		11	9	20

The research methodology incorporated a desktop review on literature as well as made use of structured interviews in the form questionnaires to provide an analytical experience of the concept under investigation so as to provide a more practical outcome to the research question. A pilot study was conducted to determine the feasibility of the study protocol and also to conclude on preliminary findings relevant to the desired study outcomes.

2.3. Data Collection

The sample for the pilot study was structured. The participants were taken from the municipal organogram of the case study municipalities and was only limited to senior and middle management as defined in the institutional organisational structure. The entire population available from the filled positions of all senior and middle managers was interviewed, totalling to 21 participants being identified as detailed in the table below.

Questionnaires were distributed in face to face structured interviews were used as the primary method for data collection for the pilot study. The questionnaires comprised of three sections. This first section related to demographic data, the second consisted of study variables regarding the ethical decision making ranked on a Likert scale

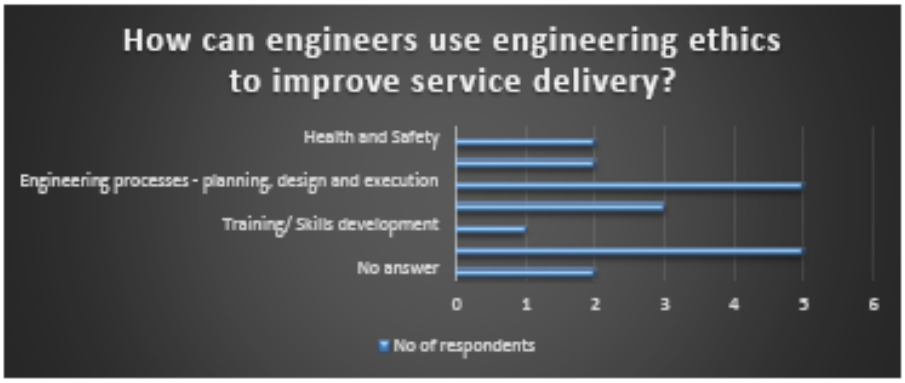


Figure 1. Response for improving service delivery using engineering ethics

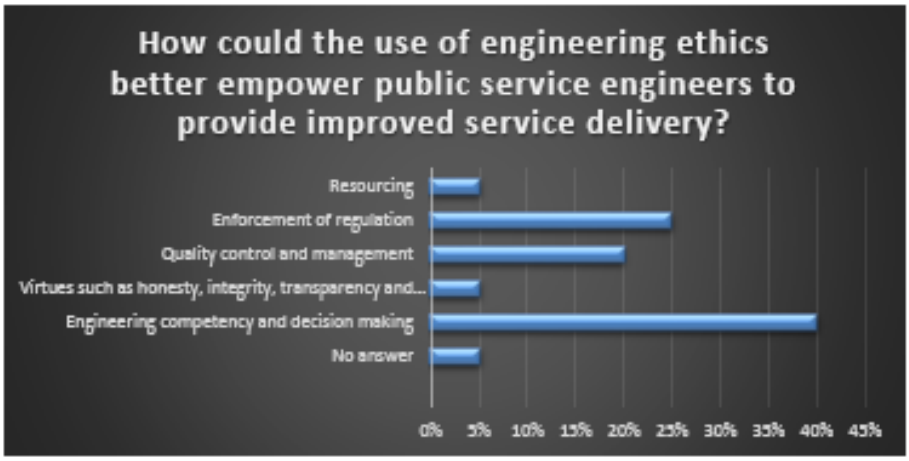


Figure 2. Response for empowering public service engineers using engineering ethics

whilst the last section incorporated open ended questions. The pilot questionnaire was administered through face to face interviews with participants and the researcher asked structured questions to the participants. The researcher was able to offer clarity in the event that some questions where clarity was sought by the participants.

2.4. Data analysis

Use of BMI SPSS Statistics was made for statistical analysis of the questionnaire data and responses received. Recoding and categorising of variables was undertaken prior to processing. Data processing comprised of editing and coding. Examination and correction of the data gathered was done in a systematic way to ensure accuracy and completeness. The coding process included classifying each response in a data processing format with convenient title or symbol.

Analysis was done making use of percentages, mean scores, standard deviation, Cronbach's alpha coefficient and factor loading. Descriptive and inferential statistics were used for further analysis of patterns in the data. Open-ended questions were qualitatively analysed.

Descriptive frequency statistics were used for examining the range of responses and their repeated occurrence. The inferential analysis was employed to analyse the summarised scores of responses from the interview responses.

The questionnaire from the pilot study was validated and the resulting revised questionnaire which will be used to conduct the main study.

The final research output will incorporate information drawn from case studies within the targeted municipalities as examples of how ethics can be used to better improve service delivery.

3. RESULTS AND DISCUSSION

The study has a high response rate since one on one interviews for the questionnaire completion were conducted, giving the researcher adequate opportunity to collect the completed questionnaires. This also minimised the waiting time required for the return of questionnaires. A total of 20 participants ended up partaking in the study. The questionnaires were validated and screened for missing answers prior to undertaking statistical analysis.

General demographic information inclusive of age, gender, employment or educational status, religious and professional affiliations was recorded on a specifically designed and standardised questionnaire to reflect a basic profile of the pilot study population.

The following information reflects the demographic frequencies for the pilot study.

Competency to do engineering work is regarded as a crucial element in the ECSA code of conduct (2006) and undertaking work that one is not

Table 12. Areas of ethical compromise are people within your designation most exposed as they carry out their duties

Categories	Percentage	No of respondents
Political	15%	3
Bribery and corruption	15%	3
Quality control and management	20%	4
Engineering competency and decision making	10%	2
Tender and procurement	15%	3
Conflict of interest	5%	1
Administrative or contractual	20%	4

Table 13. Ethical values stated in your organisation's code of conduct

Categories	Percentage	No of respondents
Honesty, Integrity, confidentiality, trustworthiness	35%	7
Fairness, justice, courtesy	20%	4
Value for money	10%	2
Administrative conduct	20%	4

Table 14. Ethical values stated in your organisation's code of conduct that are relevant to the ethics as contained in the ECSA Code of Conduct for Registered persons.

Categories	Percentage	No of respondents
Honesty, Integrity, confidentiality, trustworthiness	20%	4
Fairness, justice, courtesy	30%	6
Public health and safety	15%	3
Transparency, openness	10%	2
Corruption and bribery	5%	1
Accountability	10%	2
Competence	10%	2

Table 15. The difficult ethical issues faced

Categories	Percentage	No of respondents
Political	20%	4
Quality control and management	25%	5
Engineering processes and decision making	25%	5
Corruption and bribery	10%	2
Administrative conduct	15%	3
Conflict of interest	5%	1

qualified or trained for is regarded a violation. It is with regards to the conduct of engineering personnel, but the code of conduct is however only enforced to registered persons. From the findings, it can thus be deduced that 30% of the respondents may not directly hold a relevant qualification making them eligible for registration with the regulatory body, but would need to venture into the route for recognition of prior learning so as to be able to register in any of the recognised categories of registration.

Only 35% of the population for the study population were registered with a professional body whilst 55% of the respondents did not indicate any affiliation and these can easily be categorised under "No affiliation". 20% of the respondents indicated that they were registered with ECSA only whilst another 15% indicated they registered with both ECSA as well as with the voluntary association SAICE [6]. The they were registered with SAICE only (5%) and another professional body (reflected as SACPCMP- 5%). No other affiliations were recorded even though the questionnaire made allowance for such.

The values identified seemed consistent with those highlighted in the code of conduct, though some respondents seemed to be entirely unaware of the composition of the code of conduct for registered persons and relied on their own knowledge of other codes of conduct which may bear similarity [6].

The answers received from respondents on question 1 of the questionnaire "How can engineers use engineering ethics to improve service delivery?" were categorised into seven categories. The responses indicated the need to improve engineering processes and values such as honesty, integrity, transparency and

Engineering competency and decision making was cited as a leading (40%) area which could be used to better empower public service engineers. This was consistent with data established earlier wherein it was identified that a majority of current personnel within the case study environment did not possess the required minimum competency for practicing in engineering work, which inherently lead to a majority of them not being registered with the regulatory body. Improvement in the enforcement of regulation particularly in line with the requirements set out by ECSA was identified as the second leading (25%) solution for how engineering ethics could be used to improve service delivery in public service, but enforcement becomes a challenge when the responsible personnel are not affiliated to the regulatory body. Improvement on quality control was cited as a third area of improvement, with 20% of responses indicating such.

In the answers received from respondents on question 3 of the questionnaire "Which areas of ethical compromise are people within your designation most exposed as they carry out their duties??" a majority of the respondents indicated that administrative causes (20%) as well as quality constraints (20%). Though political interference is usually perceived as a leading cause of ethical compromise, it was recorded at 15%. This was tied with bribery and corruption and tender and procurement which also recorded responses of 15% each.

Respondents on question 3 of the questionnaire Honesty, integrity, confidentiality and trustworthiness as the leading (35%) ethics identified in the organisation codes of conduct for the case study municipalities with administrative conduct and fairness and justice being highlighted as number 2 with a response average of 20%.

The answers received from respondents on question 5 of the questionnaire "List 3 ethical values stated in your organisation's code of conduct that are relevant to the ethics as contained in the ECSA Code of Conduct for Registered persons." indicated that 30% identified fairness and justice as the leading common ethical value in their organisation's code of conduct which was similar to the ECSA code of conduct [7]. Honesty, integrity, confidentiality and trustworthiness was identified as the second common (20%) ethics identified in their organisational codes of conducts that was similar to the ethics as provided for in the ECSA Code of Conduct [8].

The values identified seemed consistent with those highlighted in the code of conduct, though some respondents seemed to be entirely unaware of the composition of the code of conduct for registered persons and relied on their own knowledge of other codes of conduct which may bear similarity [9].

Engineering decision making came was tied at number 1 with quality control wherein each of these categories recorded 25%. This accounted for 50% of the responses, indicating that some of the respondents did not feel that they were able

In the last question, participants were asked to provide general inputs regarding the use of engineering ethics and how it can be utilised for the betterment of service delivery The following inputs were received:

- The employment of young engineers and their salaries by contractors must be regulated by the government.
- There must be strict criteria in employment of the contractors that are doing engineering works, for example the owner of the company must have a relevant qualification which would improve the quality of service delivery.
- Major special trainings must be conducted for the company who deals with the engineering project to enforce the ethics so that it does not become a burden to one individual.
- If all young growing engineers can first prioritise the engineering ethics to their field of practice, lawfully compliance to statutory bodies for all engineering practices like any other field of study e.g, doctors and lawyers.
- Presentation of short courses on engineering ethics must be. made as the understanding may differ
- Engineers using engineering ethics can sometimes be seen as a setback to service delivery so this understanding would need to be shared with managers and political leadership.
- A simplified version of ethics taking into

The greediness of politicians is affecting how engineers are getting hired so the municipality needs to have its own qualified engineers.

4. CONCLUSION

By conducting the pilot study, the researcher has been able to meet key objectives that will go a long way in assisting the main study. The pilot sought to obtain preliminary data for the primary outcome measure which would inform the main study. The data collection tool has been refined for the main study and preliminary findings have been made based on the information obtained. Lack of training on engineering ethics as well as the competency of engineering personnel has been highlighted as key factors in the pilot study. In addition to this, there is also rising concern regarding political influences which may affect ethical decision making amongst personnel practising in the case study municipalities and the development of a mechanism to enable ethical decision making could provide much needed relief to the personnel within these municipalities. A tool to address the identified concerns will be formulated and tested as part of the main study to assess whether this can ease decision making thus resulting in more ethical decision making that can yield better engineering judgement, consequently improving service delivery.

5. ACKNOWLEDGEMENT

NA

7. SOURCE/S OF FUNDING

NA

8. REFERENCES

1. Ibáñez, M. E., Ferrer, D. M., Muñoz, L. V., Claros, F. M., & Ruiz, F. J. (2020). University as Change Manager of Attitudes towards Environment (The Importance of Environmental Education). Retrieved from Sustainability 12, 4568
2. Dove, M. (1993), "A revisionist view of tropical deforestation and development", EnvironmentalConservation, Vol. 20, p. 1
3. Woelcke, J. (2002), "Soil mining in Eastern Uganda", Newsletter of the International Human Dimensions Programme on Global Environmental Change, April 1.
4. Earth Org. (2020. The Biggest Environmental Problems Of 2021. Retrieved from Earth Org.: https://earth.org/the-biggest-environmental-problems-of-our-lifetime/
5. CHED Memorandum Order Number 9. Series of 2013, Enhanced Policies and Guidelines on Student Affairs and Services retrieved from https://ched.gov.ph/wp-content/uploads/2017/10/CMO-No.09-s2013.pdf
6. Ermita, Philip. (2019). Managing Safety in Higher Education Institutions: A Case in the Philippines.
7. Batangas State University Student Handbook. (2018). Batangas City, Batangas: Batangas State University.
8. Batangas State University Student Handbook. (2018). Student Organizations and Activities Policies and Guidelines. Batangas City, Batangas: Batangas State University.

20th Annual Conference of the South African Association of Public Administration and Management

PROGRAMME

Date:28 September -01 October 2021

Southern Sun Elangeni Hotel, Durban,
Kwa Zulu Natal, South Africa

Conference Theme:

Intersections in government structures and functions in the 21st century: public sector & technology, public trust and covid-19's effects

South African Association of
Public Administration and Management (SAAPAM)
www.saapam.co.za

SAAPAM

school of government
Department:
National School of Government
REPUBLIC OF SOUTH AFRICA

Digitilisation of Corporate Communication during COVID-19: Case of a district Municipality in Gauteng- **Felix Mwadiwa and Lazarus Maleho (Vaal University of Technology)**

The turnaround time for forensic evidence and results in the department of South Africa police services Pietermaritzburg- **TC Gwajuza (Durban University of Technology)**

Evaluating water service quality at uMgungundlovu district municipality- **Xolani Muthwa (Durban University of Technology) and N.S Matsiliza (Durban University of Technology)**

SESSION 35: 08:00-10:00
Chair: Bheka Ntshangase **Venue: North Ilanga**
Papers for Presentation

An Evaluation of ICT Tools in Water and Sanitation Services Management in Municipalities- **Tafadzwa Jaquline Mukasi (University of Fort Hare)**

The Assessment of the effectiveness of the GCIS community radio programme as a development communication platform championed by the Government Communication and Information System in enhancing service delivery- **Mndeni Ndwandwe (Tshwane University of Technology)**

Analyzing the relevance of the Group Model in participatory democracy within the local level of government in South Africa- **Sinenhlanhla Nkosi (University of Zululand)**

Community participation during censorious times: A category B municipalities perspective - **Nonzwakazi Beauty Makiwane (Walter Sisulu University)**

Pilot study on the use of engineering ethics for the betterment of service delivery: The Case of Ingquza hill and Elundini local municipalities- **Sisekho Sako (Durban University of Technology)**

TEA BREAK: 10:00-10:30

SESSION 36: 10:30-12:30
Chair: Bongekile YC Mvuyana **Venue: Suite 4**
Papers for Presentation

Electoral Turnover and Local Governance: The Cost of Representational Crisis in Malawi's Local Governance System- **Gift Sambo (University of Malawi)**

Assessment of District Development Model impact that improves coordination and integration of support in the local government environment, in the Eastern Cape Province, South Africa- **Zolani Tafeni (Durban University of Technology)**

Implications of Coalition Government on Service Delivery: Challenges and Opportunities in the Management of Coalition Government in the City of Johannesburg Municipality- **Vele Muhadi (City of Johannesburg Municipality)**

An Asantian Scrutiny and Analysis of the Suspicion Placed on the Public Sector Over Unscrupulous Activities: Case Study of the Covid-19 Reining period- **Francinah Nkoana (University of Limpopo)**

The quest for maintaining government legitimacy in South Africa- **Musandiwa Troy Silima (University of Mpumalanga)**

A Pilot Study on the Use of Engineering Ethics for the Betterment of Service Delivery: The Case of Ingquza Hill and Elundini Municipalities

Sisekho Sako and Dhiren Allopi
Durban University of Technology

Abstract

Service delivery is the core function of municipalities and at the forefront of this function are municipal engineers. Municipal engineers are not only tasked with providing services according to set standards, but also have to balance this with public perception since this sector is highly publicised due to previous corrupt practices which have compromised the integrity of municipal engineering. This research, therefore, seeks to determine whether the use of engineering ethics is a contributor to municipal service provision and whether these ethics can indeed be used for the betterment of service delivery. The aim of the research is to explore how the application of ethical engineering principles can be utilised to improve service delivery. During the pilot study, personnel in the civil engineering discipline, who were identified in the organogram, were interviewed. The entire population group was sampled. A total of 42 structured questions and 7 open ended questions formed part of the questionnaire. Inferential statistics were used to analyse the data. The findings established that a lack of integrity and political influence was a key concern that impacted decision making. A tool to address the identified concerns will be formulated as part of the main study. Management will be responsible for implementing/testing the model with the researcher's guidance.

Keywords: Engineering ethics, Code of Conduct, Service delivery, Municipal engineering, Engineering decision-making.

Introduction

Communities perceive the quality of service delivery by municipalities to be poor, which leads to unrest and service delivery protests. There has been public dissatisfaction over the quality of infrastructure services provided by municipalities. The technical factors contributing to quality such as design, poor application of standards, procurement and construction factors have been explored without necessarily providing a solution to the quality issue, as evidenced by the CIDB's (2009) study on quality, titled "Construction Quality in South Africa: A Client Perspective". Municipal Engineers are at the forefront of service delivery and, in

recent years, the decisions made by these public servants have been brought under scrutiny on many occasions, with the abuse of power and improper usage of state funds being a primary concern. The issue that has been on everyone's mind is that this is all a result of moral degeneration which can be underpinned by a lack of professional ethics within the public sector. It has thus become critical to explore the question of professionalism and ethics amongst public servants. Ethical judgment is needed to maintain the stability of society without the undue imposition of formal regulations for every act (SAICE, 2017). This research seeks to determine whether there is a link between engineering ethics and the quality of service delivery provided, thus determining whether the use of engineering ethics can be a driver for better quality in service delivery.

Literature Review

The literature reviewed first sought to determine the importance of studying engineering ethics and then went on to further define key terms to be used for the study. The ECSA (2006) code of conduct for registered persons was used as a key document in defining key terms, particularly, in the South African context. Further concepts that influence engineering ethics are looked at on an international scale, making reference to the Federation of Consulting Engineers (FIDIC) and the International Organization for Standardization (ISO). An argument is made that some ethical beliefs are likely to have a significant impact on service delivery, particularly when paired with other factors that have the potential to create a cumulative effect. Once the conceptual framework was established, the researcher then looked at numerous research conducted in the area of service delivery and the impact of corrupt practices in the South African public service. The researcher then explored the legislative framework governing decision-making in the local sphere of governance. A review of ethical decision-making models was undertaken. This was followed by a deeper look at ethical considerations as identified in the Guidelines for Professional Conduct for Civil Engineers issued by ASCE (2008). A counter argument that the idea that more ethical behaviour by engineers will improve service delivery is trite, on the one hand, and can be flawed, on the other, in that it has been perceived that it is possible to have successful service delivery with unethical procurement practices. An analysis of data present in the literature related to successful service delivery in an ethically compromised environment was outlined. That was then followed by a broad review on models for ethical decision-making as they apply to this present research. This was lastly followed by scenarios identified in previous research which provide for ethical considerations, and these were then contextualized in the environment of public service in which municipal engineers operate.

Research Methods

The study made use of the pragmatic approach to research. The pragmatic approach to science involves using the method which appears best suited to the research problem and not getting caught up in philosophical debates about which is the best approach. Pragmatic researchers, therefore, grant themselves the freedom to use any of the methods, techniques and procedures typically associated with quantitative or qualitative research. They

recognise that every method has its limitations and that the different approaches can be complementary (Alzheimer, 2009). The qualitative method is applicable to the study in that it seeks to establish the relationship between human behaviour (ethical decision-making of engineers) and the contribution it would make towards the improvement of service delivery. The quantitative approach will be beneficial to the study as the intention of the research involves explaining various factors influencing the ethical decision of an engineer. Simple statistical tools, such as the mean score, percentages and frequencies were used to analyse the data obtained.

The setting of the research is within the local governance sphere, and was particularly focused on two local municipalities within the Eastern Cape which have been identified for the case study. It draws attention on experiences within the Ingquza Hill Local Municipality and Elundini Municipality as application environments for engineering ethics within public service.

In its review of service delivery methodologies it will link these to the engineering code of ethics to assess whether there is a correlation between the engineering works and the practice as guided by the Code of Conduct for registered persons issued by the Engineering Council of South Africa (ECSA).

The research methodology incorporated a desktop review on literature and made use of structured interviews in the form questionnaires to provide an analytical experience of the concept under investigation so as to provide a more practical outcome to the research question. A pilot study was conducted to determine the feasibility of the study protocol and also to conclude on the preliminary findings relevant to the desired study outcomes.

The sample for the pilot study was structured. The participants were taken from the municipal organogram of the case study at municipalities, and were only limited to senior and middle management as defined in the institutional organisational structure. The entire population available from the filled positions of all senior and middle managers was interviewed. The pilot questionnaire was administered through face to face interviews with the participants and the researcher asked structured questions. The researcher was able to offer clarity in the event that some questions were ambiguous to the participants. The researcher used observation techniques to determine the willingness of the participants as well as their attitude towards the questions being asked.

The final research will incorporate information drawn from case studies within the targeted municipalities as examples of how ethics can be used to improve service delivery.

Results

The Average Recruitment Rate (ARR) was represented by a total of 20 participants who took part, divided by the identified 21 eligible participants, which translates to a recruitment rate of 95% of the intended participants. The Mean Recruitment Rate (MRR) is reflected in Table 1 on the next page.

The response rate, based on the issued (20) and returned (20) questionnaires was calculated at 100%, since all questionnaires that

Table 1: Study Participants per Site

Site Reference	Number of Eligible Participants	Number of Participants Who Partook in Study
Ingquza Hill LM	11	11
Elundini LM	10	9
Average Participants per site		10

Source: Authors

were distributed were returned. The study had a high response rate, since one-on-one interviews for the questionnaire completion were conducted, giving the researcher adequate opportunity to collect the completed questionnaires. This also minimised the waiting time required for the return of questionnaires.

General demographic information inclusive of age, gender, employment or educational status, religious and professional affiliations was recorded on a specifically designed and standardised questionnaire to reflect a basic profile of the pilot study population.

The respondents who partook in the pilot study were found to be predominantly in the age group of thirty and thirty-nine years of age (65%) from the population investigated. Respondents between the age of fifty to fifty-nine years of age and sixty and older were tied at (15%) of the population, respectively, whilst only 5% was in the forty to forty nine years' category. As a result, it may be inferred that responders to the pilot research were mature, had a high likelihood of being responsible, and had adequate industry experience.

The respondents partaking in the study were predominantly male with 85% of the respondents being males, and the remaining 15% being of the female gender. This came as no surprise, due to the industry being investigated and having historically been a male discipline, but it did reflect that significant progress was being made, although it cannot be confirmed whether this was a result of targeted practices. The gender distribution was, however, not consistent with the demographic profile of both municipalities, which seemed to be predominantly female (52.9% for Ingquza Hill, and 60,9% for Elundini) (Statistics South Africa, 2016).

Five percent of the respondents in the pilot study reflected that they had no adherence to any religion, which corresponded to the 5% of respondents who showed that religion had no importance to them. The remainder of the respondents, who showed affiliation to religion, were classified according to their religious groups which fell largely within the Christian denominations. According to Iyer (2018), religion helps to create an ethical framework and is also a regulator for values in day-to-day life which helps to build character. Religion is, therefore, perceived as an agency of socialization.

The respondents of the study were predominantly permanent employees, with only 10% of the population being on a fixed contract. The results on levels of experience within

the organisation varied. The predominant respondents were in the categories of 1-5 years' experience and those in the category of more than 10 years within the organisation. The statistics for these groups were tied at 25% respectively. Other categories were 6-10 years (30%), and the category which had more than 10 years within the organisation responded at 20% of the population. Ongori (2007) argues that the impact of staff turnover can be positive and negative for an organisation. Positive staff turnover can be essential for growth in an organisation. This happens when a non-productive employee exits an organisation. Staff turnover can also, however, be costly to the organisation if it results in the loss of human capital investment, loss of intellectual capital, costs of replacing staff personnel and a loss of productivity.

The respondents in the study had varied levels of education in the Civil Engineering and Built Environment. The ECSA policy on registration (2018) emphasises the importance of being suitably qualified and competent to practice in the field and to also perform work at a suitable level of responsibility. The respondents of the study were found to predominantly (65%) possess a diploma or a degree in the Built Environment, whilst in the remainder of the population, 25% had a certificate (TVET qualification). The respondents who did not have a matric or a post graduate diploma were tied at 5%. Competency to do engineering work is regarded as a crucial element in the ECSA code of conduct (2006), and undertaking work that one is not qualified or trained for is regarded as a violation with regards to the conduct of engineering personnel. However, the code of conduct is only enforced to registered persons. From the findings, it can thus be deduced that 30% of the respondents may not directly hold a relevant qualification, making them eligible for registration with the regulatory body, but they would need to venture into the route for recognition of prior learning so as to be able to register in any of the recognised categories of registration.

Only 35% of the population for the study population were registered with a professional body, whilst 55% of the respondents did not indicate any affiliation and these can easily be categorised under "No affiliation". 20% of the respondents indicated that they were registered with ECSA only, whilst another 15% indicated they registered with both ECSA and the voluntary association, SAICE. The remaining 10% of the respondents reflected that they were registered with SAICE only (5%), and another professional body, SACPCMP, reflected as 5%. No other affiliations were recorded, even though the questionnaire made allowance for such.

Engineering competency and decision-making were cited as a leading area (30%), which could be used to better empower public service engineers. This was consistent with data established earlier, wherein it was identified that a majority of current personnel within the case study environment did not possess the required minimum competency for practicing in engineering work, which inherently lead to a majority of them not being registered with the regulatory body. Improvement in the enforcement of regulation, particularly in line with the requirements as set out by ECSA (2000) was identified as the second leading (20%) solution for how engineering ethics could be used to improve service delivery in public service. However, enforcement becomes a

challenge when the responsible personnel are not affiliated to the regulatory body. Improvement on quality control was cited as a third area of improvement, with 15% of responses indicating such.

When participants were asked which areas of ethical compromise people within their designations were most exposed to, the majority of the respondents indicated that administrative problems, quality constraints, and bribery and corruption were the leading causes of ethical compromise for people within their designations. Although political interference is usually perceived as a leading cause of ethical compromise, it was recorded at 8%, and was identified as the fourth leading cause of compromise. This, however, directly shifted when respondents were asked to list ethical constraints which they felt impacted on their abilities to exercise engineering decision-making. 21% of the respondents listed honesty, integrity, confidentiality and trustworthiness as the leading ethical issue they had faced. Political interference was ranked as number 2 by the respondents. Engineering decision-making came in at number 3, indicating that some of the respondents did not feel that they were able to exercise ethical engineering decision-making in their environments.

A total of 60% of the respondents answered the question, "How can engineers use engineering ethics to improve service delivery?" The responses indicated the need to balance engineering processes with values such as honesty, integrity, transparency and accountability.

Based on their knowledge of their organisational code of conduct, respondents listed honesty, integrity, confidentiality and trustworthiness as the leading ethics contained in the organisation's codes of conduct for the case study municipalities, with administrative conduct being highlighted as number 2. Fairness and justice came in at number 3. When asked to compare similarities between their organisational code of conduct and that issued by ECSA for registered persons, 15% of the respondents opted not to answer, signifying that they may not have a comparison between the two guides due to a lack of information. Accountability was highlighted as the number 1 value required, whilst public health and safety came in at number 2. The values identified seemed consistent with those highlighted in the code of conduct, though some respondents seemed to be entirely unaware of the composition of the code of conduct for registered persons, and relied on their own knowledge of other codes of conduct which may bear similarity.

In the last question, participants were asked to provide general inputs regarding the use of engineering ethics and how it can be utilised for the betterment of service delivery.

The following inputs were received:

- The employment of young engineers and their salaries by contractors must be regulated by the government.
- There must be strict criteria in employment of the contractors who are doing engineering works, for example the owner of the company must have a relevant qualification which would improve the quality of service delivery.

- Major special training must be conducted for the companies that deal with the engineering project to enforce the ethics so that it does not become a burden to one individual.

- All young growing engineers should first prioritise the engineering ethics to their field of practice, lawfully complying with statutory bodies for all engineering practices like any other field of study, e.g. doctors and lawyers.

- Presentation of short courses on engineering ethics must be made as the understanding may differ.

- Engineers using engineering ethics can sometimes be seen as a setback to service delivery so this understanding would need to be shared with managers and political leadership.

- A simplified version of ethics, taking societal norms into consideration, would assist because those are not always aligned.

- The greediness of politicians is affecting how engineers are getting hired so the municipality needs to have its own qualified engineers.

These findings highlight that there is a need for improvement in the field of ethical training of engineers, since ethics is not an inherent skill. They further display a need for changes in policy formulation when it comes to recruitment and selection of competent engineers who can be better suited to face the demands of public service.

Conclusion

By conducting the pilot study, the researcher has been able to meet key objectives that will go a long way in assisting the main study. The pilot study sought to obtain preliminary data for the primary outcome measure which would inform the main study. The data collection tool has been refined for the main study and preliminary findings have been made based on the information obtained. A lack of training on engineering ethics as well as the competency of engineering personnel has been highlighted as key factors in the pilot study. In addition to this, there is also a rising concern regarding political influences which may affect ethical decision-making amongst personnel practising in the case study municipalities, and the development of a mechanism to enable ethical decision-making could provide much needed relief to the personnel within these municipalities. From the results of the study, it is evident that there is agreement that an engineer's ability to make complex moral decisions can be used to improve their performance of duties. The main study will go into greater detail in determining the role played by engineering ethics in the identified case study municipalities, which will assist in the crafting of the ethical decision-making model which will be tackled in the final study. Management will be responsible for implementing/testing the model with the researcher's guidance.

References

Alzheimers Europe. 2009. The Four Main Approaches: Types of Research, Iyer, Luxemberg.

ASCE. 2008. American Society of Civil Engineers, Guidelines for Professional Conduct for Civil Engineers.

CIDB. 2009. Construction Industry Development Board, Construction Quality in South Africa: A Client Perspective.

ECSA. 2000. Engineering Council of South Africa, Engineering Profession Act 46 of 2000.

ECSA. 2006. Engineering Council of South Africa, Government Gazette No. 28605, 17 March 2006, Rules of Conduct for Registered Persons: Engineering Profession Act, 2000 (Act No. 46 of 2000).

ECSA. 2018. Engineering Council of South Africa, Guide to the Competency Standards for Registration as a Professional Engineer.

Iyer, R. 2018. What is the importance of religion in our lives? Available at: https://www.tutorialspoint.com/what-is-the-importance-of-religion-in-our-lives#:~:text= Religion%20helps%20in%20creating%20an,empathy%2C%20respect%2C%20and%20harmony. Accessed 31 March 2020.

Ongori, H. 2007. A review of the literature on employee turnover. *African Journal of Business Management*, Page 49-54. 1 June 2009.

SAICE. 2017. The South African Institution of Civil Engineering, Code of Ethics for Members.

Statistics South Africa. 2016. Community Survey Statistical release P0301. South Africa.