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Electricity skills assessment and gap analysis for the City of Ekurhuleni Metropolitan Municipality

Energy Department

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A research report submitted to the Faculty of Commerce, Law, and Management, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Management in Energy Leadership

Johannesburg, 2025

DECLARATION

I, Cleopatra Nonhlanhla Mokgosi, declare that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Management in Energy Leadership at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Name: Cleopatra Nonhlanhla Mokgosi Signature: CN MOKGOSI

Signed at Johannesburg

On the 28th day of February 2025

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LIST OF ACRONYMS and ABBREVIATIONS

CoE	City of Ekurhuleni Metropolitan Municipality
DHET	Department of Higher Education and Training
HR	Human Resources
IPPs	Independent Power Producers
JET	Just Energy Transition
RE	Renewable Energy
SDA	Skills Development Act
SD	Skills Development
SDG	Sustainable Development Goals
TVET	Technical and Vocational Education and Training

Abstract

The Constitution of South Africa (1996) and the Municipal Structures Act (Act No. 117 of 1998) outline the creation of municipalities and their roles and functions. The CoE is a local government entity responsible for administering services and governance within the Ekurhuleni area. To ensure effective services and governance, the municipality must have skilled personnel resources. The Local Government Municipal Systems Act (Act No. 32 of 2000) provides a comprehensive framework for municipalities, including human resources management and service provision. Municipal managers appoint and train personnel in various departments, focusing on specialized areas like electricity, water, urban planning, finance, and environmental management. The Energy department in a municipality must be skilled to manage complex activities and maintain the municipality's energy infrastructure. The skills of the Energy department's personnel closely correlate with their capacity to embrace technological advancements. This study aims to investigate the skills of the municipality's electricity personnel, assess if the CoE has adequate skills, and provide a skills gap analysis and recommendations.

Keywords:

CoE, Electricity, Electricity skills, Energy, JET, Municipal Structure Act, Renewable Energy, Service delivery, Skills gap.

CHAPTER 1. INTRODUCTION

1.1 Purpose of the study

This qualitative study investigated the skills of the municipality's electricity personnel, assessed whether the City of Ekurhuleni Metropolitan Municipality (CoE) had adequate skills for electricity personnel, and provided a skills gap analysis along with recommendations.

1.2 Context of the study

The Constitution of South Africa (1996), Chapter 7 defines the municipality, functions, structure, and establishment of the municipality's predominant method for local governance and the provision of services (The Constitution of the Republic of South Africa, 1996). The Municipal Structures Act (Act No. 117 of 1998) outlines the creation of municipalities and specifies their various types, roles, and functions (Government Gazette, 1998).

Referring to the abstract above from the Constitution of South Africa and Municipal Structure Act, the CoE is a local government entity that is responsible for the administration of services and governance within the Ekurhuleni area, however, for CoE to ensure the provision of effective services and governance, the municipality must have personnel resources which are skilled and capable of delivering the municipality’s mandate.

The Local Government Municipal Systems Act (Act No. 32 of 2000) provides a comprehensive framework for the functioning of municipalities, encompassing aspects such as human resources management and service provision. A municipal manager is appointed as the head of administration and has the responsibility of appointing human resources and ensuring effective management, utilization, and training of the human resources.

Since the municipal manager is responsible for ensuring the provision of a diverse range of services, various departments are established through the municipal manager's office, focusing on specific specialized areas of services and governance. The different department structures enable the municipalities to hire specialist personnel with experience in fields such as electricity, water, urban planning, finance, and environmental management. This specialization guarantees that difficult activities, such as the distribution of electricity, controlling water supply, and urban growth, are carried out by knowledgeable personnel.

To successfully manage the complicated activities involved with power supply and maintenance within the municipality's Energy department, Figure 1 displays the Energy department required personnel high-level structure. The Municipal Systems Act, Act 32 of 2000, requires that the personnel in the structure be skilled as per their appointment in terms of section 56 of the Local Government under the direction of the municipal manager and the relevant municipal council (Government Gazette, 2000). Given the fast-changing global energy environment, it is becoming more crucial for a municipality to ensure energy personnel are skilled with the right skills in order to fulfil the CoE energy goals and objectives. *Meyer and Sunjka (2019)* highlight the importance of understanding the value of South Africa's electrical energy sector skills.

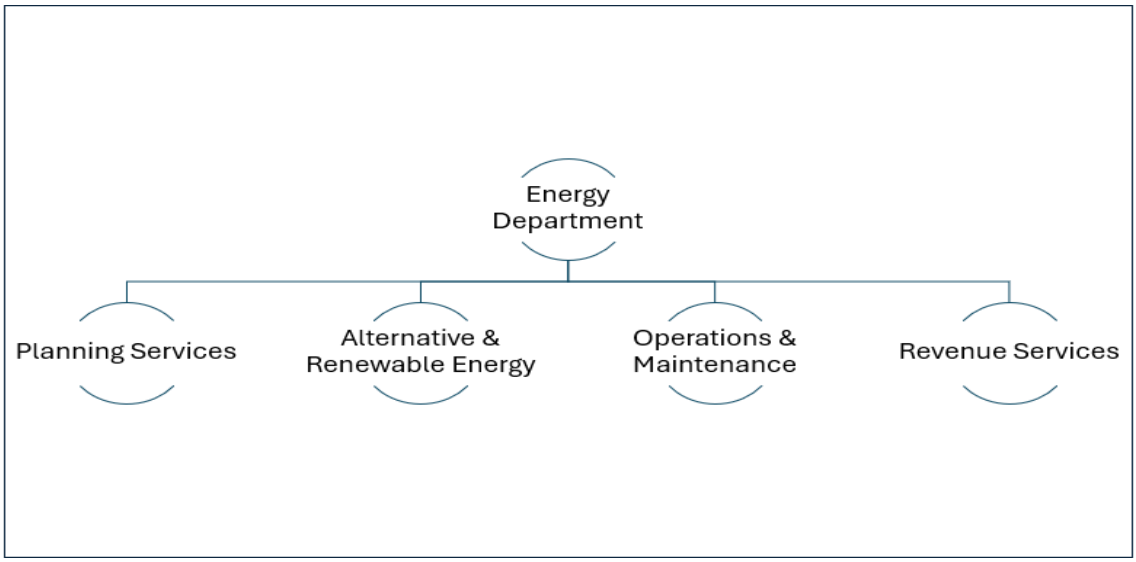

Figure 1: High level CoE Energy Department Structure

The energy sector has been transformed by technological progress, environmental considerations, and changing regulatory frameworks. Municipalities need to adjust energy skills to retain efficient, dependable, and sustainable electrical services. *Van der Merwe and Botha (2018)* argue that the skills of the Energy department's personnel closely correlate with their capacity to embrace and execute technological advancements.

In addition, for effective maintenance of the municipal electricity infrastructure, it is crucial for the municipality to possess the right energy skills. Comprehensive maintenance conducted by skilled workers not only enhances operational effectiveness but also promotes the long-term viability and robustness of the municipality's energy infrastructure *(Van der Merwe & Botha, 2018).*

From the above-mentioned, focusing on the Electricity department, this study seeks to investigate and understand the skills of the municipality's electricity personnel, assess if the CoE has adequate skills for electricity personnel, and lastly provide a skills gap analysis and recommendations.

1.2.1 Context of the study subject

The CoE is the administrative arm of government that is in closest reach to the citizens of Ekurhuleni, therefore, playing a crucial role in delivering fundamental services to society *(Reddy, 2016).* The administrative office is the place where Ekurhuleni residents engage directly with the government and experience the nature and quality of the services provided. *(Reddy, 2020).*

Referring to the definitions from the Constitution of South Africa and the Municipal Structures Act, CoE is responsible for the administration of services including electricity, water, and roads. These services are then rendered in different departments of the CoE. The departments must be in a well-functional, effective, and efficient state, with all required resources (personnel, finance, equipment, etc.) to be able to deliver services.

The CoE Electricity department is required to have skilled electrical personnel to guarantee the effective, safe, and reliable delivery of electrical services to the Ekurhuleni community. To align with electricity policies and regulations, and to be able to implement government initiatives such as Just Energy Transition (JET) and the city's innovative electricity strategies, electrical skilled human resources are mandatory.

The city's Electricity department faces significant performance challenges, the evidence is presented by infrastructure failures, management deficiency, personnel performance, community dissatisfaction, poor leadership, and budget constraints.

Poor management and leadership skills within the Energy department have severely impeded service delivery and operational effectiveness. Ineffective leadership has resulted in resource mismanagement, absence of strategic direction, and reduced employee engagement, ultimately leading to worse service delivery. The South African Local Government Association (SALGA) asserts that insufficient leadership skills contribute to ineffective control and accountability, worsening problems such as unclear roadmap for the Electricity department, unlawful spending, and regulatory non-compliance.

Poor project management within the Energy department has substantial difficulties stemming from a deficiency of skilled project management personnel. This deficit results in project hold-ups, excess expenditures, and impaired service delivery, diminishing public confidence and the municipality's effectiveness in operation. A study by *Kalonda and Govender (2021)* reveals that insufficient project management skills in South African municipalities obstruct the design and execution of infrastructure projects, leading to unsatisfactory delivery of services and development.

Budgetary limitations have significantly affected the Energy department by constraining its capacity to recruit and maintain skilled personnel vital for efficient service delivery.

The financial constraints have led to diminished training and capacity-building programs, negatively impacting employee engagement and the organizational culture. The Human Sciences Research Council (HSRC) research revealed that financial limitations impede municipalities' ability to establish sufficient training programs, leading to a workforce potentially deficient in essential skills *(HSRC, 2021).*

Poor communication skills by personnel significantly impact on both internal and external stakeholders. The lack of communication among skilled electrical staff in the Energy department effectively has an impact on guaranteeing operational efficiency, safety and the effective execution of projects.

Furthermore, due to the poor personnel communication skills, the external stakeholders (including residents and businesses) experience inconsistent or unclear information regarding electricity services, leading to confusion and diminished trust in the municipality's capabilities. *Malik et al. (2023)* believes that good communication is essential for success, as it improves decision-making and involvement of stakeholders, therefore, diminishing disputes and enhancing results. Effective communication promotes the accurate transfer of information, minimizes misinterpretations and strengthens collaboration, resulting in enhanced service provision to the community.

Moreover, with the department’s personnel having inadequate safety skills, several incidences and accidents have occurred within the Energy department, compromising operational safety and efficiency. The complexity of electrical networks necessitates a team that is both technically skilled and knowledgeable in safety standards and good communication. A deficit in these domains has resulted in significant repercussions. Veriforce (2023) emphasizes that an absence of skilled workers may result in equipment malfunctions and a reduction in routine maintenance, hence increasing the likelihood of accidents.

Additionally, with the lack of sufficient trained personnel and expertise in technical report writing, precise identification and management of electrical dangers are hindered.

A study evaluating electrical accidents in the electricity sector revealed that numerous injuries correlated with employment characteristics and educational attainment, suggesting that less educated or insufficiently trained workers are more vulnerable to accidents (Assessment of electric accidents in the power industry, n.d.). This highlights the need for extensive report writing and technical training programs to provide the Energy department personnel with the essential skills and expertise. Furthermore, with adequate technical reports, CoE energy management can be able to produce preventative strategies, which will help alleviate accidents and incidents.

The poor technical report-writing abilities of personnel in the Energy department have considerably impeded efficient future planning and infrastructure maintenance. Technical reports are crucial for recording existing infrastructure conditions, determining maintenance requirements, and forecasting future initiatives. Poorly prepared reports may result in misinterpretations, ignoring concerns, and erroneous decision-making. This ambiguity hinders the Energy department’s capacity to formulate precise maintenance plans and strategize for essential infrastructure enhancements. As a result, the municipality may see elevated service interruptions, increased maintenance expenses, and a reduced ability to satisfy the escalating energy requirements of its communities. The significance of proficient articulation in technical domains, particularly in report writing, is extensively recorded. Research by Nel (2019) stresses that clear communication is essential for successful risk management and service delivery in local government settings. The Ekurhuleni Municipality's Energy department risks undermining the quality and sustainability of its services without adept technical report writing.

Figures 2 and 3 illustrate the burned substations and these are not isolated incidents. For instance, these incidents have occurred on average twice per year over the past three years. This demonstrates a potential skills deficit required to prevent such incidents. Preventative maintenance is one of the critical measures that the Energy department typically uses to mitigate such risks, and the availability of skilled personnel is crucial.



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Figure 2: KwaThema substation 2022, source: CoE, 2024.



Figure 3: CoE Springs town substation in 2023, source: CoE, 2024.

The defect in skilled personnel impedes the maintenance of electrical infrastructure, leading to repeated power outages and equipment failures (Municipal Systems Act, 2000). This in turn, impacts community satisfaction,

since residents suffer due to disruptions in the energy supply which threatens their safety and well-being.

Staff performance is hindered, resulting in poor performance, inefficient operations, and safety risks. Consequently, the city's electricity service delivery is impeded.

The defect of skilled personnel impacts on compliance with safety regulations and standards. It is critical that CoE possesses skilled personnel in electrical safety to protect personnel from hazardous conditions such as arc flashes, electrical shocks, equipment explosions, substation fires, and electrocution. Organizations must teach workers to protect themselves from these hazards, underscoring the essential importance of electrical skills in ensuring workplace safety (Vector Solutions, 2018).

1.2.1.1 CoE's Clean Energy Innovation Strategies

The city initiated a renewable energy project in 2015 which is a biomass plant that generates 1 megawatt (MW). The plant has aided in reducing capacity constraints at Wychwood substation in Germiston, through the use of a clean form of energy to generate electricity (Ekurhuleni, 2024).

To date, the plant is still generating 1 MW due to the CoE not investing in expertise (human resources skills) to manage and expand the plant capacity. CoE has a demarcation of nine towns (Alberton, Benoni, Brakpan, Boksburg, Edenvale, Germiston, Springs/Nigel, Kempton Park and Thembisa). The renewable energy initiative was implemented in the Germiston area, with the model proven to be successful. Replicating the model across all nine towns would have been a plausible approach for CoE. However, a major challenge has been the lack of focus on upskilling and developing human resources to manage and operate the plant, since the plant's establishment.

During the year 2019, the city appointed 47 Independent Power Producers (IPPs). This initiative was intended to benefit the city in terms of renewable and

clean energy, deliver affordable energy to the city's customers, realize savings on the city's bulk Eskom purchases, address JET initiatives, create temporary jobs, and contribute to the CoE economic development. Table 1 below indicates the number of IPPs that have been appointed as service providers and renewable energy technologies to be implemented by the IPPs.

Table 1: CoE IPPs renewable energy technologies.

Technology	Number of service providers	Range (MW)	Total Proposed Capacity (MW)
Solar PV	31	5 -10	298
Waste to Energy	6	5 - 33	139
Landfill Gas	1	5	5
Gas	7	17 - 50	195
Fine Coal Gasification	1	36	36
Kinetic Power Production	1	10	10
Total	**47**		**683**

The CoE's Integrated Renewable Energy program is currently progressing successfully, with a number of solar projects being completed. However, the current internal city's human resources have no skills to maintain the renewable energy installed infrastructure. And there are no plans in place for upskilling of the internal personnel. The U.S. Department of Energy (2017) emphasizes that the electricity business needs employees who are proficient in both conventional electrical engineering and advanced information and communication technologies to efficiently manage contemporary electrical network systems.

The IPP's are contracted for 20 years, and during that period, they must establish, construct, commission and handover the energy plants to CoE. During the transition phase, the city may face difficulties in maintaining its new plants because it lacks qualified workers who possess the necessary skills to operate and maintain the new plants (example: Gas plant). Consequently, an intervention by the CoE is necessary to further develop human resource capabilities and

enhance the existing workforce skills. The absence of competent people may hinder the adoption of new technology and the upkeep of current systems, leading to operational shortcomings and even regulatory violations.

In the light of the aforementioned, the CoE Electricity department currently has significant skills challenges that must be addressed promptly. Given these challenges, it is crucial to determine whether the department has the plans and resources to address potential skills gaps in areas such as renewable energy, planning, maintenance, and management.

This requires a study to evaluate if CoE's electrical department's does have capacity to meet municipality electricity needs, identify skills gaps, and point out the necessary interventions to address them.

1.3 Research problem

The challenges experienced by the CoE Energy department include a constantly changing environment due to climate change, new technologies, smart grids and renewable energy sources. Consequently, the efficient integration and utilization of these innovations may be hampered by the incompetency of personnel. As such, this may impede the advancement and application of new technologies.

Infrastructure maintenance and distribution challenges, the reliability, efficacy, and safety of electrical infrastructure are directly influenced by the competency of electrical personnel. Power outages, equipment malfunctions, and safety hazards are prevented by the proper installation, maintenance, and repair of skilled personnel. Their proficiency contributes to the optimization of energy distribution, the reduction of delay, and the extension of the lifecycle of electrical systems. In contrast, the residential, commercial, and industrial sectors may experience costly repairs and disruptions as a result of inefficiencies, system malfunctions, or safety hazards caused by unqualified personnel.

In the absence of competent human resources, the upkeep and functionality of the current infrastructure are jeopardized. The dependability and security of electricity generation, transmission and distribution systems depend on competent workers. Incompetence in these areas may result in power supply disruption, increased outage time and safety hazards, therefore, impacting the city and its customers negatively. The city's customers are fully dependent on the healthy reliability of electrical supply for their day-to-day operations.

Effective implementation of operating standards and policies, and compliance with regulations are dependent on well-skilled personnel. In the absence of such knowledge, regulatory non-compliance, poor management, incidents/accidents and infrastructure deterioration are all possible.

1.4 Research objectives

Looking at the challenge that CoE is currently experiencing, this study intends to:

a) Conduct an assessment to evaluate whether CoE Energy department employees possess the required energy skills,

b) Identify skills gaps and provide recommendations that the municipality can implement to enhance performance, as well as align them to energy transition and global energy changes. Furthermore, the recommendations can help the municipality to define the anticipated work performance resulting from the energy transition, new technologies and renewable energies.

1.5 Significance of the study

In the light of the growing need for dependable and sustainable electrical supply worldwide, as well as in local contexts. In the CoE, similar to several other municipalities in South Africa, the Electrical department performs a crucial function in promoting economic operations, satisfying residential, businesses and local industry requirements and providing public services. An analysis that specifically examines the abilities of the Energy department skills can uncover

significant deficiencies that could impede the municipality's capacity to sustain infrastructure, adopt new technology and efficiently address catastrophes.
Meyer and Fourie (2020) note that it is crucial to fix these deficiencies to enhance service delivery, guarantee safety and improve operational efficiency.

The CoE will have an opportunity to gain experience about differences in electrical skills deployment and development from the developed countries and local municipalities. For example, developed countries have continuous development training and the implementation of advanced technologies, enabling them to uphold excellent standards in their energy services. The study conducted by *Van der Merwe and Botha (2018)* highlights the need of highly trained individuals in the implementation of smart grid technology and the addition of renewable energy sources. These are among the areas where CoE may be falling behind.

Additionally, by evaluating Ekurhuleni's Energy department skills with those of other South African municipalities under similar socioeconomic conditions, one can ascertain the relative performance of the former. This process may reveal exemplary methods that can be duplicated or deficiencies that require immediate attention. *Reddy and Govender (2019)* highlight the use of specified skills development by municipalities such as City of Johannesburg (CoJ) to enhance their power infrastructure. This might provide valuable insights that the CoE and other local municipalities may learn from.

Lastly the study results could guide specific initiatives, such as offering specialized training programs, implementing recruitment tactics that emphasize essential skills, and establishing partnerships with academic institutions such as TVET colleges and the DHET, to guarantee a consistent supply of skilled personnel. The study can also provide significant insights into optimal strategies for skills enhancement, operational effectiveness and technology integration. It can serve as a benchmark for future evaluations, thereby fostering continuous improvement in service delivery.

1.6 Delimitations of the study

- The study will be confined within the City of Ekurhuleni Metropolitan Municipality (CoE), Gauteng, South Africa.
- The study will be limited to the Energy department within the CoE municipality.
- The study population will involve the Energy Department personnel.

1.7 Definition of terms

Skills: Skilled human resources play a fundamental role in the municipality, and their significance can be observed through various scopes. It refers to knowledge, competencies, and abilities for operational tasks, developed through life and work experiences, and can be measured through skill tests. Miller (2021), describes a skill as the capacity to do activities and solve issues efficiently, which is generally obtained via practice and experience. Technical, interpersonal, and cognitive skills are examples of abilities that are important for personal and professional growth.

Electrical skills: Include abilities and expertise necessary for competently operating electrical systems, spanning from simple installation and maintenance to sophisticated problem-solving, system design, and safety management. These skills incorporate technical, soft, and cognitive skills. According to Smith, J. A. (2020), Electrical skills refer to the technical competencies and knowledge necessary for working with electrical systems, including the installation, maintenance, troubleshooting, and repair of electrical equipment and circuits.

Electrical Energy competency: Electrical competency is the ability to do tasks involving electrical systems in a safe and efficient manner. It is the possession of the essential expertise, abilities, and knowledge. According to Smith and Johnson, (2020), Electrical energy competence refers to the knowledge, skills, and abilities needed to successfully comprehend, manage, and apply electrical energy concepts in a variety of situations, such as safety, energy efficiency, and

electrical system operation. This skill is essential for professionals in industries such as engineering, technology, and maintenance.

A municipality, Municipal Demarcation Act, 1998, in line with No. 21776 Government Gazette of 2000, describes a municipality as an entity that is under the local government domain and is governed by the Local Government. Furthermore, as an arm of government with a legal existence and the authority to exercise self-governance or control under local, state, and federal laws. Usually, it is an area with its local authority, such as a town, village, city, or district. Local services, amenities, infrastructure, safeguarding, and administration are the responsibilities of municipalities towards their citizens.

1.8 Assumptions

- The CoE Energy Department human resources have basic skills level requirements.
- The CoE Energy Department managers have a desire to enhance skills of available resources to align with various energy spaces.
- The purposes and questions of the study shall be understood by those who participate in the study.

CHAPTER 2. LITERATURE REVIEW

2.1 Introduction

The city has a range of responsibilities and functions outlined in the country's local government structure. Those responsibilities include local governance, service delivery, economic development, social and community development. As such, the city is required to be capacitated with skilled and competent personnel who can deliver the city’s responsibilities and obligations.

The significance of highly skilled personnel in municipal electrical utilities cannot be overstated, as they have a vital role in guaranteeing the secure and efficient supply of energy services, which are fundamental to the operation of today's economies. Skilled individuals contribute specialized knowledge and talents, whereas competence guarantees that these skills are used effectively in the workplace. Skills development and training strives to increase workforce knowledge and competency to boost workplace productivity *(Republic of South Africa Government Gazette, 2000).*

2.2 Overview of the Energy Department Role

The purpose of the Energy department is to distribute electricity by applying electrical standards and using resources optimally whilst considering the environmental and developmental needs of the CoE community. Energy department has an essential role in ensuring that the CoE is powered, however, in the absence of skilled personnel, significant challenges may arise.

The challenges experienced by the Energy department include a constantly changing environment due to climate change, new technologies, smart grids and renewable energy sources. Consequently, the efficient integration and utilization of these innovations may be hampered by the incompetency of personnel. As such, this may impede the advancement and application of new technologies.

In the absence of competent human resources, the upkeep and functionality of the current infrastructure are jeopardized. The dependability and security of electricity generation, transmission and distribution systems depend on competent workers. Incompetence in these areas may result in power supply disruption, increased outage time and safety hazards, therefore, impacting the city and its customers negatively. The city's customers are fully dependent on the healthy reliability of electrical supply for their day-to-day operations.

Effective implementation of operating electrical standards and policies, and compliance with regulations are dependent on well-skilled personnel. In the absence of such knowledge, regulatory non-compliance, poor management, incidents/accidents and infrastructure deterioration are all possible.

2.3 Basic skills within the Municipal Energy Department

2.3.1 Defining skills

Skilled human resources play a fundamental role in the municipality. It refers to knowledge, competencies and abilities for operational tasks developed through life and work experiences and can be measured through skills tests. Some skills are easier to access for certain individuals and professions *(Khuzwayo & Khuzwayo, 2018).*

2.3.2 Defining electrical skills

Electrical skills include abilities and expertise necessary for competently operating electrical systems, spanning from simple installation and maintenance to sophisticated problem-solving, system design and safety management. These skills incorporate technical, soft and cognitive skills. *Ayers and Kenworthy (2017, 2019)* define electrical skills as a skills set which is inclusive of the knowledge, capabilities and competences necessary for the design, installation, maintenance and repair of electrical systems, equipment and devices *(Ayers, 2017; Kenworthy, 2019).*

Furthermore, *Smith (2021)* elaborate that such skills involve comprehension of electrical circuits, adherence to safety regulations, wiring techniques and proficiency in the use of specialized equipment and devices *(Smith et al., 2021).*

2.3.3 Electrical Technical skills

The literature argues that electricity technical skills are vital for ensuring the reliable and competent operation of municipal electrical networks. *Kraiger and Jung (2011)* emphasize the need for technical abilities, including the understanding of electrical theoretical terms, electrical structures and electrical safety standards, for electricians and electrical technicians to perform their duties efficiently.

Electrical engineers require advanced technical skills in electrical engineering principles, electrical system design and analysis, and electrical safety standards and regulations to design and develop electrical systems *(Becker et al., 2011).* Electrical engineers need comprehensive expertise in electrical engineering concepts, electrical system development and evaluation, as well as electrical safety standards and regulations to develop and build electrical networks *(Becker et al., 2011).* An apprenticeship is one of the fundamental trainings required for electrical personnel, it is a structured training program in which energy personnel acquire a trade or skill via a blend of practical, hands-on experience and theoretical education, guided by seasoned experts. This technique is often used to cultivate job-specific competencies and frequently results in certification or qualification in a certain domain *(Smith & Brennan, 2014).*

The literature also stresses the need to keep current with emerging technologies and technological developments in electrical networks, including smart grids and renewable energy systems, to enable electricity workers to adjust to evolving demands and needs *(Brynjolfsson & McAfee, 2014).*

The research also emphasizes the need for continuous training and development programs to enhance electrical technical skills, as well as the importance of industry partnerships and collaborations to share knowledge and best practices *(Gallagher & Dunn, 2017).*

Overall, electrical technical skills are a significant component of skilled personnel in municipalities, and investing in these skills is crucial.

2.3.4 Soft Skills Required for Electrical Municipality Workers

The literature asserts that electricity employees must possess crucial soft skills to efficiently interact in teams, engage with customers, and adjust to changes within the electricity industry. *Noe (2017)* emphasizes that electricians, technicians and engineers must possess essential soft skills, including communication, collaboration and time management, to effectively collaborate with teammates, interact with customers and successfully manage their work.

Electrical engineers need advanced interpersonal abilities in leadership, problem-solving, and conflict resolution to effectively guide teams, oversee projects and address technological challenges *(Dychtwald et al., 2013).* Additionally, the research highlights the significance of electricity soft skills in guaranteeing electrical safety, as individuals with robust soft skills are more capable of recognizing and reducing possible safety hazards *(Reason, 2000).* The literature highlights the importance of energy professionals having soft skills such as flexibility, ongoing education and emotional intelligence to successfully address evolving technology, customer requirements and workplace expectations *(Gallagher & Dunn, 2017).*

Mentoring in the field of electricity is a formal connection whereby a seasoned expert (mentor) imparts instruction, information and support to less experienced persons (mentees) to improve their technical, safety and leadership competencies within the industry. This procedure seeks to enhance professional development, guarantee the transmission of essential information, and maintain

elevated standards of performance and safety within the industry. According to *Smith & Johnson (2020),* mentoring encompasses the enhancement of skills and knowledge via the supervision of seasoned experts, particularly vital in technical sectors such as electricity *(Smith & Johnson, 2020).*

Overall, the research indicates that electrical soft skills are a crucial element of skilled employees in municipalities, and it is necessary for municipalities to invest in such skills.

2.3.5 Cognitive skills required for Electrical Municipality Workers

The literature suggests that electrical cognitive skills, including attention, memory, and processing speed, are essential for electricity employees to effectively and safely fulfil their responsibilities. *Reason (2000)* believes that crucial cognitive abilities are necessary for the identification and mitigation of possible electrical risks, as well as for making prompt and precise judgments in high-pressure conditions.

Studies also indicate that cognitive abilities such as attentiveness and working capacity are crucial for electricians, technicians and engineers to adhere to complicated procedures and regulations, as well as to identify and fix problems with electrical systems *(Kraiger & Jung, 2011).* Specialized cognitive abilities in spatial thinking and visual processing are necessary for electrical engineers to create and construct extensive electrical networks *(Becker et al., 2011).* Scholarly literature stresses the significance of cognitive abilities in adjusting to emerging technology and changing workplace conditions, as well as in guaranteeing adherence to safety standards and regulations *(Gallagher & Dunn, 2017)*. Overall, the study indicates that electrical cognitive abilities are a crucial element of a proficient workforce in municipalities.

According to *Chetty & Moodley (2022),* municipalities have challenges in executing environmental programs and sustainability efforts owing to a lack of qualified experts. *Davids (2022)* emphasises that economic limitations, like power

shortages, impede investment and economic development. The absence of training facilities and infrastructure impedes the development of future talents *(Davids, 2022). Bonifacio (2023)* advocated for a proactive approach to workforce planning and development to foster sustainable growth, emphasizing the recruitment and cultivation of personnel with the requisite skills.

2.4 Skills Assessment in Municipal Energy Departments

2.4.1 Overview of Skills Assessment

Definition of skills assessment: Skills assessment is the methodical evaluation of the person's or group's abilities, expertise and knowledge to ascertain their degree of competency, identify areas of deficiencies and define requirements for training and development *(Kraiger & Jung, 2011).* It entails using diverse techniques and instruments to assess an individual's abilities in comparison to a predefined set of criteria, competencies or prerequisites *(Noe, 2017).*

Purpose: Conducting a skills evaluation is crucial to ensure that municipal electrical personnel possess the necessary skills to carry out their responsibilities efficiently. It assists in evaluating the present skills levels of personnel, discovering gaps in knowledge and establishing focused training programs to overcome those gaps. Regular skills evaluations guarantee that personnel are not just competent in their present tasks but also equipped to adapt to new technology and legislative environments. For example, when renewable energy technology and smart grid systems become more widely used, municipal staff must enhance their abilities to effectively oversee this emerging infrastructure ***(Jones & Smith, 2021).***

The Department of Higher Education (DHET) attests that skills gap analysis is crucial for organisations to assess workforce effectiveness and identify any gaps that limit company performance *(DHET, 2019).*

As digitization and automation transform business sectors, the need for skills gap analysis is growing. According to *Statistics South Africa (2023)*, research shows

that 87% of organisations expect to experience skills gaps in the coming years, with 43% already having one. A 2022 Deloitte survey found labour and skills shortages as the second most cited external factor disrupting business strategy. Salesforce found that 76% of global workers do not feel equipped to operate in new digitally focused workplaces. Overcoming skills gaps leads to benefits such as a better understanding of the workforce, greater productivity, improved agility, clear workforce planning strategy, and competitive advantages over other organisations *(Maxontana, 2022; Whitehead, 2022).*

2.4.2 Methods of Skills Assessment

Within the electricity sector, studies demonstrates that many strategies of skills evaluation are used to measure the technical, cognitive and soft skills of electricity personnel. However, amongst the many strategies competency-based evaluation, performance assessment, and training analysis are essential and be most effective employed strategies for assessing municipal electricity personnel's skill deficiencies.

Competency-based evaluations, performance appraisals and training analyses are crucial elements of an integrated approach to guarantee the competency of power sector personnel. Evidence indicates that competency-based assessments, which appraise an individual's capacity to conduct certain activities and responsibilities, are successful in detecting deficiencies in skills and guiding the requirement for training *(Gallagher & Dunn, 2019).*

Performance assessments, which assess an individual's work performance, may also serve the purpose of pinpointing areas that need improvement and providing information on training requirements *(Noe, 2019).* Performance assessments are essential for the identification of electrical skill deficiencies among municipal electricity personnel. Through the evaluation of their work performance, these assessments can identify deficiencies in their technical understanding, safety adherence, and problem-solving capabilities. For example, structured

assessments might highlight deficiencies in compliance with electrical codes, standards, and regulations, defect and infrastructure diagnosis.

Understanding these skill deficiencies enables municipal electricity department to create focused training initiatives to improve expertise in critical areas, including high-voltage operations, system protection, and energy efficiency methodologies. This guarantees that employees can execute their responsibilities safely and effectively, minimizing the likelihood of electrical breaks down, accidents, incidences and service disruptions.

Performance evaluations facilitate worker growth by synchronizing training programs with technological advances and regulatory requirements. Rectifying these deficiencies promotes operational dependability and improves service delivery to the community, while confirming the municipality's adherence to electrical security and productivity.

Training analysis is a crucial process that includes determining training requirements and assessing the efficiency of training programs. Its primary objective is to ensure that workers possess the essential skills and knowledge required to perform their duties with safety and efficiency *(Kraiger & Jung, 2018).* Kura and Kaur (2021) assert that training needs assessment is essential for finding discrepancies between existing capabilities and industry requirements, hence enabling the development of focused training programs that improve employee performance and safety.

A comparative study of assessment methods employed in various South African metropolitan municipalities' Electricity departments, shows substantial variations in methods for evaluating personnel skills. It shows that larger metropolitan municipalities like the City of Cape Town, eThekwini Metropolitan Municipality and City of Johannesburg tend to utilize more advanced assessment methods, including online testing and simulation-based training, whereas smaller

municipalities depend on more traditional approaches, such as written tests and practical exams *(Mokoena & Mabuza, 2020).*

A comparative examination of assessment techniques used in metropolitan municipalities in South Africa revealed that those using sophisticated assessment methods had greater levels of worker competence and reduced occurrences of accidents and mistakes *(Nkosi & Moyo, 2020).*

The research indicates that the efficiency of evaluation techniques in the electrical departments of South African metropolitan municipalities is influenced by variables such as the size of the municipality, the range of skills of personnel, and the technical resources available.

2.4.3 Challenges in Skills Assessment

Several challenges in municipality skills assessment are highlighted in the literature, these challenges include the need to maintain the relevance of assessments in the context of fast-evolving technology, limitations in resources and the scarcity of competent assessors. *Mokoena & Mabuza, (2020)* highlight that the significant growth in technological advancement in the energy industry poses difficulties in creating and sustaining evaluations that are both pertinent and efficient.

Resource limitations, such as restricted budgets and staff, impede the creation and execution of detailed skills evaluation programs *(Nkosi & Moyo, 2020).*

Studies also highlight that the scarcity of competent assessors is a considerable obstacle, especially in rural or isolated regions where access to specialised knowledge may be restricted *(Makhubela & Mulaudzi, 2020).* The absence of uniformity in methods and instruments for evaluating abilities across various municipalities worsens these challenges *(Thwala & Phaladi, 2020)*.

2.5 Skills Gap in Municipal Electricity Departments

2.5.1 Identifying Skills Gaps

Advancements in the energy industry are instigating transformations on both global and local scales. These changes have significant consequences for skills development; not just will existing employment be affected, but new vocations and skills are going to be required. Therefore, it is essential to identify skills gaps and address the skills demands.

Du Toit and Visser (2017) describe a skills gap as the disparity between an employee's existing competencies and the skillset most appropriate for their position. *Khuzwayo and Khuzwayo (2018)* point out that the reasons leading to skills gaps include insufficient experience, lack of training, ineffective recruiting, staff turnover, deficiencies in the educational system, and changes in roles.

These gaps can lead to workplace inefficiency and can be addressed at a corporation-wide level through skill gap assessments and work culture considerations. On that note, *ILO (2020)* reported that the skills gap is a significant challenge in the job market, with fifty-eight percent of employees needing new skills to excel.

The problem is complex, shaped by technology progress, employment demands, and educational environments. It may result in extended employment openings, diminished productivity, and heightened training expenses (ILO, 2020).

The skills gap is widening across various industries, with sectors like renewable energy, technology, finance, business, manufacturing, and telecommunications experiencing the most difficulty in finding skilled candidates. Recruiters must understand the intricacies of the skills gap to create a harmonious and efficient workplace *(Maxontana, 2022).*

Mokoena and Mabuza (2020) indicate that a variety of methods is necessary to get a thorough understanding of skills gaps. Competency-based evaluations analyse workers' abilities against industry standards, whereas job task analysis

entails breaking down jobs into particular skills and knowledge needs *(Nkosi & Moyo, 2020).* Skills matrices provide a graphical depiction of deficiencies in skills, therefore, facilitating focused training and development efforts *(Makhubela & Mulaudzi, 2020).*

In addition, the literature emphasizes the need to engage stakeholders, such as employees, managers and clients, to accurately identify and successfully resolve any deficiencies in skills *(Thwala & Phaladi, 2020).* Systematic identification of skills gaps is considered essential in the literature for the development of successful training programs and enhancement of worker productivity in municipal electrical departments.

Undertaking continuous skills gap analysis allows municipalities to detect developing skills gaps and take proactive measures to remedy them, therefore, assuring that employees have the requisite abilities to operate and maintain new technologies and systems *(Nkosi & Moyo, 2020).*

Moreover, standard skills evaluations help to identify training requirements, hence allowing for focused training initiatives that improve worker proficiency and efficiency *(Makhubela & Mulaudzi, 2020).* The literature emphasizes that ongoing skills gap analysis facilitates succession planning, talent development and workforce planning, thereby assuring that departments possess the requisite skills and competence to tackle forthcoming difficulties *(Thwala & Phaladi, 2020).* The literature contends that ongoing study of skills gaps is crucial for municipal electrical departments to maintain flexibility, adaptability and responsiveness to evolving work demands and industry demands.

2.5.2 Types of Skills Gaps

The electricity sector in South Africa is in turmoil and encounters significant uncertainty in formulating a skills plan. *Du Toit and Visser (2017)* assert that there are three primary categories of skills gaps:

Knowledge: Knowledge gaps refer to the insufficient knowledge necessary for a job, affecting performance, organisational fit, or institutional knowledge, and can be addressed to enhance employee collaboration.

Skills: The skills gap refers to the ability to apply knowledge in specific situations, requiring mental, physical, or interpersonal competencies include communication and interpersonal skills, rather than just learning information through studying.

Performance: Performance gaps are when employees with all the tools for success underperform due to poor management or cultural fit issues *(Du Toit & Visser, 2017).*

On the other hand, *Gideon (2017) and Kraiger (2017)* highlight other forms of skills available out there. On that note, *Rogan (2022)* focuses on the analysis of the responsiveness of TVET college programme qualifications (PQMs) to the world of work.

Individual: An individual skills gap refers to a lack of necessary skills for a job, affecting both technical and soft skills. Technical skills gaps involve specific skills needed for specific tasks, such as software or machinery.

Soft skills gaps, on the other hand, involve people skills like communication, problem-solving, emotional intelligence and adaptability. Recruiters should identify and nurture these skills.

Organisational: The organisational skills gap refers to a company's insufficient skills to achieve its strategic objectives. It can be categorised into leadership skills gaps, where individuals lack the necessary skills for leadership, and functional skills gaps, where specific skills are lacking in different departments. Addressing these gaps requires analysing and developing training programs.

Sectoral: A sectoral skills gap is a discrepancy in skills within a specific industry, resulting from industry-specific skills lacking due to technological advancements or evolving standards. Regional skills gaps occur when a region lacks the

necessary workforce for its predominant industries, often due to education system disparities or migration trends.

Generational: The generational skills gap is a significant issue in the workforce, affecting different generations like baby boomers, millennials and generation z. Understanding these differences can help create policies and environments that cater to each generation's strengths and preferences, promoting a harmonious and productive workplace *(ILO, 2020; Rogan 2022; Behbahani, 2023).*

2.5.3 Causes of the Skills Gap

The South African National Energy Association (2023) suggests that the engineering sector is highly affected by the skills gap due to several reasons, some of which are explained below:

Rapid Technological Advancements: The rapid changes of technological advancements in the modern era necessitate a workforce proficient in using current technologies and adapting to new developments, particularly in fields like artificial intelligence and machine learning.

Changing Industry Standards and Regulations: Industry standards and regulations change, necessitates a workforce that adapts to future shifts. Proactive professional development is crucial for staying updated on trends and regulatory requirements.

Educational System Limitations: Educational system limitations often result in a gap between curriculum and job market demands, highlighting the need for practical exposure and industry collaborations to bridge this gap.

Inadequate Training and Development Programs: Continuous training and development are crucial for organisations to maintain a skilled workforce and stay competitive in the market.

Generational Shifts in the Workforce: The retirement of older generations leads to a shift in the workforce, potentially resulting in a loss of experience and

skill sets, necessitating a harmonious integration of different generational strengths.

Geographical Disparities: Geographical disparities can lead to a skills gap in certain regions, especially those with high concentrations of specific industries.

Company Culture and Employee Engagement: A positive company culture fosters employee engagement, promoting growth and learning, which in turn helps close the skills gap and encourages investment in skill enhancement.

Economic Fluctuations: Economic fluctuations can exacerbate the skills gap, necessitating organisations to remain agile and innovative in utilizing limited resources for training and development.

Mismatch of Skills and Job Requirements: A mismatch between job seekers' skills and market requirements can occur due to unclear job descriptions or educational program disconnect. Collaboration between educational institutions and industry leaders is crucial for a well-equipped workforce *(Mancy and Stanz, 2019; Deloitte, 2020; ILO, 2020; Behbahani, 2023).*

2.6 Consequences of Skills Gaps

In the municipality energy department, the skills gap has a significant impact on service delivery, a hindrance to new infrastructure development projects, infrastructure maintenance and the implementation of new technologies such as renewable energy projects.

Studies show that deficiencies in skills result in higher periods of inactivity, diminished power quality and worse levels of client satisfaction *(Mokoena & Mabuza, 2020)*. The deficiencies in skills impede efficient maintenance, leading to equipment failures and prolonged periods of outages *(Nkosi & Moyo, 2020).*

Skills gaps result in increased cost of maintenance, reduced efficiency of personnel, reduced life span of equipment and decreased competitiveness

(Thwala & Phaladi, 2020). Nkosi & Moyo (2020) point out that skills gaps can increase accidents and incidences, legal liabilities, high maintenance and repair costs, equipment failures and environmental disasters. While *Makhubela & Mulaudzi (2020)* highlight that skills gaps can hamper the employment of energy-efficient and cost-saving technologies, resulting in underutilized opportunities for revenue growth and limited competitiveness.

2.7 Strategies for Addressing Skills Gaps

A multi-dimensional approach to skills development is a virtue in the energy sector. *DHET (2019)* affirms that in the modern business world, recruiters play a crucial role in closing the skills gap, where an organization's needs and workers' skills do not match.

To address this issue, recruiters can develop a skills inventory, promote a culture of collaborative learning, help future leaders grow through training programs and establish continuous learning programs *(DHET, 2019).*

Technology can also be used to improve skills, such as online workshops and courses, allowing employees to learn at their own pace.

A comprehensive candidate assessment, such as coding tests can help identify the best candidates for the job to ensure they grow with the company and help fill any skills gaps in the future. These steps help recruiters ensure the best fit for their team and the company's success *(Maxontana, 2022; Behbahani, 2023).*

According to *Isaac (2021),* the skills gap is a pressing issue requiring urgent attention and action. Addressing this through targeted training programs and collaborations between industries and educational institutions can foster a more skilled workforce *(Isaac, 2021).*

The *South African National Energy Association (2023)* suggests developing a future-proof electrical engineering workforce where organisations can fill skills gaps through retraining, developing, digital training and hiring practices. On that

note, *SSACI (2024)* asserts that addressing these gaps requires extensive skills gap analysis, accurately reflecting employee performance, and identifying underdeveloped skillsets and knowledge.

2.8 Training and Development Programs

To address the skills gap in the municipality energy departments, it is necessary to create comprehensive scenarios that impact employment, consider the degrees of expertise in each area, and monitor uncertainties to enhance flexibility in skills planning. The energy skills development roadmap seeks to retrain and develop personnel to effectively manage the energy transition across different stages of the energy value chain. It integrates the energy skills development framework with future workforce requirements, emphasizing employment for an equitable energy transition. The strategy further reforms the education system to enhance the workforce's adaptable potential. The skills plan should offer national and local level strategic support, focusing on bottom-up skills processes driven by local affected communities *(Morris, 2020).*

The following information highlights the process of conducting a workplace-based survey and the development of an occupation and skills compendium, mapping skills ecosystems, identifying soft skills across job levels, and considering transversal occupations and skills for national initiatives.

The education sector needs to look into how many students are entering energy-related jobs and what employers need. They should check the curriculum, learn about career paths in the energy field, and build better partnerships for training and education, especially in important areas, to prepare job seekers for the energy transition. The skills implementation plan should involve government, industry, university and civil society at all levels, ensuring adequate provision and responsiveness to uncertainties, and cross-SETA collaboration for the energy transition *(South African National Energy Association, 2023).*

2.8.1 Training and development

The objective is to improve energy personnel skills and understanding so they can successfully handle the energy shift at every step of the energy value chain. According to *Gideon (2017),* training and development programs are educational activities that enhance job performance, employee knowledge, professional skills, fostering motivation and career progression *(Gideon, 2017).* According to the Society for Human Resource Management (SHRM), training and development is an ongoing process that helps personnel improve their skills, information, and perspectives by means of organized learning. It focuses on enhancing individual and group performance through a proper system within an organisation *(SHRM, 2019).* Good training helps employees develop their skills and knowledge, leading to overall company growth. Organizational development focuses on improving the ability of an organization to reach and maintain a new positive situation that helps the organization, its community, and the wider world *(Dewi & Kordofanian, 2018, Morris, 2020).*

Isaac (2021) is of the view that training and development is a crucial process for businesses to improve their skills, knowledge and work quality. It involves determining the need for training, establishing specific objectives, selecting methods and implementing programs. The process can be conducted in various formats, such as classroom, online, self-paced courses, certification courses, or instructor-led online training. Post-training, performance evaluations are conducted to assess the effectiveness of the training *(Isaac, 2021).*

Figure 4 below is a continuous process flow chart which the which the management can continually use to monitor and evaluate the performance to determine if the current training program is sufficient and if more training is needed. This continuous process ensures that employees are equipped with the necessary skills and knowledge for the ever-changing business environment *(Alsalamah & Callinan, 2022; OECD, 2023).*

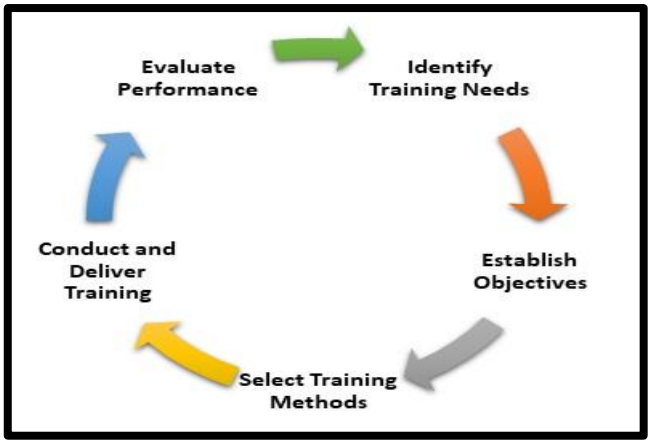

Figure 4: Continuous process flow chart.

2.8.2 Types of training and development

The focus is on aligning energy skills development with future labour force needs, focusing on jobs to ensure a just energy transition. Training programs, often driven by an organisation's Human Resources Development (HRD) function, aim to improve business outcomes by promoting employee growth and retention *(Kraiger, 2017).*

These programs may be developed autonomously or in conjunction with a learning management system, and may include orientations, classroom lectures, case studies, role-playing, modelling, and computer-based training. Employee Training and Development programs aim to enhance business outcomes by promoting personnel development and retention, while Management Training and Development focuses on developing managers and leaders *(Dewi & Kartowagiran, 2018; Klepić, 2021).*

2.8.3 Importance of training and development

Soft skills must be recognized and integrated across different levels of energy employment. According to *Khuzwayo and Khuzwayo (2018),* training and development are crucial for organisations to warrant that their personnel has the necessary skills to achieve in the ever-evolving technological landscape. Employee training not only benefits new appointments but also existing

employees, ensuring they are well prepared for new projects and challenges. *Morris (2020)* argues that the advantages of employee training include learning opportunities, enhanced development, rectification of flaws, increased productivity and performance of workers, and compliance with quality standards. *The South African National Energy Association (2023)* says that training helps personnel learn new skills and improve their abilities, no matter how much experience or education they have.

Mncayi and Stanz (2019) are of the opinion that a strong team is essential for organisational growth, and that corporate training programs can aid personnel to focus on enhancing their capabilities and develop them further. Addressing weaknesses, such as skill gaps is also essential, and training methods can help fill these gaps. Training and development are essential for organisations to ensure their workforce is equipped with the necessary skills to succeed in the ever-evolving professional environment. *Isaac (2021)* attests that training employees on soft skills can lead to several benefits, including improved work ethic, better determination, job satisfaction, lower turnover ratescreativity, risk tolerance, and enhanced reputation.

Training activities should be fun, engaging and focused on developing skills, fostering a positive learning atmosphere. Additionally, the ***South African Government (2023)*** asserts that training can help employees embrace technological advancements and innovation, as they are less likely to leave a company that provides opportunities for skill development.

Mncayi and Stanz (2019) recognizes that a robust training approach may enhance the influence of an employer brand, driving more skills into the organisation and making it a prime consideration for new graduates and recruits. Various training methodologies include instructor-led training, coaching or mentoring, e-learning, lectures, role-playing, on-the-job training, group discussions, simulation-based training, management-specific activities, case studies, and the acquisition of new technology. *Osterman (2019)* is of the view that continuous training is essential for long-term success and efficiency.

Organisations should develop employee training and development programs tailored to their business objectives and long-term goals. By focusing on these benefits, businesses can ensure their employees are well equipped for long-term success.

According to *Rogan (2022),* training and development are crucial for businesses as they increase productivity, reduce micro-management, train future leaders, increase job satisfaction and retention, attract highly skilled employees, ensure uniformity in tasks, foster companionship, strengthen safety, enable cross-training and contribute to innovation. The *OECD (2023)* attests that these programs also help attract top recruits, maintain quality control, foster a spirit of collaboration, and ensure safety. Consistent training also allows employees to cross-train, contributing to the company's success and overall bottom line *(OECD, 2023).*

2.8.4 Current trends in training and development

Cross-SETA collaboration and co-ordination to support skills provisioning for the energy transition are essential in the modern world. *Khuzwayo and Khuzwayo (2018)* attests that the corporate marketplace is rapidly evolving, necessitating businesses to adapt quickly.

Technology, particularly automation and AI, is driving this change *(Khuzwayo & Khuzwayo, 2018).* According to *Whitehead (2022),* four key trends affecting training and development include remote mobile training, AI training, agile learning and remote flexible learning models. Mobile technology is enabling companies to provide "just-in-time" information and recommendations to workers across industries. information and suggestions for employees in various sectors.

Artificial intelligence systems are capable of processing unstructured data, similarly to humans, allowing for personalised content delivery and predictive learning. Agile learning encourages employees to learn by doing, inspiring organisational change and buy-in *(Whitehead, 2022; SSACI, 2024).*

2.8.5 Training and Development Challenges

Tracking uncertainties to feed into flexibility of the skills planning is an issue. *Kraiger (2017)* asserts that corporate training may be ineffective due to the lack of retention among learners. To address this, *Maxontana (2022)* suggests that businesses should focus on self-directed, self-motivated learning through distance learning programs and mobile "just-in-time" training. A recent IBM study predicts that over 120 million workers in the world's twelve largest economies may need retraining due to AI-enabled automation in the next three years. The study highlights the importance of digital skills, the threat of skills availability and quality, and the shift in organisational cultures. To close the skills gap, businesses should tailor training experiences to employees' goals, improve transparency and adopt an open technology architecture *(Maxontana, 2022).*

According to *Dochy, Gijbels, Segers and Van den Bossche (2021),* organisational change is a significant challenge for Learning and Development (L&D) professionals. To address this, they can collaborate with leaders and other stakeholders to create effective messaging and resources that support the "why" behind changes. They can also develop leaders at all levels, from team leads to CEOs, to ensure the business's success *(Dochy et al., 2021).* According to *Statistics South Africa (2023),* investing in leadership development can lead to 2.4 times more performance goals.

L&D professionals can support this by understanding the business's competencies, providing opportunities for leaders to develop those competencies, and collaborating with business leaders to create a learning roadmap *(Statistics South Africa, 2023).*

Engaging learners is another challenge, and L&D professionals must communicate the importance of learning and development. To address this, they should work with HR and leadership teams to make learning and development an organisational priority, making it job-relevant, understanding individual employee goals and offering individualized development plans *(Alsalamah & Callinan, 2022).*

Reddy and Klopper (2017) suggest that the development challenges of a company include delivering consistent training, tracking skills application and instilling conflict management skills. On that note, *Dochy et al. (2021)* realise that global companies face challenges such as geographic limitations, increased costs, language barriers, translation issues and virtual training needs *(Dochy et al., 2021).* To address these, L&D leaders can communicate across various media, provide tailored training opportunities, provide real-time feedback, build relationships with team members and schedule regular meetings. Tracking skills application is crucial for long-term success. To resolve this, create a skills-application assignment and review employee development. Conflict management skills are essential for preventing turnover, employee morale and business longevity. L&D leaders should develop training that helps employees explore and apply conflict resolution stages, including defining conflict, identifying needs, brainstorming solutions and agreeing on implementation *(Klepić, 2021; Maxontana, 2022; South African Government, 2023).*

According to *Kraiger (2017),* the development of employee training and development is a crucial aspect of organisational success. However, the Local Government Sector Education and Training *(LGSETA) (2020)* affirms that it is often left to key leaders to determine the quota of learning, who will receive it and how much funding is allocated for development. To address this, leaders should collaborate with customers to identify emerging needs, challenges and pain points related to human capital performance.

They should also identify skill gaps and identify necessary competencies. Quantifying training effectiveness is another challenge, as it is essential to demonstrate the return on investment.

Leaders should identify existing measures or KPIs that can be linked to training initiatives, as well as consider softer measures like engagement scores, team-member satisfaction, turnover reduction and job satisfaction. Improving training effectiveness is another challenge, as it requires creativity and unique delivery methods. To address this, leaders should ask the right questions, provide

trainees with opportunities to discuss ideas, include real-world scenarios, and consider alternative learning modalities *(SSACI, 2024).*

2.9 Skills framework

The development of an occupation and skills atlas is a challenge for the energy sector, especially within the municipalities. *Du Toit and Visser (2017)* defines a skill framework as a structure that outlines the skills and attributes required for each role in an organisation, aiding in employee effectiveness and decision-making in talent recruitment, retention and succession planning. It communicates the organisation's values and performance expectations to team members, ensuring a clear understanding of their roles. On that note, skill framework aids employees and organisations by providing clarity on expectations and competencies for specific roles. It helps identify areas for skill development and provides information about the organisation's values *(Alsalamah & Callinan, 2022).* For organisations, it aids in talent management, human resources, identifying qualified candidates during interviews and creating a benchmarking tool for each position *(Akoobhai, 2023).*

Maxontana (2022) asserts that a skill framework in the energy sector offers clear expectations for all roles within an organisation; helps detect skills gaps, promotes career growth, aids in recruitment and supports the creation of training and professional development programs. It helps managers to identify areas for improvement and develop mentoring and training programs to help employees meet their expected competencies *(Maxontana, 2022).*

SkillsFuture (2023) proposes a skills framework for human resources in order to address the skills gap across the board. Figure 5 provides an overview of TVET delivery modes, including institution-based, workplace-based and a combination of both. Public schools, private providers, NGOs, and faith-based organisations can provide TVET. Formal, non-formal, and informal TVET have a larger market offer in developed infrastructures *(ILO, 2022).*

To create a skill framework, organisations should define its purpose, gather relevant information, construct it for each position, implement it and revise it over time. The framework should be straight forward, communicate its purpose and goals, and provide training to fill gaps in specific competencies. It should also be updated to reflect the changing importance and work involved in each job role *(SkillsFuture, 2023).* Organisations should build a competency framework by being clear, extensive, collecting diverse viewpoints, integrating it into existing processes, and maintaining upkeep to ensure competencies remain relevant, as roles can change over time. One needs a conceptual framework of the impact of training and development programs on competitive advantage in this case *(World Bank, 2023; SSACI, 2024).*

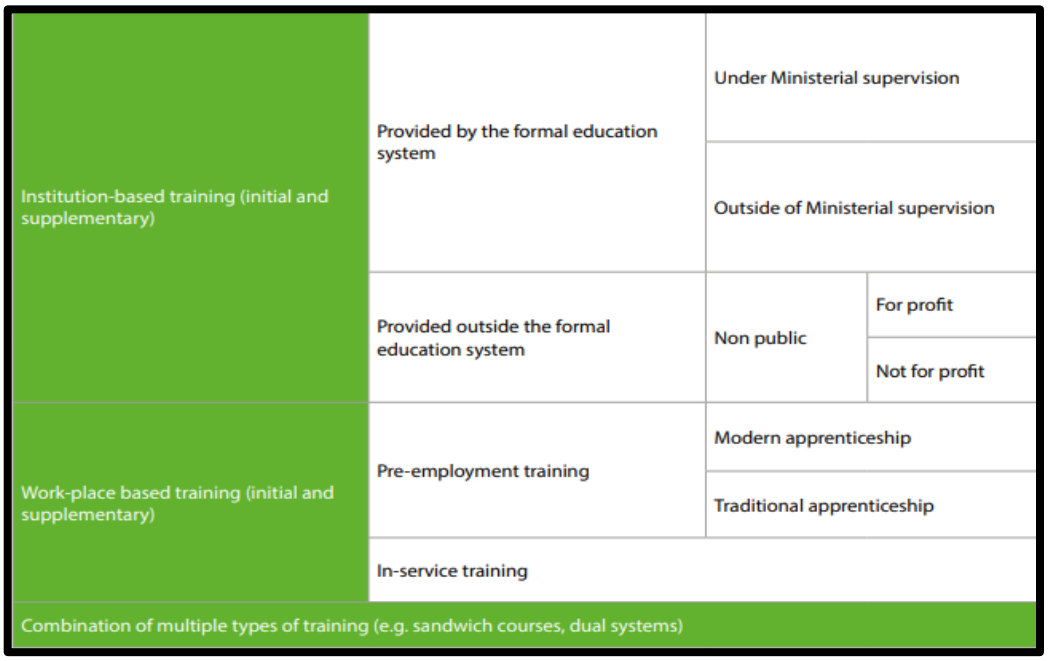

Figure 5: Skills framework - Modalities for training professionals, source: ILO 2022

2.10 Conclusion of Literature Review

The CoE Electricity department can employ different methods for the identification of skills gaps, those methods can include skills matrices, competency-based assessment and job task analysis. *Mokoena & Mabuza*

(2020) recommend that organizations use a mixed-method strategy to realize a comprehensive knowledge of skills gaps in their organization.

CoE employing the use of job task analysis implies breaking down jobs into particular skills and knowledge needs, whereas employing competency-based assessments implies assessing personnel abilities against electrical industry standards *(Nkosi & Moyo, 2020).*

On the other hand, employing skills matrices will enable the CoE to see a graphical depiction of deficiencies in skills, which will help with enabling targeted training and development strategies *(Makhubela & Mulaudzi, 2020).* Lastly, it is important that CoE involves all the stakeholders, including workers, supervisors, and customers, to ensure that skills gaps are identified and addressed effectively *(Thwala & Phaladi, 2020).*

The literature emphasizes that a systematic approach to identifying skills gaps is crucial for developing effective training programs and improving workforce performance in municipality electricity departments.

Table 3: Consistency table - research question and proposition

RQ #	State Research Question or Objective	Prop	State Proposition
1	First, this study is intended to investigate the skills of the municipality's electricity personnel and if the City of Ekurhuleni has adequate skills for electricity personnel.		
1.1	What specific skills gaps exist among the energy personnel in the City of Ekurhuleni municipality's Centre of Excellence?	1.1	The skills gap in the City of Ekurhuleni municipality, particularly within the Centre of Excellence (CoE) for energy personnel, is a significant concern. The competency of the CoE energy management is essential, as it encompasses the fundamental energy competencies and abilities required for effective performance. To address this skills gap, it is crucial to implement strategies for maintaining and improving these competencies continuously. This may involve targeted training programs, professional development opportunities, and ongoing assessments to ensure that personnel remain

RQ #	State Research Question or Objective	Prop	State Proposition
			equipped with the necessary skills to meet the evolving energy management demands.
2	State RQ 2	2	State proposition 2
2	Second, this study is intended to provide a skills gap analysis and recommendations for the CoE Energy Department human resources, to enhance performance, as well as align to energy transition and global energy changes.		
2.1	What strategies or frameworks could be implemented to effectively address the skills gap and improve the competencies of energy personnel?	2.1	To close the skills gap and enhance the skills of energy personnel, several strategies and frameworks can be employed. The Centre of Excellence (CoE) can implement targeted training programs that focus on specific competencies required in the energy sector. Additionally, establishing partnerships with educational institutions and industry stakeholders can facilitate knowledge transfer and resource sharing. To overcome difficulties such as limited funding and a lack of resources, the CoE can explore various measures, including seeking grants or alternative funding sources, prioritizing essential training initiatives, and utilizing online training platforms to reduce costs. Furthermore, creating a supportive work environment that emphasizes professional development and career advancement can aid in the retention of qualified energy workers.

CHAPTER 3. RESEARCH METHODOLOGY

3.1 Research approach

The qualitative inductive approach will be employed in the study. According to *Muhammad, N., Wilson, O., Kerry, H., & Silvia, (R. 2023),* research approaches are plans and procedures for research, ranging from broad assumptions to detailed data collection, analysis and interpretation. These decisions are influenced by philosophical assumptions, research designs and specific methods. The problem researchers' experience and study audiences, also influence the selection of a research approach. These terms represent a perspective on research from broad constructions to narrow procedures *(Muhammad, N., Wilson, O., Kerry, H., & Silvia, (R. 2023)*. Three research approaches are discussed *(Maree, 2016; Creswell & Creswell, 2017)* namely: (a) qualitative, (b) quantitative and (c) mixed methods.

Qualitative research explores the meaning individuals or groups attribute to social or human problems through inductive analysis and interpretation. Quantitative research tests objective theories by examining the relationship among variables, typically measured on instruments. Mixed methods research involves collecting both quantitative and qualitative data, integrating them, and using distinct designs. These approaches aim to evaluate theories deductively, protect against bias, control for alternative explanations and generalize findings. The core assumption is that integrating both forms of data yields additional insight beyond the information provided by either *(Denscombe, 2017).*

In this study, qualitative research will be employed since it involves collecting, analysing and interpreting non-numerical data based on factors like research question, study type, time, costs, data availability and respondents' availability.

The inductive approach will be employed for this study. The three main research approaches are deductive, inductive and abductive. Deductive approaches begin with a hypothesis and are assessed through data collection and analysis.

Inductive approaches collect and analyse data, developing theories based on patterns and themes. Abductive approaches combine deductive and inductive methods, starting with a problem and developing a plausible explanation. The goal is to refine or evaluate the theory.

Accordingly, an inductive research approach will be undertaken. Inductive approaches begin by collecting relevant data and then examining it to identify patterns. They then develop a theory to explain these patterns. This approach moves from data to theory, moving from specific experiences to general propositions. Both approaches can be complementary or different, depending on the research topic *(Bell, Bryman & Harley, 2019).*

3.2 Research design

The study will be guided by an interpretive design. When discussing qualitative research, interpretive design refers to a methodology that places an emphasis on comprehending the subjective meanings and interpretations that people ascribe to their experiences and the social circumstances in which they find themselves. According to Creswell and Poth (2018), the purpose of this design is to investigate the complexity of human behavior by taking into account the views and insights of participants. Moreover, by emphasizing the subjective interpretations of individuals, interpretive design would enable the researcher to acquire a more profound understanding of personal narratives, cultural contexts, and social phenomena (Creswell, 2013). This method is especially advantageous in qualitative research, as it enables a nuanced and comprehensive analysis of complex CoE human behaviours and social interactions.

The competencies, experiences, and difficulties encountered by Ekurhuleni's electricity workers may be better understood using a qualitative research technique. This approach will allow researcher to collect comprehensive, descriptive data via a set of questions, interviews, focus groups, and observations, yielding insights on skill deficiencies, training requirements, and working conditions. Moreover, qualitative research encompasses contextual and

subjective elements, such as workplace culture and employee viewpoints, which quantitative approaches may neglect. The qualitative method would assist the research to clearly see if the CoE municipality has the electrical, and technical skills needed to continue maintaining and improve its energy services.

Data collection methods

A semi-structured interview and questionnaires will be utilized for the study. Individual interviews are a trusted and widely used qualitative data collection method, involving direct conversations between two people. The interview questionnaire aims to gather the interviewee's knowledge or perspective on a topic. The conversation can be structured or informal, and often open-ended. This method is ideal for researchers seeking personalized information and for further exploration and follow-up questions.

Interviews are a crucial qualitative research tool, conducted in one-to-one settings with open-ended questions. There are three main types *(Maree, 2016; Creswell & Creswell, 2017)* namely: structured, semi-structured and unstructured interviews. interviews provide extensive information, often beyond the interviewer's knowledge, and are useful in market research for gathering attitudinal insights, such as customer satisfaction or product demand.

Observation is a traditional method of qualitative data collection, used by researchers to observe people and their behaviour at events or natural settings. There are two main types: Covert observation, where the observer is concealed, and overt observation, where everyone is aware of being watched. Observation is useful for studying ongoing processes, situations or reactions related to the people being observed. It is the best and most trusted collection method for qualitative data, as it requires minimal effort from participants *(Dionysia Bouzioti, 2023).*

A semi-structured interview will be employed and a pre-defined questionnaire with open-ended questions, similar to structured interviews. The interviewer can ask detailed questions or prompt participants to expand on answers. This type of

interview is time-consuming and requires thematic analysis to identify common themes. Despite this, it can provide informative, comprehensive and qualitative data, making it a valuable tool for research *(Saunders, Lewis & Thornhill, 2019).*

3.3 Population and sample

3.3.1 Target Population

Maree (2016) attests that a target population is a group of individuals selected for study or research, while a sample population is a subset of the target population, ideal for reflecting demographics. Different sampling methods provide different data methods. The study will include chief engineers, senior engineers, technicians and electricians within the CoE Energy department. The selected group will all benefit from the recommendations and skills development program, so as the entire large energy group and the CoE.

3.3.2 Sampling Methods

A non-probability purposive sampling strategy will be employed. Probability sampling and non-probability sampling are two approaches to sampling. Probability sampling involves selecting participants based on a pre-determined process, ensuring a random sample.

This method is commonly used in quantitative research for representative results. Non-probability sampling, on the other hand, is based on the researcher's discretion and judgment, often used in qualitative research for data richness and depth *(Maree, 2016).*

Purposive sampling is a non-probability sampling technique used in qualitative research to select participants with specific characteristics or unique experiences related to the research question. It aims to provide rich and diverse data to enhance the research findings. Purposive sampling is beneficial for studying groups with technical characteristics or experiences, as random selection may yield different results. However, researchers should be aware of potential bias and the potential for it to not accurately represent the broader population. To

ensure the accuracy and dependability of data obtained through purposive sampling, researchers must provide a clear and transparent justification of their selection criteria and sampling approach *(Denscombe, 2017).*

Convenience sampling is a non-probability sampling technique used in qualitative research to recruit participants quickly and cost-effectively. It was particularly useful during the COVID-19 pandemic, as it allowed researchers to quickly gather data from easily accessible and willing participants. However, convenience sampling has limitations, such as potential selection bias and potential reliability issues. Researchers should carefully define the population of interest and ensure the sample is drawn from that population, using statistical techniques like stratified sampling or weighting to adjust for potential biases. Despite these limitations, convenience sampling remains a valuable method for researchers in urgent situations with limited time and resources.

Snowball sampling is a qualitative research method where researchers recruit participants by identifying initial participants who meet eligibility criteria and referring others. This technique allows researchers to reach marginalized communities, such as undocumented immigrants. Snowball sampling produces detailed data from participants with common characteristics, providing insights into attitudes, behaviours and perspectives, however, it has its limitations.

Theoretical sampling is a strategic method used by researchers to refine their research question and theory based on emerging data. It involves selecting participants based on their potential to contribute to emerging themes and concepts, rather than convenience or accessibility. This method is used when researchers have developed an initial theory or conceptual framework.

Theoretical sampling can, however, lead to overrepresentation of specific perspectives or experiences and can be time-consuming and resource intensive. To mitigate bias, researchers can use a diverse team of researchers and reflexive sampling, which involves selecting participants aware of their biases and experiences, resulting in more nuanced and self-aware findings *(Creswell & Creswell, 2017; Bell et al., 2019).*

This study will employ purposive sampling since it is a method used in research studies to select a specific group of individuals or units for analysis. The selected participants will have electrical industry knowledge.

3.3.3 Sample Size

A purposive sample of 35 people will be selected. According to *Maree (2016),* sample size is the number of individuals or data points selected from a larger population in a study or experiment, crucial for research reliability and generalizability. The suggested sample sizes for qualitative research vary, with standards stating that 30 participants are excellent for complete findings, 10 participants for positive outcomes, and 20 to 30 participants for foundational, formative, or summative investigations (Creswell & Poth, 2018).

A high-quality sample should include participants who meet criteria from quantitative studies and client's research, and actively recruit those who match audience specifications and background relevance *(Maree, 2016).* The researcher will select participants based on specific criteria relevant to their research question or objectives. This method is often used when the population of interest is rare or hard to reach.

Purposive sampling increases the validity and reliability of research findings, enabling researchers to make more accurate inferences and develop more effective interventions *(Saunders et al., 2019).*

3.4 The research instrument

A semi-structured interview will be employed and is a pre-defined questionnaire with open-ended questions, similar to structured interviews.

Denscombe (2017) asserts that the interviewer can ask detailed questions or prompt participants to expand on answers. This type of interview is time-consuming and requires thematic analysis to identify common themes. Despite this, it can provide informative, comprehensive and qualitative data, making it a

valuable tool for research *(Denscombe, 2017).* A semi-structured questionnaire is a research tool that combines elements of both structured and unstructured methods. It provides a framework for data collection but also allows flexibility for further exploration. The questionnaire consists of closed-ended and open-ended questions, allowing respondents to provide detailed and personalized answers. Researchers can administer semi-structured questionnaires through face-to-face interviews, telephone interviews or online surveys, depending on the research objectives, target population and available resources *(Creswell & Creswell, 2017).*

3.5 Procedure for data collection

Qualitative data collected through questionnaires, interviews or observations provides descriptive and conceptual insights to allow for the exploration of ideas and explanation of quantitative results *(Kumar, 2014).* To conduct a semi-structured interview, goals and objectives will be set, questions will be designed, participants will be assembled, a medium will be chosen, and informed consent will be obtained. Set guiding questions about the research question, the purpose of the interview and anticipated follow-up questions. The following procedures are vital *(Denscombe, 2017; Saunders et al., 2019)*:

- Design questions concisely and carefully phrase them, considering sensitive topics. Hypothesise questions that could arise from participants' answers.
- Assemble participants using voluntary response sampling, stratified sampling or convenience sampling and be cautious of sampling bias.
- Decide on the medium, whether live or pen-and-paper, and ensure informed consent from participants.
- Conduct interviews in a consistent environment to avoid bias, pay attention to body language and moderate tone of voice. Ensure unbiased questions, especially when asking spontaneous questions or unscripted follow-ups. Refer to your guide and keep the research question front-of-mind when asking unplanned questions. Keep the research question relevant to the

topic and ensure the interview is conducted in a way that maintains the reliability of the data.

3.6 Data analysis and interpretation

Thematic data analysis will be employed for the study. According to *Maree (2016)*, qualitative data analysis methods include content analysis, narrative analysis, discourse analysis, thematic analysis and grounded theory. Content analysis identifies patterns in text by grouping it into words, concepts and themes, and quantifies their relationship. Narrative analysis focuses on people's stories and language, particularly in qualitative research. Discourse analysis examines political, cultural and power dynamics in specific situations, often used by brand strategists. Thematic analysis deduces meaning behind words by discovering repeating themes in text, which can be quantified when paired with sentiment analysis. Grounded theory is useful when little is known about a subject, starting with a single data case and then examining additional cases to add to the original theory *(Maree, 2016).*

Thematic analysis will be used since it is a method focusing on concepts, opinions and experiences rather than pure statistics.

According to *Denscombe (2017),* it involves a complex, exploratory approach, often applied to texts like survey responses, interviews or focus group discussions.

A six-step system was developed to help establish clarity and consistency around the thematic process, and it is this system that is most commonly used when conducting a thematic analysis. The six steps followed in this study are *(Denscombe, 2017)*:

- Familiarisation
- Generating codes
- Generating themes
- Reviewing themes

- Defining and naming themes
- Creating the report

Familiarising with data involves a comprehensive analysis, including reading through written responses, transcribing audio and recording patterns. Repeating this process helps develop a thorough understanding of the data and thereafter, coding notable features of the data using labels such as highlighting text to describe their content. After creating codes, examine them, identify patterns and generate themes. These are more comprehensive than codes, as they typically combine multiple codes into a single theme. The process of creating a thematic analysis involves reviewing themes, defining and naming them and presenting the findings in a report. This involves a thorough review of the data, assessing the validity of the themes and identifying any gaps or areas for improvement. The report should include an introduction, statement about the research question and methodology, a detailed discussion of each theme and examples from the data. The conclusion section summarises the analysis' answer to the research question and key points *(Bell et al., 2019).*

3.7 Limitations of the study

Despite its explorative nature, the study could have been impacted by some limitations *(Creswell & Creswell, 2017).* In this study, qualitative research might present some limitations, including being time-consuming, limiting interpretations due to personal experience and knowledge, and not being able to objectively verify results due to open-ended nature.

Investigating causality could be difficult due to the unique nature of qualitative research and the need for careful planning. Additionally, qualitative research is not statistically representative as responses are not measured, perhaps making comparisons difficult. To overcome these limitations, the researcher could cross-reference qualitative data with quantitative data and continuously survey prospects to build a stronger database of useful information *(Saunders et al., 2019).*

3.8 Validity and reliability OR trustworthiness

Kumar (2014) asserts that validity and reliability are traditionally associated with quantitative studies but are now applied to qualitative research. In qualitative research, validity refers to the correctness or credibility of a description, while reliability refers to the application and appropriateness of methods and the integrity of final conclusions. Bias inevitably exists in qualitative research, and threats to validity are common *(Kumar, 2014).* Therefore, *Maree (2016)* affirms that it is essential for qualitative researchers to present a well-considered strategy for ensuring validity and reliability in interview-based studies. Accordingly, trustworthiness in qualitative research is achieved by demonstrating dependable, credible, confirmable and transferable findings *(Bell et al., 2019).*

Dependability in qualitative research is crucial for ensuring the consistency and reliability of results. It involves tracking data collection, analysis and interpretation methods, providing contextual information, and ensuring the study can be replicated by other researchers. Tools like inquiry audits and screening parameters can help solidify research dependability, as will be done in this study.

Credibility in qualitative research is crucial for the accuracy of findings. Researchers' credibility and research methods, such as triangulation and member checks, can enhance credibility. The study uses technical team to summarise data from semi-structured interviews, identifying consistent themes and key insights. Their industry experience allows them to formulate strategic recommendations.

Confirmability in qualitative research ensures that the findings are neutral and not influenced by the researchers' assumptions or biases. This is achieved by providing an audit trail detailing each step of data analysis and demonstrating that the findings are not coloured by conscious or unconscious bias. This study will achieve confirmability by summarising each question during semi-structured interviews.

Transferability in qualitative research refers to the extent to which a study's results are applicable in other contexts or settings. To demonstrate transferability in this study, the researcher will provide detailed information about the site, participants and data collection methods, ensuring the results are highly likely and trustworthy *(Denscombe, 2017; Bell et al., 2019).*

3.9 Ethical considerations

Ethical considerations in research involve principles and guidelines that researchers must follow to ensure responsible and ethical conduct of their studies *(Kumar, 2014).* Key ethical considerations in this study include obtaining informed consent, protecting privacy and confidentiality, minimizing harm, ensuring fairness and equity, using deception only when necessary, working with vulnerable populations, disclosing potential conflicts of interest, avoiding data manipulation, respecting intellectual property rights, and being sensitive to cultural norms and beliefs.

According to *Denscombe (2017),* researchers must also avoid imposing their values or beliefs on participants and respect their cultural practices. They must also disclose potential conflicts of interest, respect intellectual property rights and cultural sensitivity. Researchers must adhere to ethical guidelines and best practices to protect participants' rights and well-being, while organisations must ensure employees follow best practices.

Voluntary participation: The study emphasizes the importance of voluntary participation, allowing individuals to choose to participate without feeling compelled or pressured into anything they do not want to do.

Informed consent: Informed consent is an ethical and legal requirement, requiring participants to understand the study's methods, potential risks, study duration, researcher/sponsor contact information, and their right to withdraw without penalty, using a consent form.

Anonymity: Anonymity in this study will ensure research data is not identifiable, preventing tracing back to individual participants through digital ID's that cannot be linked to their original identities.

Confidentiality: Confidentiality in this research is crucial to protect participants' privacy and prevent unauthorized disclosure. Techniques used in the study include using secure servers, removing identifying information, limiting record retention and avoiding public discussion.

Potential for harm: The potential for harm, including psychological, social, physical and legal, is a critical consideration in this research study, necessitating an ethical review to minimize potential harm.

Permission to conduct the study: The researcher obtained permission from the University's Ethics Committee and study organisation, adhering to institutional guidelines. Informed consent is crucial, requiring written consent from participants and parents. Institutional Review Boards review human subject research to ensure ethical standards, protecting participants' rights and well-being *(Saunders et al., 2019).*

3.10 Consistency table

Table 4: Consistency table - research question and proposition

RQ #	State Research Question or Objective	Prop	State Proposition	Data collection detail	Data analysis method
1	Firstly, this study is intended to investigate the skills of the municipality's electricity personnel and if the CoE has adequate skills for electricity personnel.				
1.1	What specific skills gaps exist among the energy personnel in the City of Ekurhuleni municipality's Centre of Excellence?	1.1	The skills gap in the City of Ekurhuleni municipality, particularly within the Centre of Excellence (CoE) for energy personnel, is a significant concern. The competency of the CoE energy management is essential, as it encompasses the fundamental energy	Interview guide questions	Thematic analysis

RQ #	State Research Question or Objective	Prop	State Proposition	Data collection detail	Data analysis method
			competencies and abilities required for effective performance. To address this skills gap, it is crucial to implement strategies for maintaining and improving these competencies continuously. This may involve targeted training programs, professional development opportunities, and ongoing assessments to ensure that personnel remain equipped with the necessary skills to meet the evolving energy management demands.		
2	State RQ 2	2	State proposition 2		
2	Secondly, this study is intended to provide a skills gap analysis and recommendations for the CoE Energy department, human resources, to enhance performance, as well as align to energy transition and global energy changes.				
2.1	What strategies or frameworks could be implemented to effectively address the skills gap and improve the competencies of energy personnel?	2.1	To close the skills gap and enhance the skills of energy personnel, several strategies and frameworks can be employed. The Centre of Excellence (CoE) can implement targeted training programs that focus on specific competencies required in the energy sector. Additionally, establishing partnerships with educational institutions and industry stakeholders can facilitate knowledge transfer and resource sharing. To overcome difficulties such as limited funding and a lack of resources, the CoE can explore various measures, including seeking grants or alternative funding sources, prioritizing essential training initiatives, and utilizing online training platforms to reduce costs. Furthermore, creating a supportive work environment that emphasizes professional development and career advancement can aid in the retention of qualified energy workers.	Interview guide questions	Thematic analysis

CHAPTER 4. DATA PRESENTATION AND ANALYSIS

4.1. Introduction

The previous chapter focused on the research methodology that underpins the study. This qualitative study investigated the skills of the municipality's electricity personnel, assessed whether the City of Ekurhuleni Metropolitan Municipality (CoE) had adequate skills for electricity personnel, and provided a skills gap analysis along with recommendations.

By understanding current competencies and identifying deficiencies, this study seeks to offer actionable insights for enhancing the workforce's capabilities and addressing future challenges in the energy sector. Therefore, this chapter presents the sample employed to generate primary data, findings from thematic analysis, and the related discussions.

4.2. The Sample

Thirty-five personnel employed within the CoE Energy department were selected to participate in the study. Only twenty individuals responded to the study. The study questionnaires, consent forms, the research summary, and the context of the study were sent out by e-mail to each participant. The comments of the twenty persons who participated in the research came from an array of levels within the Energy department organizational structure, which included five chief engineers, six senior engineers, five technicians, and four electricians. The purpose of this diverse sample questionnaire aimed to get an in-depth understanding of the skill levels that are present throughout all of the roles that are included within the Energy department.

As a finding, Tables 4.1 to 4.4, show the descriptive data for the sample with respect to age, gender, education, and experience. The experts were all above the age of 18 years and were in a position to conduct this study freely and voluntarily were approached. The sample was drawn across both genders, thereby getting all views from across the board.

Members of the sample were educated enough to inform the study as they are in possession of at least a national diploma, right up to the master's degree, and a related electrical trade qualification. In terms of experience, most of the members had at least 5 years with the organisation, therefore, they were well placed to inform the study.

The demographic information for the sample, including age, gender, education, and experience, demonstrated that individuals were qualified to contribute to the research. The outcomes presented in this study are therefore valid and may be depended upon for present and future applications.

Table 4.1: Descriptive Data for Age

Age	Chief Engineers	Senior Engineers	Technicians	Electricians
20-30	0	0	1	2
31-40	1	4	3	1
41-50	3	2	1	1
51-60	1	0	0	0

Table 4.2: Descriptive Data for Gender

Gender	Chief Engineers	Senior Engineers	Technicians	Electricians
Male	4	2	2	2
Female	1	4	3	2

Table 4.3: Descriptive Data for Education

Education	Chief Engineers	Senior Engineers	Technicians	Electricians
National Diploma	0	0	5	4
Bachelor's Degree	3	5	0	0
Master's Degree	2	1	0	0
Trade test	5	3	3	4
Government Certificate of Competency (GCC)	5	0	0	0

Table 4.4: Descriptive Data for Experience

Experience	Chief Engineers	Senior Engineers	Technicians	Electricians
0-5 years	0	0	1	2
6-10 years	0	2	1	2
11-15 years	1	3	3	0
16+ years	4	1	0	0

4.3. Thematic Analysis

Thematic analysis is a qualitative research methodology used for detecting, interpreting, and reporting patterns (themes) within data. This adaptable methodology systematically organizes and articulates data in comprehensive detail, often used to analyse several facets of a study subject. *Braun and Clarke (2006)* define the process of thematic analysis as comprised of six stages:

- Becoming acquainted with the data,
- Creating initial codes,
- Looking for themes,
- Evaluating themes,
- Defining and labelling themes, and
- Publishing the report.

Its theoretical flexibility, which means that it may be employed across a variety of epistemological frameworks and research paradigms, is one of the attributes that contribute to its worth.

For the purpose of the study, thematic analysis will aid in extracting complicated qualitative data into significant themes that align with the study's objectives. Themes such as "technical competency," "training deficiencies," or "skill sufficiency for infrastructure maintenance" might elucidate the personnel's existing capabilities and shortcomings.

Furthermore, the versatility of thematic analysis also allows for the integration of data from many sources, including surveys, focus groups, and legislative documents. This correlates perfectly with the study, which might involve many

viewpoints from workers, managers, and stakeholders inside the CoE. This strategy facilitates the consolidation of diverse viewpoints into cohesive conclusions.

The thematic analysis will be very proficient at evaluating the energy department's skills sufficiency and identifying deficiencies. By examining participant responses, identification of particular areas in which individual abilities correspond with or diverge from municipal requirements, such as competence in renewable energy technology or sophisticated grid systems.

The interpretative aspect of thematic analysis enables practical recommendations. By correlating discovered themes with overarching CoE objectives, electrical industry standards, and municipal regulations, the research may recommend specific solutions, such as tailored training programs or recruiting methods.

Lastly, thematic analysis is appropriate for this study as it offers a systematic but flexible framework for examining individuals' abilities, evaluating their sufficiency, and pinpointing deficiencies. It enables significant insights and guarantees that suggestions are based on data-driven facts.

The following themes were formulated to assess the extent of the skills gap deficit, leading to suggestions aimed at mitigating this deficiency:

4.3.1. Electrical Skills

Municipal officials identified a significant need for electrical abilities, particularly a lack of understanding of developing technologies like smart grids and renewable energy systems, as highlighted by sixty percent of respondents. Seventy percent of senior engineers and technicians indicated difficulties in adjusting to new grid management systems, suggesting that conventional training has inadequately equipped personnel for contemporary technical requirements. Therefore, fifty percent of electricians indicated insufficient maintenance abilities for energy-efficient devices, including solar inverters. Forty percent of chief engineers noted

a substantial deficiency in analytical skills regarding energy consumption data, highlighting the need for personnel to comprehend and respond to real-time data to improve system efficiency. These shortcomings indicate that whereas fundamental electrical knowledge is robust, sophisticated technical skills necessary for progressive energy systems are still lacking.

4.3.2 Electrical Technical Skills

- **Identification of Critical Electrical Skills Deficiencies**

The energy participants have identified a significant gap in technical skills among their workforce. Significant shortcomings include a lack of proficiency in renewable energy systems, smart grid technology, infrastructure maintenance technologies, and advanced diagnostic skills. A deficiency exists in comprehending current automation tools and adherence to revised safety regulations.

Sixty percent of respondents emphasize communication as an essential ability, indicating that excellent communication is crucial to the functioning of the Energy Department in the City of Ekurhuleni. The focus on communication indicates that staff acknowledge its significance in facilitating seamless collaboration across teams, augmenting client interactions, and expediting response times for maintenance and issue repair. Communication is sometimes seen as a soft talent, yet in the energy industry, especially within the City of Ekurhuleni's Energy Department, it constitutes a vital technical skill that directly influences operational efficiency, safety, and service delivery.

Seventy percent of senior engineers responded that communication is crucial for accuracy in technical instructions. Electrical work requires precise comprehension of instructions, whether they are written (blueprints, circuit diagrams, technical manuals) or verbal (team orders, emergency procedures). Miscommunication may result in wiring inaccuracies, erroneous system settings, or safety risks. Consequently, excellent communication guarantees that

professionals comprehend and perform their duties accurately, making it a vital technical ability.

sixty-five percent of the entire team stressed the importance of problem solving and troubleshooting, clear reporting, and cooperative problem-solving between engineers, electricians, and control room operators are essential to the diagnosis of electrical failures. A technician must communicate test findings, explain issues clearly, and decipher automated systems' or coworkers' comments. Ineffective power restoration, needless downtime, and misdiagnosed issues may all be caused by poor communication.

Emergency response and safety compliance: Working with electricity is risky by nature. Effective safety communication guarantees adherence to workplace safety rules and helps to avoid accidents by means of standardized language, danger alerts, and emergency reporting systems. Effective communication is just as important as technical expertise in high-risk settings like substations to avoid electrocution or equipment failure.

Eighty percent of electricians responded by indicating that customers' engagement and service effectiveness can be affected by communication. Customers are often contacted by municipal energy staff with questions about bills, power disruptions, and meter installations. The reputation of the municipality is improved, customer annoyance is reduced, and service delivery is improved when a professional can clearly explain technical concerns.

Overall, ninety percent of technical staff concluded that communication is an essential component for technical skill and is not distinct from technical ability. Even the most proficient electricians, technicians, and engineers could have trouble with execution, collaboration, and safety compliance without it. As a result, communication must be acknowledged, cultivated, and evaluated as a fundamental technological ability in the energy industry.

Eighty percent of the participants also highlighted the criticality of time management. Proper time management is essential for meeting project

deadlines, ensuring efficient workflow, customer service, and realizing the energy department’s objectives. The participants' responses reveal that municipal workers often struggle with managing their time effectively.

- **Strategies for Adapting to Evolving Power Technologies**

The Energy personnel’s responses, ninety percent stressed the importance of being educated to adjust to changing electricity technology via focused enhancing skills programs and ongoing professional development. A significant fifty-five percent of respondents, especially senior engineers and chief engineers, advocated for modular training programs centred on smart grids and renewable energy technology. Forty-five percent of participants endorsed e-learning platforms as a cost-efficient and accessible alternative for distant education. Additionally, fifty percent of technicians recommended hands-on seminars and real-world simulations to provide practical experience with new equipment and technology. Sixty percent of respondents consistently emphasized the need for co-operation with academic institutions and technology suppliers to connect training programs with industrial improvements. These initiatives, together with regular technological upgrades and certifications, help provide workers with the necessary abilities to address emerging difficulties proficiently. Ninety percent are advocating that municipal staff can be taught to adapt to evolving power technologies through continuous training and education programs. This includes attending workshops, seminars, and conferences focused on the latest advancements in electrical technology. Participation in industry-specific seminars and conferences can provide municipal staff with exposure to new technologies and best practices, to ensure they stay updated and adapt to changes.

- **Acceptance and Application of New Technologies**

From the responses, it is highlighted that municipal Energy departments often implement new technology gradually and prudently. Fifty-five percent of respondents indicate that the process often starts with pilot projects, whereby new technologies like smart meters or solar systems are evaluated on a limited

scale prior to wider deployment. This incremental strategy alleviates hazards and provides personnel with the opportunity to acclimate to the new technologies.

Forty-five percent of participants said that the adoption of technology is often propelled by external requirements or financing, like governmental programs for renewable energy or smart grid infrastructure. Nonetheless, forty percent of respondents indicated that opposition could occur to the adoption of new technology due to apprehensions around initial costs or the potential disruption of current procedures.

To resolve these challenges, fifty percent of engineers and technicians recommended that providing further training and instruction about the advantages and practical uses of new technology would facilitate easier transitions.

- **Obstacles to Using New Technology**

The participant's responses vastly highlight that the main impediments to the adoption of new technologies in municipal Energy departments are financial limitations, insufficient training, and reluctance to change in personnel. Inadequate technical support, post-implementation, may impede the effective utilization of new technologies. Around sixty-five percent of respondents cited insufficient financial resources as the primary obstacle hindering the acquisition of modern technology or the employment of specialist trainers. Fifty percent of participants underscored the insufficiency of current training programs in equipping workers for emerging technologies, including smart grid systems and renewable energy solutions.

Resistance to change, especially from senior personnel, was seen by fifty-five percent of respondents as an additional barrier. A considerable number of employees are proficient with current technologies and may see the implementation of new systems as superfluous or too complex.

- **Role of Apprenticeships and Mentoring Programs**

Based on the eighty percent of participants' replies, apprenticeships and mentorship programs are essential in alleviating electrical skills gaps by facilitating practical knowledge transfer and experiential learning. A significant sixty-five percent of participants identified mentorship as an essential mechanism for connecting seasoned experts with younger employees. Ninety percent of senior engineers agreed that mentoring and apprenticeships facilitate the transmission of essential problem-solving and diagnostic abilities, which are often absent from formal schooling. Likewise, sixty percent of technicians underscored the need for practical apprenticeships in providing new CoE employees with essential electrical competencies. The results were also clear that mentoring and apprenticeships significantly enhance retention rates.

Fifty percent of respondents said that mentees are more inclined to stay in the department owing to the robust connections and tailored development possibilities fostered by these programs. Ninety-five percent of electricians said that planned apprenticeships help cultivate confidence and proficiency in young professionals within the organisation, equipping them to address intricate duties autonomously.

Furthermore, the results highlight the absence of experienced mentors to guide and train new employees, which is a notable deficiency. This hinders the transfer of knowledge and skills from seasoned professionals to newcomers. With several of the older, more experienced personnel exiting the Energy department, the skills gap is continuing to increase. It is evident that the Energy Department is lacking structured programs for skills transfer and succession planning, which affects the continuity and sustainability of expertise within the department.

- **Motivation for Ongoing Professional Development**

Approximately sixty percent of participants saw financial incentives, like bonuses or pay augmentations linked to certificates as effective motivators, and fifty percent of senior engineers advocated for the establishment of explicit career

advancement paths associated with skill development, therefore, allowing personnel to see the concrete advantages of additional training. Forty-five percent of technicians and electricians preferred flexible training schedules and sponsorships for external courses, enabling personnel to reconcile job and education. Additionally, forty percent of chief engineers vouch for the establishment of recognition programs, including rewards for skill accomplishments, to promote a culture of ongoing learning. 4.3.5. Recruitment and Retention of Qualified Electrical Professionals

Seventy percent of participants emphasized the need for attractive compensation and perks to recruit qualified workers. Sixty percent of participants highlighted the need for offering training opportunities and career progression as essential for retention, especially for younger employees. Fifty percent of participants endorsed flexible working circumstances as a crucial element for talent retention, particularly in challenging municipal settings. A further forty-five percent of senior engineers indicated that a healthy company culture, including mentoring programs and team-building activities, cultivates employee loyalty.

4.3.2 Soft skills

- **Effective Communication with Consumers and Stakeholders**

Training personnel in successful communication includes education in soft skills and the use of suitable tools. Approximately eighty percent of respondents highlighted the need for seminars focused on interpersonal communication and stakeholder engagement. Role-playing activities, endorsed by fifty percent of participants, may replicate real-world events, so augmenting staff confidence in managing inquiries and grievances. In addition, forty percent of electricians recommended training aimed at reducing technical jargon to enhance the accessibility of difficult material for non-technical stakeholders. Forty-five percent of senior engineers preferred digital communication methods, including applications and online platforms, for delivering consistent and timely information.

Integrating these methodologies enables personnel to establish trust and cultivate constructive connections with stakeholders.

- **Deficient Soft Skills Among Municipal Electrical Professionals**

From the responses, the predominant deficiencies in soft skills among municipal electrical personnel are communication, problem-solving and collaboration. Fifty-five percent of respondents identified communication, both with co-workers and external stakeholders as the most often reported deficiency. Technicians and electricians often find it challenging to communicate technical information clearly and succinctly. Fifty percent of participants highlighted problem-solving as an area for improvement, with several employees unable to diagnose intricate situations in real time.

Teamwork, emphasized by forty-five percent of respondents as an obstacle, since personnel must often collaborate on extensive projects but encounter difficulties in co-ordination and conflict resolution. Rectifying these weaknesses with specialized training and workshops centred on soft skills development may augment team interactions and promote overall efficiency.

- **Perception of Soft Skills Significance**

Several municipal electrical specialists think that technical knowledge supersedes interpersonal abilities, assuming that their tasks are accomplished effectively. This impression may impede the development of vital soft skills, acknowledging the significance of soft skills for efficient co-operation.

Seventy percent of respondents highlighted that proficient communication, collaboration, and problem-solving are crucial for successful project implementation. Senior and chief engineers emphasized that the absence of robust interpersonal skills may lead to project delays, day-to-day operations and misunderstandings adversely impacting productivity and safety. Technicians and electricians said that effective communication is essential when diagnosing

issues or collaborating with colleagues during maintenance and installation activities.

Fifty percent of participants indicated that effective collaboration enhances job satisfaction and morale, cultivating a more supportive and efficient workplace. These insights highlight the need for soft skills training in conjunction with technological progress.

4.3.4 Cognitive skills

- **Challenges in Energy Efficiency and Sustainability Initiatives**

The primary challenges that municipal energy personnel face in implementing energy-saving initiatives are opposition to change, inadequate training and limited resources. About ninety percent of participants saw financial limitations as a significant obstacle, hindering access to innovative technology and advanced training initiatives. This hinders the implementation of new projects and technologies. Forty-five percent of technicians pointed out insufficient experience in energy-efficient systems, whilst sixty percent of senior engineers indicated challenges in aligning sustainability objectives with current infrastructure. Forty percent of respondents saw resistance to adopting new methods, especially among seasoned personnel, as a notable concern.

- **Role of E-learning and Online Training**

According to the participant's responses, online education and training provide adaptable and economical methods for remedying skill gaps. Around sixty-five percent of technicians acknowledged the openness of online platforms, enabling workers to study at their own speed and review content as necessary. Fifty-five percent of senior engineers emphasized the adaptability of e-learning, allowing extensive cohorts of personnel to get uniform training and quality, irrespective of their geographical location.

Interactive courses and virtual laboratories, endorsed by forty-five percent of technicians, provide practical practice in simulated settings. E-learning enables ongoing updates, with fifty percent of senior engineers highlighting the need of staying abreast of technology progress. Consequently, e-learning supplements conventional training and augmenting skills development at all tiers.

- **Education on Emerging Electrical Technology**

About fifty-five percent of participants recommended modular programs on technologies such as smart grids and renewable systems, facilitated by collaborations with universities and industry specialists. Sixty percent of technicians identified hands-on workshops and simulations as essential for acquiring practical experience. E-learning systems, endorsed by forty-five percent of the participants, provide readily available on-demand resources for employees to study at their own speed.

Fifty percent of participants supported involvement in pilot projects, allowing personnel to see and interact with new technology in practical settings. These methods together equip personnel to implement creative ideas efficiently.

- **Motivation for Acquiring Specific Competencies**

Municipal personnel may be incentivized to develop expertise in the Energy department through a mix of explicit rewards and practical training. Sixty percent of respondents advocated for the provision of specialist credentials in energy distribution, perhaps facilitating promotions or career developments within the organization.

Fifty percent of senior engineers advocated for the provision of practical, project-oriented learning opportunities to enable personnel to immediately use newly acquired information. Forty-five percent of participants supported the provision of financial incentives, such as bonuses or salary increases for obtaining higher credentials.

An additional fifty-five percent of electricians supported mentoring programs in which seasoned workers advise less experienced personnel in navigating intricate transmission networks, therefore, cultivating a feeling of responsibility and achievement.

- **Evaluation and Rectification of Skills Deficiencies**

Coming out largely from the responses, the electrical department should presently identify and rectify skills gaps via performance evaluations, training assessments, and feedback systems. Sixty percent of respondents said that yearly performance reviews assist in identifying skills shortages, nevertheless, some employees believe the assessments emphasize technical competence excessively and fail to sufficiently address soft skills or the requirements of evolving technologies. To address weaknesses, fifty-five percent of participants said that the municipality depends on specialized training programs, often created in partnership with external specialists. Fifty percent of senior engineers indicated that mentoring and peer evaluations are used to provide continuous feedback, particularly for new or younger personnel.

According to forty percent of the respondents, a formal skills audit and skills gap analysis should be conducted to ensure a comprehensive understanding of the department's needs and the requisite resources to address them.

4.4. Summary of Key Themes

The study identified critical skills deficiencies in technical, communication and time management areas within the CoE Energy department. The lack of mentors and structured skills transfer programs also pose significant challenges. Adapting to evolving technologies requires continuous training and education. Apprenticeships and mentoring programs are essential for improving job satisfaction and performance.

Effective recruitment and retention tactics, such as incentives and promotions, help attract and retain qualified professionals. Transparent communication

channels and accessible information are crucial for building trust with consumers and stakeholders.

Flexible e-learning and online training provide convenient learning options, while specific competency incentives motivate staff. Deficiencies in soft skills, particularly leadership and time management, impact team dynamics and productivity. Successful technology adoption depends on getting buy-in, provide training and offering continuous support. Funding and service support are significant obstacles to technology use.

Summarised Table of Key Themes

Theme	Aspect	Details	Examples/Impact
Identification of Critical Skills	Technical Skills	Deficiencies in advanced electrical systems	Impacts efficiency and innovation
Identification of Critical Skills	Technical Skills	Deficiencies in advanced electrical systems	Impacts efficiency and innovation
	Communication Skills	Poor communication skills	Leads to misunderstandings and poor service delivery
	Time Management	Inadequate time management skills	Delays and inefficient resource utilization
	Lack of Mentors	Absence of experienced mentors	Impedes transfer of knowledge and skill acquisition
	Skills Transfer (Succession Planning)	Insufficient structured programs	Impacts the sustainability and continuity of professional knowledge
Adapting to Technologies	Training and Education	Continuous training and education programs	Keeps personnel informed about technology developments
	Seminars and Conferences	Participation in seminars and conferences	Acquaintance to new technologies and best practices
Apprenticeships and Mentoring	Job Satisfaction	Growth and development opportunities	Enhanced retention and morale

Theme	Aspect	Details	Examples/Impact
	Improved Performance	Hands-on training and guidance	Enhanced degree of effectiveness
Professional Development	Incentives and Rewards	Offering incentives and rewards	Monetary incentives and professional progression
	Clear Goals	Setting clear professional development goals	Encourages staff motivation
	Opportunities for Growth	Providing growth opportunities	Promotes ongoing advancement
Recruitment and Retention	Incentives	Competitive incentives to attract and retain professionals	Salary raises and performance-based incentives
	Promotions	Clear career advancement pathways	Encourages employee retention
	Celebrating Top Performers	Recognizing and celebrating top-performing employees	Enhances morale and promotes excellence
Emerging Electrical Technology	Training and Support	Comprehensive training programs and support	Education on new technologies
Energy Efficiency Initiatives	Lack of Funding	Insufficient funding for initiatives	impedes the execution of new initiatives
Effective Communication	Transparent Channels	Providing transparent communication channels	Gains the confidence of stakeholders and customers
E-learning and Online Training	Flexibility	Flexible learning options	Alleviates skill inadequacies
Specific Competencies Motivation	Promotions	Offering promotions for new competencies	Promotes the development of skills
	KPI Incentives	Implementing KPI incentives	Inspires the attainment of objectives
	Fully Paid Bursaries	Providing bursaries for further education	Facilitates the acquisition of new talents
Deficient Soft Skills	Leadership Skills	Deficiencies in leadership skills	Impacts the capacity to manage organizations
	Time Management Skills	Lack of time management skills	impacts productivity and efficiency
Perception of Soft Skills	Technical Over Soft Skills	Belief technical skills are more important	Impedes the development of soft skills
Skills Deficiencies Rectification	Identify Skills Gaps	Evaluating and identifying skills gaps	Imparts vital skills and ethical professional behaviour
New Technology Acceptance	Buy-in from Start	Importance of getting employee buy-in	Benefits and training encourage adoption
	Continuous Support	Providing ongoing support	Guarantees effective execution
Obstacles to New Technology	Lack of Funding	Insufficient funding	Impedes adoption

Theme	Aspect	Details	Examples/Impact
	Lack of Service Support	Insufficient support after implementation	Impacts efficient utilization

This table summarises the key themes identified in the study of electricity skills assessment and gap analysis for the City of Ekurhuleni Metropolitan Municipality, Energy department. Addressing these themes through targeted interventions can help improve the overall efficiency and effectiveness of the department and the organisation.

CHAPTER 5: DISCUSSION AND SUMMARY OF FINDINGS

5.1. Introduction

The previous chapter focused on data presentation and thematic analysis that guided the study. This chapter examines the study results and summarises the findings from both secondary and primary research, whilst integrating the insights to provide a comprehensive understanding of the skills assessment and gap analysis for the CoE Energy department. This chapter's discussion is structured around electrical skills, which comprises of technical skills, soft skills and cognitive skills. The discussion is elaborated with the aid of research questions, responses to the questions, and the literature aimed to investigate the skills of the municipality's energy personnel, assess whether the CoE has adequate skills for energy personnel, and provide a skills gap analysis along with recommendations.

5.2. Discussions from primary and secondary data from the study

The objective of the Energy department within the municipality is to distribute electricity, while applying electrical standards and utilising resources optimally, and to consider the environmental and developmental needs of the CoE community. To enable the Energy department to fulfil its objective, electrical skills are crucial.

Highlighted in the study, are the challenges experienced by the Energy department as a result of constantly changing environment due to climate change, new technologies, smart grids and renewable energy sources. To resolve these issues, the theory as well as the responses from CoE participants demonstrates that it is necessary to adopt an ecosystem-based approach, as opposed to isolated methods. This also necessitate the development of a skills roadmap and framework and the ongoing monitoring of the environment.

5.2.1 Electrical skills

Electrical skills include abilities and expertise necessary for competently operating electrical systems, spanning from simple installation and maintenance to sophisticated problem-solving, system design and safety management. These skills incorporate technical, soft and cognitive skills. *Ayers and Kenworthy (2017, 2019)* define electrical skills as a skills set which is inclusive of the knowledge, capabilities and competency necessary for the design, installation, maintenance and repair of electrical systems, equipment and devices *(Ayers, 2017; Kenworthy, 2019).* Furthermore, *Smith (2021)* elaborate that such skills involve comprehension of electrical circuits, adherence to safety regulations, wiring techniques and proficiency in the use of specialized equipment and devices *(Smith et al., 2021).*

From the study, both theory and responses confirm that electrical skills integrate technical, interpersonal and cognitive abilities, since each of the skill is essential for the operations performed by electrical personnel.

5.2.2 Electrical technical skills

- **Identification of Critical Electrical Skills Deficiencies**

The significance of highly skilled personnel in municipal electrical utilities cannot be overstated, as they have a vital role to guarantee the secure and efficient supply of energy services, which are fundamental to the operation of today's economy.

The literature emphasizes that technical skills in electricity are essential for the reliable and proficient operation of municipal electrical networks. *Kraiger and Jung (2011)* emphasize the need for technical abilities, including the understanding of electrical theoretical terms, electrical structures and electrical safety standards for electricians and electrical technicians to carry out their duties efficiently.

The energy personnel in the survey emphasized a substantial deficiency in technical capabilities among their workforces. They have also identified a need for electrical abilities, particularly a lack of understanding of developing technologies. Analytical skills regarding energy consumption data, highlighting the need for personnel to comprehend and respond to real-time data to improve system efficiency, is a challenge.

Chetty and Moodley (2022) highlight that municipalities, particularly in South Africa's Gauteng province, encounter obstacles as a result of deficiencies in skill sets and inadequate performance *(Chetty & Moodley, 2022).* The transition from a techno-economic to a socio-economic perspective is resulting in an increase in employment demand, as a result of the shift toward decarbonisation and electrification *(ILO, 2020).* The private sector hires professionals who specialize in renewable hydrogen, while the government sector prioritizes current employment opportunities. New job categories and locations are driven by emergent energy markets, while job types are shifted from technical to development by decentralisation and automation/AI trends *(Maxontana, 2022).*

Highlighted in the study, the CoE Energy department initiated innovative technologies projects, with several IPP’s appointed. From the participants responses, the employees are concerned about the lack of knowledge regarding emerging technology. Seventy percent of senior engineers and technicians indicated difficulties in adjusting to new grid management systems, while fifty percent of electricians indicated insufficient maintenance abilities for energy-efficient devices, including solar inverters.

The study demonstrates technical deficiencies which the CoE Energy department need, not just a solid foundation in electrical knowledge, but also advanced technical abilities, which are currently insufficient for the advancement of energy systems.

- **Strategies for adapting to evolving power technologies**

The research emphasizes the need for continuous training and development programs to enhance electrical technical skills, as well as the importance of industry partnerships and collaborations to share knowledge and best practices *(Gallagher & Dunn, 2017).*

The energy personnel in the survey advocate for modular training programs focused on smart grids, renewable technologies, and new electrical technologies, with technicians recommending hands-on seminars and real-world simulations to provide practical experience on the latest equipment and technology. A vast number also consistently emphasize a need for co-operation with academic institutions and technology suppliers to connect training programs with industrial improvements. Emphasizing that these initiatives, together with regular technological upgrades and certifications, also help to provide workers with the necessary abilities to address emerging difficulties proficiently.

- **Obstacles to using new technology**

The literature emphasizes the need for continuous training and development programs to enhance electrical technical skills, as well as the importance of industry partnerships and collaborations to share knowledge and best practices *(Gallagher & Dunn, 2017).* The transition from a techno-economic to a socio-economic perspective is resulting in an increase in employment demand, as a result of the shift toward decarbonisation and electrification *(ILO, 2020).* The private sector hires professionals who specialize in renewable hydrogen, while the government sector prioritizes current employment opportunities. New job categories and locations are driven by emergent energy markets, while job types are shifted from technical to development by decentralization and automation/AI trends *(Maxontana, 2022).*

From the participant's responses, the study indicates that development is essential for skill growth, however, municipal energy staff face challenges that impede their acquisition of new technologies. A considerable number of

employees are proficient with current technologies and may see the implementation of new systems as superfluous or too complex. Consequently, addressing these challenges require deliberate investment in training, continuous support for personnel and a culture transformation within the department to adopt technological progress *(Bonifacio, 2023; David et al., 2023).*

Davids (2022) suggested that technology acceptance models, originating from psychological theories like reasoned action and planned behaviour, have evolved into a mix of psychology, sociology, and information technology. These models help understand human behaviour predictors for potential adoption or rejection of innovation *(Davids, 2022).*

As such, implementing new technology requires obtaining buy-in from personnel right from the beginning. Proper training, along with advantages for change, could support this process of acceptance and implementation of new technologies. Continuous support and user-friendly technology are necessary for effective deployment.

The respondents also cited insufficient financial resources as the primary obstacle hindering the acquisition of modern technology, or the employment of specialist trainers. Some participants underscored the insufficiency of current training programs in equipping workers for emerging technologies, including smart grid systems and renewable energy solutions. Another barrier being resistance to change, especially from senior personnel.

- **Apprenticeship programs**

In the study the theory advocates that apprenticeship is one of the fundamental trainings required for electrical personnel, as it is a structured training program where energy personnel acquire a trade or skill via a blend of practical, hands-on experience and theoretical education, guided by seasoned experts. This technique is often used to cultivate job-specific competencies and frequently results in certification or qualification in a certain domain *(Smith & Brennan, 2014).*

According to the participants response, apprenticeship is critical in alleviating the electrical skills gap, facilitating practical knowledge transfer and experiential learning. Technicians and electricians emphasized the need for apprenticeship in providing new CoE employees with essential electrical competencies. Ninety-five percent of electricians indicated that planned apprenticeships help cultivate confidence and proficiency in young professionals within the organisation, equipping them to address intricate duties autonomously.

In conclusion, the importance of apprenticeships programs, fills the gap between academic understanding and actual implementation. This initiative enables skilled professionals to pass their knowledge onto junior staff, promoting retention of expertise and skill-building within the municipality.

- **Recruitment and retention of qualified electrical professional**

Donovan et al. (2022) emphasised that a skills gap is a significant discrepancy between a municipality's current capabilities, and the skills needed to meet community demand and achieve objectives. It occurs when qualified staff members do not fulfil sector objectives or lack the necessary abilities. This can lead to difficulties in finding qualified candidates, reduce productivity and hinder economic growth *(Donovan et al., 2022).*

On that note, *Bonifacio (2023)* suggested that effective training and educational systems are needed to bridge skills gaps, and municipal skills audits are conducted to identify strengths and weaknesses, career development, performance management, workforce planning, training and succession planning

The participant's response in the study highlighted the need for offering training opportunities and career progression as essential for retention, especially for younger employees. Senior engineers indicated that a healthy company culture, including mentoring programs and team-building activities, cultivates employee loyalty. The several responses indicate that flexible working circumstances are a crucial element for talent retention, particularly in challenging municipal settings.

Establishing an atmosphere that promotes and rewards development guarantees sustained commitment to professional advancement. *Davids (2022)* suggested that professional growth should be intentional, well-planned, and involve training and development. It is crucial to research and prepare for any endeavour, as it is the most impactful growth that happens outside one's comfort zone *(Davids, 2022)*.

In conclusion, offering incentives and rewards can motivate municipal staff to engage in ongoing professional development. This can include financial bonuses, recognition programs, and career advancement opportunities. Setting clear and achievable goals for professional development can help employees stay focused and motivated to improve their skills. Providing opportunities for growth, such as promotions and additional training, can encourage employees to continuously develop their competencies. Encouraging municipal employees to participate in professional development necessitates a blend of incentives and conducive conditions.

5.2.3 Soft skills

- **Effective communication with stakeholders and consumers, Perception of soft skills significance**

The literature asserts that electricity employees must possess crucial soft skills to efficiently interact in teams, engage with customers, and adjust to changes within the electricity industry. *Noe (2017)* emphasizes that electricians, technicians and engineers must possess essential soft skills, including communication, collaboration and time management, to effectively collaborate with teammates, interact with customers and successfully handle their work.

The responses from energy personnel highlighted the need for seminars, focusing on interpersonal communication and stakeholder engagement. Seventy percent of respondents highlighted that proficient communication, collaboration and problem-solving are crucial for successful project implementation.

Technicians and electricians indicated that effective communication is essential when diagnosing issues or collaborating with colleagues during maintenance and installation activities.

Furthermore, the respondents emphasised the preference in digital communication methods, which will yield effective and efficient operations and communication with internal and external stakeholders.

It is interesting to note that from the theory and responses to the study, communication skills are a crucial element for the energy personnel, and it is essential for the Energy department to invest in communication methods.

- **Deficient soft skills among municipal electrical personnel**

Noe (2017) emphasizes that electricians, technicians, and engineers must possess essential soft skills, including communication, collaboration, and time management, to effectively collaborate with teammates, interact with customers, and successfully handle their work. *David (2023)* noted that skills constraints refer to the absence of specific attributes, qualifications, and competencies in individuals, including soft skills and educational qualifications *(David et al., 2023).*

The participant's responses indicated that the predominant deficiencies in soft skills among municipal electrical personnel are communication, problem-solving, and collaboration. Communication for both co-workers and external stakeholders was identified as the weak spot. Technicians and electricians indicate that they often find it to be challenging to communicate technical information clearly and succinctly. Some participants highlighted problem-solving as an area for improvement, with several employees unable to diagnose intricate situations in real-time. According to *Bonifacio (2023)* and *David et al. (2023),* soft skills are social attributes that facilitate collaboration, while hard skills are specific abilities like coding or data analysis. Examples include clear communication, teamwork, problem-solving, adaptability, emotional intelligence and efficient time management, relating to communication, collaboration and emotional intelligence *(Bonifacio, 2023; David et al., 2023).*

Leadership skills are often deficient among municipal electrical professionals, affecting their ability to lead teams and projects effectively. The deficiency in time management skills adversely affects the efficiency and productivity of municipal personnel.

- **Mentoring programs**

In the study, the theory advocates that mentoring in the field of electricity is a formal connection whereby a seasoned expert (mentor) imparts instruction, information, and support to less experienced persons (mentees) to improve their technical, safety, and leadership competencies within the industry. This procedure seeks to enhance professional development, guarantee the transmission of essential information, and maintain elevated standards of performance and safety within the industry.

According to *Smith & Johnson (2020),* mentoring encompasses the enhancement of skills and knowledge via the supervision of seasoned experts which is particularly vital in technical sectors such as electricity *(Smith & Johnson, 2020).*

The participants responses show that mentorship is essential for improving electrical skills gaps. A significant percentage of participants identified mentorship as an essential mechanism for connecting seasoned experts with younger employees. Mentoring also improves the retention rates, as mentees are more inclined to stay in the department owing to the robust connections and tailored development possibilities fostered by the programs.

5.2.4 Cognitive skills

- **E-learning and online training**

The literature highlights that specialized cognitive abilities in spatial thinking and visual processing are necessary for electrical engineers to create and construct extensive electrical networks *(Becker et al., 2011).* Scholarly literature stresses the significance of cognitive abilities in adjusting to emerging technology and

changing workplace conditions, as well as in guaranteeing adherence to safety standards and regulations *(Gallagher & Dunn, 2017).*

According to the participants' responses, online education and training provide adaptable and economical methods for remedying skill gaps. It enables workers to study at their own speed and review content as necessary, while keeping the personnel with ongoing updates. Furthermore, it supplements conventional training and augmenting skills development at all tiers. E-learning is transforming corporate training with its flexibility, accessibility, and cost-effectiveness, revolutionising employee knowledge acquisition and benefiting organisations and employees in modern workplaces. According to *David et al. (2023),* e-learning is transforming corporate training with its flexibility, accessibility, and cost-effectiveness, revolutionising employee knowledge acquisition and benefiting organisations and employees in modern workplaces.

For the Energy personnel, E-learning offers a cost-effective and adaptable platform for ongoing education. It allows employees to study at their own speed and provides access to current information, interactive modules, and virtual mentoring from industry experts.

- **Motivation for acquiring specific competencies**

The literature emphasizes the need for continuous training and development programs to enhance electrical technical skills, as well as the importance of industry partnerships and collaborations to share knowledge and best practices *(Gallagher & Dunn, 2017)*. *Bick and Keele (2022)* emphasize that the learning competence motivation theory aids team leaders in motivating employees to apply more effort, persist and tackle challenging tasks. It requires practice and understanding to effectively apply in the workplace *(Bick & Keele, 2022).*

The participants responses indicate that the municipality must reward staff to maintain motivation in gaining certain abilities, and also endorse the allocation of financial incentives, including bonuses or pay augmentations for acquiring advanced qualifications. The Energy department must offer fully funded

scholarships for further education and training to assist energy personnel in obtaining new skills and knowledge. They also advocated for the provision of specialist credentials in energy distribution, perhaps facilitating promotions or career developments within the organization to entice the workers. Senior engineers advocated for the provision of practical, project-oriented learning opportunities to enable personnel to immediately use newly acquired information.

- **Evaluating and rectification of skills deficiencies**

Municipalities face challenges in executing environmental programs and sustainability efforts owing to a lack of qualified experts *(Chetty & Moodley, 2022). Davids (2022)* asserts that economic limitations, like power shortages impede investment and economic development. The absence of training facilities and infrastructure also impedes the development of future talents *(Davids, 2022). Bonifacio (2023)* recommend a proactive approach to workforce planning and development to foster sustainable growth, emphasizing the recruitment and cultivation of personnel with the requisite skills.

Sixty percent of the respondents believe that a yearly performance review can assist in identifying skills shortage, however, some employees believe the assessments emphasize technical competence excessively and fail to sufficiently address soft skills or the requirements of evolving technologies. Forty percent of respondents stated that a formal skills audit and skills gap analysis should be conducted to ensure a comprehensive understanding of the department's needs, and the requisite resources to address them.

Resultantly, *Loughlin (2023)* comprehended that skill deficiencies are widespread across organisations, causing recruitment problems and a lack of proficiency in the workforce. These issues significantly impact economic performance, impacting immediate perceptions and long-term business performance. The evidence suggests that skills do matter, and that the business cycle is not the sole cause of skill deficiencies *(Loughlin, 2023).* Therefore, it is important that the municipality evaluate skills deficiencies by identifying gaps in their workforce's competencies. Once identified, the municipality must work towards equipping

employees with the necessary skills and work ethics to enhance productivity and address deficiencies.

- **Challenges in energy efficiency and sustainability initiatives**

The literature in the study highlights that the main obstacle encountered by municipal personnel in executing energy efficiency and sustainable initiatives is inadequate training and finance. *Bick and Keele (2022)* noted that energy efficiency is crucial for achieving Sustainable Development Goals (SDGs), reducing climate change and enhancing energy security, but numerous obstacles hinder its achievement.

The participants' replies also indicate that financial limitations is a significant obstacle, hindering access to innovative technology and advanced training initiatives. Forty-five percent of technicians pointed out insufficient experience in energy-efficient systems, whilst sixty percent of senior engineers identified challenges in aligning sustainability objectives with current infrastructure.

Confronting these difficulties requires focused investment, capacity-building programs, and the promotion of an innovative culture within the Energy department. In line with these findings, *Bick and Keele (2022)* noted that energy efficiency is crucial for achieving Sustainable Development Goals (SDGs), reducing climate change, and enhancing energy security, but numerous obstacles hinder this achievement.

5.3 Conclusion

The energy environment is constantly changing due to climate change, new technologies, smart grids and renewable energy sources, but the efficient integration and utilisation of these developments may be hampered by a shortage of qualified experts. As such, incompetency may impede the advancement and application of new technologies.

The findings from both secondary and primary research underscore the importance of addressing skills deficiencies, providing continuous training and education, and implementing effective recruitment and retention strategies. Transparent communication and accessible information are crucial for building trust with stakeholders. Addressing funding and service support challenges is essential for successful technology adoption.

The next chapter focuses on the main conclusions and recommendations that direct the path of the study.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1. Introduction

This chapter summarises the study findings with regards to the CoE Energy department personnel skills. The objective of this chapter is as follows:

a) To conduct an assessment to evaluate whether CoE Energy department employees possess the required energy skills,
b) Identify skills gaps and provide recommendations that the municipality can implement to enhance performance, as well as align them to energy transition and global energy changes. Furthermore, the recommendations can help the municipality to define the anticipated work performance resulting from the energy transition, new technologies and renewable energies.

The assessment was conducted in chapter four of the study to evaluate CoE personnel energy skills, and gaps were identified. The study indicated the need to address the CoE energy personnel skills deficit, with the intention of enhancing energy personnel skills, and meeting the City's obligation of delivering effective, safe and reliable electrical services to the community of Ekurhuleni. The chapter concludes with recommendations.

6.2. Summary/Conclusions

The study assessed the City of Ekurhuleni Metropolitan Municipality Energy department electrical skills and investigated the skills gap for the CoE Energy department personnel. The outcome analysis revealed a deficiency in electrical skills and several obstacles towards enhancing the skills and possibilities in achieving the present and future objectives on developing Energy department personnel.

An analysis on the viewpoints of twenty respondents, comprising of chief engineers, senior engineers, technicians and electricians, revealed essential issues concerning skill deficits, training methodologies and Comprehensive organizational strategies essential for developing a competent and adaptable workforce.

The results prominently highlighted significant shortages in crucial skills, particularly a deficiency in understanding the developing energy technologies, including smart grids, renewable energy systems, network maintenance and energy-efficient solutions. The identified deficiencies highlight the urgent need for Energy department personnel to go beyond conventional electrical skills. The need for practical experience and advanced technical training was constantly highlighted, coupled with the requirement for improved problem-solving, technical report writing and critical thinking skills, particularly in the management of contemporary energy infrastructures.

The conversation prominently included training and education initiatives, with a robust agreement on the need to incorporate flexible and different learning methodologies. Modular training programs, e-learning platforms and practical simulations were the most endorsed approaches for preparing personnel with the competencies needed to adeptly manage rapidly advancing power technology. Collaborative initiatives with academic institutions and industry specialists were emphasized as crucial for synchronizing training programs with contemporary technology breakthroughs. The mentoring and apprenticeship programs were considered critical for imparting practical knowledge and promoting professional development, with participants emphasizing their importance in bridging generational divides and successfully addressing skills shortfalls.

Motivation and involvement have shown to be essential elements for the sustained advancement of energy personnel. Monetary incentives, professional development opportunities and recognition initiatives were seen as the most effective form of encouragement. Participants highlighted the need to foster a culture that prioritizes ongoing education and professional development.

This involves mitigating resistance to transformation by highlighting the advantages of obtaining new skills and competencies for personal career advancement and fulfilling organizational objectives.

The analysis emphasized the overarching difficulties, confronting the municipality's Energy department finances. Budget constraints is an opposition to innovative technology and restricted access to specialist training surfaced as major impediments. These problems directly affect municipality energy personnel’s capacity to execute energy efficiency and sustainability projects, as well as day-to-day effective operations. Addressing these challenges requires deliberate investment in infrastructure, focused financing for training and the cultivation of a creative attitude within the staff.

Another important area of interest was the evaluation of soft skills, which include communication, collaboration and problem-solving abilities. It was notably stressed that the capacity to communicate meaningfully with customers and stakeholders is very important. Many of the respondents acknowledged that technical knowledge alone is not adequate for solving the complex demands of contemporary municipal energy systems. For the purpose of enhancing communication between both internal teams and external stakeholders, the development of these competencies necessitates participation in specialized training programs on top of practical experience.

To overcome skill shortages that already are present, the study highlights several tactics for recruiting and keeping competent individuals. It was determined that the most effective strategies include offering competitive compensation, creating chances for professional growth and cultivating supportive company cultures. Those who participated in the survey stressed the need of making municipal Energy departments appealing, not only as places of employment but also as centres of innovation and expansion within the energy industry.

The results of the study further highlighted the significance of using new technology in order to modernize municipality energy administration systems.

Despite the fact that respondents recognized the advantages of technologies such as smart grids and renewable energy solutions, they also brought attention to the difficulties associated with their implementation. These difficulties include unwillingness to change and a lack of adequate training. It was advised that a gradual implementation plan be used in order to overcome these concerns. This strategy would be supported by targeted education and pilot initiatives.

E-learning and online training platforms have emerged as a key alternative for alleviating the effects of skills inadequacies, which is the last point to be made. According to the participants, these platforms are a useful tool for providing Energy department personnel with the information necessary to keep abreast of technological changes because of their accessibility, adaptability and scalability. Participants underlined these characteristics.

The study's results indicate a need for a thorough strategy to rectify the skills gap within the Energy department of the City of Ekurhuleni Metropolitan Municipality. This plan must include the development of both technical and interpersonal skills, including new training methodologies, motivational frameworks, and systematic techniques to mitigate resource constraints. Developing a workforce that can address the needs of an ever-changing energy environment is something that the Energy department can do by means of mentoring programs, e-learning platforms and strategic collaborations. The promotion of a culture that emphasizes the need for continual learning and flexibility will not only assist individuals improve their skills but will also ensure that the Energy department will continue to be a driving force for the municipality's capacity for sustainable development and innovation.

6.3 Recommendations

Proposals for addressing skills deficiencies in the Energy Department of the Ekurhuleni Metropolitan Municipality

To rectify skill deficiencies and to meet the evolving requirements of the energy sector, CoE municipality electrical personnel need technical training programs

that emphasize both foundational and contemporary technology. The recommended trainings incorporate technical, soft and cognitive skills, which can help to address the deficiencies of CoE energy personnel as highlighted by participants in chapter four of the study. The proposed recommendations would aid rectify existing deficiencies while equipping individuals with the skills to tackle future challenges.

6.3.1 Addressing Critical Technical Skills Deficiencies

Legislative and Regulatory: The CoE electricity department function under a legal framework defined by national legislation, regulatory standards, and municipal by-laws to provide a safe, dependable, and compliant electrical supply. The principal rules overseeing municipal electricity, as such the energy personnel must align their day-to-day activities and operations to the legal frameworks.

Primary areas of emphasis in training should include compulsory attendance of:

- Municipal Finance Management Act (MFMA) (Act No. 56 of 2003). The MFMA governs financial management in municipalities, mandating that electrical departments provide budgets for infrastructure upkeep, expansion, and training (RSA, 2003). Mitigates financial mismanagement in municipal power operations. The Act equips the municipal personnel, especially in managerial position (Chief engineers and senior engineers) with better understand and manage of the municipal finances.

- Occupational Health and Safety Act (OHS Act) (Act No. 85 of 1993), The Act defines workplace safety regulations, including the management of electrical apparatus, risk mitigation, and personal protective procedures (RSA, 1993). This is mandatory for all energy personnel since they work on electricity which is highly dangerous.

- The Municipal Systems Act (Act No. 32 of 2000) mandates municipalities to provide efficient and sustainable power services while fostering transparent government (RSA, 2000), which is essential for all CoE energy personnel to understand and implement.

- Regulations for Electrical Machinery (2009), this law is part of the OHS Act, and it stipulates that only qualified and trained individuals are permitted to operate, install, and repair electrical equipment (RSA, 2009). This makes it compulsory for the CoE to ensure that personnel receive training.

- Occupational Health and Safety Act (OHS Act) (Act No. 85 of 1993), which is mandatory to all energy personnel. The OHS Act delineates workplace safety mandates, including the management of electrical apparatus, risk mitigation, and personal protective protocols (RSA, 1993). The Electrical Installation Regulations require that all electrical installations adhere to sanctioned safety requirements.

Training in Smart Grid Technology: Smart grids are critical for modern energy infrastructure, and knowledge about their design, implementation, and maintenance is crucial. Primary areas of emphasis in training should include:

- Installation and troubleshooting of advanced metering infrastructure (AMI).
- Analytical assessment of grid performance for monitoring and optimization.
- Cybersecurity measures to safeguard grid infrastructure.

Training in Renewable Energy Systems: CoE Energy department is progressively integrating renewable energy sources such as solar and waste-to-energy. Primary areas of emphasis in training should include:

- The installation, operation and maintenance of solar photovoltaic (PV) systems, waste-to-energy and energy storage devices, such as batteries.
- Integration of renewable energy into the grid, including hybrid systems.

- Diagnosing renewable energy technologies to guarantee dependability.

High Voltage Operations and Safety Procedures: The Occupational Health and Safety Act (OHSA) No. 85 of 1993 in South Africa emphasizes the necessity for safety measures to safeguard workers in many sectors. The Electrical Machinery Regulations established under this Act provide detailed directives to protect personnel using electrical equipment. These rules mandate that employers guarantee the safety of all electrical apparatus and ensure that workers get sufficient training to operate such machinery safely. They underscore the need of routine maintenance and compliance with safety requirements to avert accidents (Electrical Machinery Regulations, 2009).

Integration of high voltage operations and safety procedures is not only a best practice but a legal requirement in South Africa, which makes it legal requirement for CoE, since CoE is governed by South African constitution.

Maintaining high-voltage systems is a critical duty of CoE energy personnel. High voltage operations and compliance with safety regulations are essential for electrical operators to guarantee personal safety and the integrity of electrical systems. Engaging with high-voltage apparatus entails considerable risks, such as severe electrical shocks, burns, arc flashes, and even deaths. Enforcing stringent safety measures reduces these hazards, guaranteeing a safe working environment and the dependable operation of electrical infrastructure.

Primary areas of emphasis in training should include:

- Advanced methodologies for the handling and maintenance of high-voltage equipment.
- Procedures for switching isolation and grounding in substations.
- Compliance with workplace health and safety regulations to mitigate potential dangers.

Supervisory Control and Data Acquisition (SCADA) and Automation Systems Training: Supervisory Control and Data Acquisition (SCADA) systems

in electricity industry are regulated by national and international standards and regulations.

The Occupational Health and Safety Act (Act No. 85 of 1993) enforce that only authorized personnel are permitted to operate, manage and maintain SCADA systems. This SCADA operations regulation ensure compliance with electrical safety regulations to prevent incidences and accidents.

National Energy Regulator of South Africa (NERSA) Guidelines, ensures that competent municipal electricity personnel adhere to best practices in systems monitoring, and are capable of identifying fault, and managing electrical loads on SCADA systems.

South African National Standards (SANS 507, Control and Instrumentation Systems for the Electricity Supply Industry) provides technical guidelines for the personnel operating the SCADA systems, for SCADA system design, implementation, and integration in South Africa's electricity infrastructure.

International Standards (IEC 61850, Communication Networks and Systems for Power Utility Automation) requires personnel to be knowledgeable about standardized SCADA communication protocols for substation automation and remote control.

Supervisory Control and Data Acquisition (SCADA) systems are crucial for the monitoring and management of the entire CoE electrical networks, as such personnel operating and monitoring the SCADA systems requires regular training on all related standards and regulations. Trained skilled personnel on SCADA systems can guarantee compliance with SANS, NERSA, and IEC standards, preventing legal violations and penalties. Primary areas of emphasis in training should include:

- Mechanisms for fault detection and automatic reaction.
- The installation and programming of SCADA systems.

- Immediate oversight and regulation of substations and distribution systems.

Power Quality and Reliability Instruction: in South Africa, power quality and reliability, is governed by regulations and standards ensuring that electricity supply is consistent, efficient, and safe. As such the CoE electricity personnel should be knowledgeable on those power quality and reliability standards and regulations.

Electricity Regulation Act (No. 4 of 2006): the CoE electrical personnel must ensure compliance with regulations that are established for electricity generation, transmission and distribution licensees, which requires CoE to provide a consistent and high-quality supply of energy (RSA, 2006).

South African Grid Code (SAGC), the electrical personnel must ensure that power produced by the CoE electricity department adhere to the specifications, power factor, frequency control, and voltage stability (NERSA, 2010).

Electricity personnel requires training on all above mentioned regulations and standards, this will ensure that reliability and power quality it is maintained. Whilst, ensuring steady supply of electricity, reduced interruptions, customers satisfactions, safeguarding electrical infrastructure, and long-term reliability of electrical equipment.

Primary areas of emphasis in training should include:

- Executing power factor adjustment strategies.
- Methods to enhance grid dependability during periods of high demand.
- The diagnosis and mitigation of power quality concerns, including voltage sags, surges and harmonics.

Protection and Control of Power Systems: Ensuring proper training for electricity personnel responsible for protection and control of power systems in the CoE electricity departments requires adherence to national and international standards, such as SANS 10142-1, NRS 048, IEC 60255, and IEC 61850.

Personnel must receive specialized technical training in relay coordination, fault analysis, and electrical safety to maintain grid stability, prevent power outages, and ensure compliance with legal requirements.

Primary areas of emphasis in training should include:

- Fault analysis and relay protection co-operation.
- Strategies for emergency reaction to system faults.
- Employment of contemporary protective relays and SCADA (Supervisory Control and Data Acquisition) systems.

Energy Efficiency and Demand-Side Management: are governed by South African regulations, and policies such as National Energy Act (No. 34 of 2008), South African National Standards (SANS) for Energy Efficiency, Municipal Energy Efficiency and Demand-Side Management (EEDSM) Program (DMRE, 2019), in order to lessen power usage, control peak demand and encourage sustainable energy use.

CoE electrical personnel require training in energy efficiency strategies, demand-side management methodologies. Compliance with training will help CoE to reduce power use, improve grid stability, and save operating expenses, while facilitating sustainable power management

Primary areas of emphasis in training should include:

- Instructing customers on energy maintenance techniques.
- Emphasize the execution of energy audits to detect inefficiencies.
- Executing demand-side management (DSM) technologies and initiatives.

Sophisticated Metering and Billing Systems: As the CoE Energy department adopts smart meters, and provide energy billing, the energy personnel need training in standards such as Code of Practice for Electricity Metering NRS 057, Install and Replace a Metering Unit or Measuring Instrument Unit Standard 258919. This guaranteed accuracy, dependability, and fairness in energy measurement and consumer billing.

Primary areas of emphasis in training should include:

- The installation, calibration and maintenance of modern metering systems.
- Troubleshooting communication protocols for Advanced Metering Infrastructure (AMI).
- Employing software for data collection, analysis and automated invoicing.

Software for Electrical System Design and Simulation: The CoE Geographic Information System (GIS) office energy personnel is responsible for planning and analysis of the electrical network. To guarantee safety, dependability, and interoperability in the CoE electrical networks design and simulation, compliance with established standards and regulations such as Engineering Council of South Africa (ECSA) Code of Practice, International Electrotechnical Commission IEC 61508: Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems, is essential.

Primary areas of emphasis in training should include:

- Software such as AutoCAD Electrical, for electrical design and simulations.
- Integration of distributed energy resources (DER) into urban electrical systems.
- Analysis of load flow, investigations of fault currents and evaluations of power quality.

Grid Resilience and Catastrophe Management: The Energy department must prepare for emergencies and other disturbances. This requires personnel to be knowledgeable on the regulations established by National Energy Regulator of South Africa (NERSA) and are encapsulated in the South African Grid Code and Electricity Regulation Act (No. 4 of 2006).

Primary areas of emphasis in training should include:

- Emphasize the design of robust grids capable of withstanding adverse weather conditions.

- Planning for emergency reaction and recovery in the event of disruptions.
- Implementing transportable substations and contingency mechanisms during emergencies.

Electric Vehicle (EV) Infrastructure Education: CoE Energy department possesses an electric vehicle, and as the increase of electric cars transpires especially within the other departments of CoE, it necessitates the establishment of EV charging infrastructure within the municipality's departments. Primary areas of emphasis in training should include:

- Safety protocols pertinent to high-voltage electric vehicle systems.
- The installation and maintenance of electric vehicle charging stations.
- Implement load management to include electric vehicle chargers into the grid.

6.3.2 Adapting to Evolving Power Technologies

The CoE energy personnel must be proficient in managing swiftly advancing electricity technology via ongoing professional development. The Energy department needs to implement modular training programs addressing contemporary technology breakthroughs, including energy storage technologies and digital grid management. Providing experiential seminars and realistic simulations may augment practical education. E-learning systems have to be included into training programs to provide adaptable, on-demand resources. Collaborating with technology suppliers for certifications and pilot projects will guarantee that training stays aligned with industry progress.

6.3.3 Employing Apprenticeships and Mentorship Initiatives

Apprenticeships and mentorship programs are crucial for imparting practical information and promoting skill development. The municipality need to implement structured apprenticeship programs for new employees, associating them with seasoned mentors. This method facilitates experiential learning, guaranteeing the successful transmission of essential technical and people skills.

Mentoring programs may improve staff retention by cultivating supportive professional ties. Acknowledgment for mentors and incentives for involvement may further promote the broad acceptance of such programs.

6.3.4 Encouraging Personnel for Professional Development

Encouraging employees to engage in continuous professional development necessitates the alignment of training with career progression prospects. The municipality need to establish a definitive professional advancement structure linked to skill development and certifications. Monetary incentives, such as bonuses for completing training programs or obtaining higher certifications, may enhance employee motivation. Adaptable training schedules and funding for external courses will further mitigate obstacles to participation. Recognition systems, including rewards for skill accomplishments, may foster a culture of ongoing learning and success.

6.3.5 Recruitment and Retention of Qualified Professionals

The municipality must provide adequate benefits and compensation to attract and retain competent electrical specialists. Offering opportunities for job advancement via training, certifications and leadership development would entice proficient people. Establishing a constructive workplace culture that prioritizes collaboration, mentoring and professional growth can significantly improve retention. Flexible employment opportunities, including remote work possibilities for certain jobs, may enhance work satisfaction. Consistent feedback systems and employee engagement programs may guarantee that personnel feel appreciated and supported.

6.3.6 Training for Advancing Technologies

Equipping energy personnel to interact with developing technology necessitates a thorough training approach. The CoE Energy department needs to provide training courses on technologies like smart grids, renewable energy systems, network maintenance and digital energy management tools.

Collaborating with academic institutions and technology suppliers may provide access to advanced resources and expertise. Practical experience may be gained via hands-on workshops, pilot projects and simulations, while e-learning platforms can enhance these initiatives. Consistent technological upgrades and refresher training will guarantee personnel proficiency as improvements arise.

6.3.7 Addressing Obstacles in Sustainability Projects

The municipality must prioritize resource allocation and personnel training to tackle the obstacles to conduct energy efficiency and sustainability projects. Obtaining funds via grants or public-private partnerships helps mitigate budgetary limitations. Staff training must emphasize energy-efficient technology and the incorporation of sustainability objectives into daily operations. Communication methods highlighting the enduring advantages of these activities might mitigate opposition to change. Establishing task groups focused on sustainability initiatives may enhance execution and bolster accountability.

6.3.8 Enhancing Communication Competencies

Effective communication is essential for engaging consumers and stakeholders about electricity-related issues. The municipality need to provide resources for soft skills training for all personnel, emphasizing customer service, stakeholder participation and dispute resolution. Workshops and role-playing exercises may replicate real-world encounters, assisting workers in enhancing their communication skills and confidence. Training should prioritize the simplification of technical jargon to guarantee that communications are comprehensible to non-technical audiences. Offering digital communication tools may improve the clarity and consistency of stakeholder engagement.

6.3.9 Improving E-Learning and Virtual Training

E-learning as well as virtual training technologies ought to be used to successfully mitigate skills deficits in a cost-efficient manner.

CoE needs to invest extensive on online tools that include both technical and people skills development. Interactive modules, virtual laboratories and real-time feedback systems may enhance the engagement and efficiency of online training. Regularly updating e-learning materials will keep personnel informed about industry trends and technology improvements. Incorporating e-learning into a blended training model, in conjunction with practical workshops, may provide a comprehensive educational experience.

6.3.10 Incentivizing Personnel for Energy Distribution Skills

The CoE Energy department should match training with concrete advantages to motivate energy personnel in developing capabilities in energy distribution and transmission. Implementing role-specific certificates that facilitate promotions or wage enhancements may motivate engagement. Experiential training options, including site visits and actual projects, enhance the engagement and practicality of learning. Recognition initiatives that acknowledge staff accomplishments in energy distribution training may increase employee motivation. Aligning training with the municipality's strategic objectives will add to staff comprehension of the significance of attaining these abilities.

6.3.11 Rectifying Shortcomings in Soft Skills

The Energy department need to conduct focused soft skills training to rectify shortcomings in communication, problem-solving and collaboration. Workshops emphasizing co-operation, conflict resolution and critical thinking may enhance team relationships and project results. Promoting peer-to-peer learning and providing chances for workers to use these abilities in practical situations will augment their efficiency. Incorporating soft skills as a factor for performance assessment may underscore their significance and motivate employees to prioritize their improvement.

6.3.12 Advocating for the Importance of Soft Skills

Promoting the importance of soft skills for effective co-operation necessitates their incorporation into the company culture. Consistent dialogues, team-building activities and case studies illustrating the influence of soft skills on project performance may underscore their significance. Leadership needs to exemplify proficient soft skills, serving as a model for the remaining workers. Emphasizing the significance of communication, co-operation and problem-solving in attaining departmental objectives, helps enhance staff appreciation for their value.

6.3.13 Assessing and Addressing Skills Deficiencies

The municipality need to establish a strict skills audit process to consistently assess and identify skills deficiencies. This procedure needs to incorporate performance evaluations, peer assessments and stakeholder input. Targeted training programs should be established to rectify identified inadequacies in line with the audit findings. Utilizing data analytics to assess training results and skill enhancements might guarantee ongoing advancement. Establishing a consolidated database of employee credentials and training history may facilitate the identification of areas necessitating additional growth.

6.3.14 Expediting the Embrace of Innovative Technologies

To promote the use of new technology, the municipality needs to address employee doubts and foster trust in their utilization. This could be accomplished via extensive training programs, pilot initiatives and demonstrations that illustrate the advantages of novel technology. Engaging personnel in the decision-making process for technology implementation helps mitigate opposition and cultivate a feeling of ownership. Acquiring financial resources for technological enhancements and guaranteeing that new instruments are intuitive and well supported, will promote adoption.

6.3.15 Overcoming Barriers to Technological Utilization

To address challenges like financial limitations, training deficiencies and opposition to change, the municipality need to seek partnerships and funding opportunities. Collaborating with technology providers, governmental entities and private sector allies may facilitate access to resources and knowledge. Staff training should emphasize the development of confidence and proficiency in using new technology. Consistent communication of the enduring advantages of technology adoption may mitigate resistance and cultivate a culture of innovation. Providing sufficient technical assistance and infrastructure can improve the efficiency of new technology installations.

6.3.16 Salient Features

- Effective succession planning to avert skills shortage: Skills enhancement programs guarantee that knowledge is transferred from experienced personnel to junior employees, thereby establishing a pool of competent staff members. This avoids operational disruptions that may occur when senior technicians retire and promotes the electricity sector's long-term stability.

- Funding solutions for ensuring enough budget provision for training, new technologies: the municipality can capitalize on emerging technologies such as grid automation and smart metering by developing its employees. Skilled personnel can effectively substantiate the necessity for innovative tools, thereby securing funding and demonstrating the return on investment for infrastructure enhancements and training.

- Revenue protection and enhancement: Personnel who have been adequately trained can effectively identify instances of electricity theft, meter tampering, and billing inaccuracies. This ensures that the municipality maximizes its income from electricity distribution by minimizing revenue losses and improving collection rates.

- Sourcing of funding with specific reference to SETA: a competent workforce is more capable of aligning training initiatives with the requirements of the Sector Education and Training Authority (SETA) and developing funding proposals. The resources are unlocked for the continuous development of talents and capacity.

- Change management: employees are better prepared to navigate technological shifts and organizational changes with the assistance of skills enhancement, such as leadership and adaptability training. This encourages the adoption of new systems and reduces resistance to innovation.

- Cost of doing business skilled personnel enhance resource allocation, lessen equipment failures, and reduce operational inefficiencies. This guarantees cost-effective electricity service delivery, prevents prolonged outages, and reduces repair costs.

6.4 Recommendations for further research

Conducting research within the City of Ekurhuleni Metropolitan Municipality (CoE) Energy Department in the following suggested topics can help energy department to improve service delivery. The research subjects of customer satisfaction with electricity services and the influence of leadership in mitigating skills inadequacies are closely linked to the examination of electrical skills assessment and gap analysis for the City of Ekurhuleni (CoE) Energy Department.

Customer satisfaction is a crucial measure for assessing service quality, operational efficiency, and employee competence. Frequent customer complaints of power outages, billing discrepancies, or inadequate response times may indicate deficiencies in the technical and operational competencies of electrical employees.

Leadership is essential in addressing and resolving skill deficiencies within the department. Effective leadership guarantees ongoing staff training, alignment of policies with technology improvements, and deliberate implementation of skills development projects. Leadership shape workplace culture, resource distribution, and employee motivation, all of which affect performance and, therefore, service quality. A leadership-oriented strategy for skills development may alleviate technical deficiencies, promote work performance, and increase customer satisfaction.

- An examination of how satisfied customers are with electricity services in the CoE
- Understanding the Function of Leadership in Combating Skills Deficiencies

6.4.1 An examination of how satisfied customers are with electricity services in the CoE

The City of Ekurhuleni (CoE) is mandated for delivering electricity services to a substantial broad community, including Industrial, Commercial and residential, industrial customers. However, persistent problems like power outages, voltage fluctuations, elevated energy rates, prolonged response times, and inadequate customer service have caused apprehensions over consumer satisfaction. This research is crucial for assessing customer happiness, identifying service deficiencies, and formulating enhancements for energy service delivery in the municipality.

In Ekurhuleni, electricity is a basic service that has an impact on company operations, economic development, and quality of life. If community is unhappy due to regular load shedding, unreliable power supply, or inadequate communication from the CoE, it can negatively impact the local economy and public trust in CoE energy department.

This study will help municipality politicians and energy department workers figure out where service needs to be improved. The study can help with strategy

planning, policy changes, and investments in infrastructure upgrades to make energy more reliable and better respond to customer issues by getting feedback from people and businesses. It will also help figure out how digital platforms, like mobile apps and online billing, affect the customer experience.

Lastly, this study would contribute in the development of a more customer-centric strategies to electricity service management in CoE, ensuring that electricity customers receive efficient, and reliable energy services. It will also assist the municipality to improve its customers engagement approaches, revenue collection efficiency, and generally operational performance, resulting to better customer satisfaction.

6.4.2 Understanding the Function of Leadership in Combating Skills Deficiencies

Leadership is essential for facilitating organizational transformation and promoting a culture of continual improvement. Future study may examine the impact of leadership styles and management practices on the implementation of training programs, employee motivation and the effective incorporation of new technology. This may include an analysis of how leaders in the CoE Energy department may motivate and direct their staff to adjust to evolving industry requirements.

In conclusion, integrating these two suggested topics for further research, can provide a comprehensive analysis of how skill gaps affect customers service delivery in the CoE and how leadership interventions can drive workforce improvement. This integrated approach will offer actionable recommendations for developing training programs, policy frameworks, and leadership strategies to optimize electricity service delivery in CoE.

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