ASSESSMENT OF TECHNICAL AND FINANCIAL VIABILITY OF TRANSFORMING A DIESEL POWER TO SOLAR POWER OF WATER SUPPLY SCHEMES: A CASE STUDY OF KILOSA

BY

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MPPM-01-0090-2022

A research dissertation submitted in partial fulfiment of the requirement for the

Degree of Masters of Project Planning and Management (MSC.PPM) of the

Institute of Accountancy Arusha.

November 2023

Author's Declaration

I, Sebastian Nicodem declare that this Dissertation is my original work and that it has not been presented and will not be presented to any Higher Institution for similar or any other degree awards.

Signature ……………………………..…………Date……..........……………………………………

Certification by Supervisor (S)

I the undersigned certify that I have read and hereby recommend for acceptance by the Institute of Accountancy the dissertation entitled: **Assessment of Technical and Financial Viability of Transforming a Diesel Power to Solar Power of Water Supply Schemes**: **A case of Kilosa** in fulfilment of the requirements for the Degree of Master of Project Planning and Management (MSC.PPM).

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Acknowledgements

I express my profound gratitude to The Almighty God for His blessings, love, protection, and peace that have guided me throughout the preparation of this research dissertation. My heartfelt thanks extend to everyone who played a pivotal role in supporting me on this journey. Special recognition goes to my dedicated supervisor, Mr. Kabeya Almasi, whose invaluable guidance significantly influenced the quality and direction of this study. I am deeply appreciative of the Rural Urban Water Supply Agency (RUWASA) Kilosa for providing crucial preliminary information, and I thank my employer for granting me the opportunity to conduct this research in Kilosa District.

Furthermore, I extend my gratitude to Eng. Silvia – Kilosa District Manager RUWASA and her management team, along with all Kilosa Zone DC employees, for their substantial support during the data collection phase. I would like to acknowledge my wife, Niael Nickson Mduma, and my son, Alvin Sebastian Lyakurwa, and my sister Rehema for their unwavering support and understanding throughout this challenging yet rewarding endeavor. To all those who have indirectly contributed, your involvement has played an integral role in shaping the trajectory of this research dissertation, and for that, I express my sincere thanks. Their prayers and support are always recognized and appreciated, and I believe that the time they spent without me will not be considered wasted, but rather fruitful. May God bless you all.

ABSTRACT

The general objective of this study is to assess the technical and financial viability of transforming a diesel power to solar power in water supply schemes. Three objectives were to evaluate the financial viability of the transformation by conducting a detailed cost-benefit analysis, to determine the technical feasibility of integrating solar power into the existing diesel-powered water supply scheme and to analyze the reliability and performance aspects of the proposed solar-powered water supply scheme.The population of the study was 423 people in which 81 of people were the sample that used to obtain data from RWASA Kilosa The questionnaires and interview were the tools used for collecting data from RUWASA while descriptive and content analysis were employed for analyzing data.

The result found that, there is financial viability of the transformation by conducting a detailed cost-benefit analysis, technical feasibility of integrating solar power into the existing diesel-powered water supply scheme and reliability and performance aspects of the proposed solar-powered water supply scheme at RUWASA Kilosa. The study further recommends that, due to the importance of solar power water supply to the community both private and public sectors should support through providing fund and technical skills in the development of transforming from diesel power to solar power to enhance efficiency water supply scheme at RUWASA
Key words*: Technical Viability, Financial Viability and Water Supply Schemes*

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LIST OF ABBREVIATIONS

COE	Cost Of Energy
KDC	Kilosa District Council
NPC	Net Pesent Cost
OC	Operation Cost
O&M	Operating and Maintenance cost
RUWASA	Rural Urban Water Supply Agency
SPSS	Statistical Package for Social Science
WB	World Bank

CHAPTER ONE

1.0 INTRODUCTION AND BACKGROUND TO THE PROBLEM

1.1 Introduction

Access to clean drinking water is a fundamental human right that is essential for maintaining health and well-being. However, many remote areas lack access to clean drinking water, and the lack of reliable power sources makes it difficult to operate water supply systems. Diesel-powered generators have been commonly used in such areas to power water supply schemes, but they pose environmental and health risks. To address this issue, solar power has emerged as a potential alternative that is clean, renewable, and abundant. Solar-powered water supply systems have been successfully implemented in some remote areas, but their technical and financial feasibility needs to be evaluated more comprehensively.(Shouman et al., 2016)

The economic analysis and the comparison were concluded for the following parameters; - Net Pesent Cost (NPC); represents the total cost over the life time of the system including the capital, installations, running and operating and maintenance costs. - Operating and Maintenance cost (O&M); represents the total cost for running and maintain the systems. - Operation Cost (OC); describes the yearly cost of operation in $/year. - Cost Of Energy (COE); describes the total average cost of the system for generating electrical energy of one kWh. The NPC cost of the PV system is the lowest one due to a very low running costs and long life of the PV panels (more than 20 years) compared with Diesel unit. (Shouman et al., 2016)

Costs of diesel for water supply schemes are increasing sharply due to the lack of availability of diesel in the markets. Moreover, the use of diesel fuel is also more expensive in the rural areas due to the remoteness of these sites. Taking into account the costs of transportation of diesel, maintenance and overhauling of generators. Diesel cost is already prohibitive to the world's poorest people. No one knows what the price will be next year or 5 years from now but all indications suggest that oil-derived fuels will only continue to increase in cost as global oil production slips over the top of the curve and heads downward in the face of rapidly increasing demand. (Shouman et al., 2016)

The purpose of this study is to assess the technical and financial viability of transforming diesel-powered water supply schemes to solar power. The study aims to evaluate the feasibility of using solar power as a sustainable energy source to replace diesel power for water supply schemes. The study was also considering the environmental, economic, and social benefits of switching from diesel to solar power for water supply schemes.

The study was conducted using a combination of literature reviews, case studies, data analysis, and expert interviews. The geographical scope of the study will be limited to specific regions where the use of solar power for water supply schemes has potential.

The findings of this study provide evidence-based recommendations for decision-makers, stakeholders, and practitioners in the water supply sector to promote the use of sustainable energy alternatives, improve access to clean drinking water, reduce carbon emissions, and contribute to the global efforts towards achieving a sustainable future for all.

1.2 Background to the Problem

Access to clean drinking water is a basic human need and a fundamental human right. However, many rural and remote areas still lack access to clean drinking water, and the lack of reliable power sources makes it difficult to operate water supply systems. In these areas, diesel-powered generators have been commonly used to power water supply schemes. However, diesel generators are polluting, noisy, expensive to operate, sustainable, and their use poses health risks for people who consume unsafe water due to the lack of reliable power sources for water treatment systems.(Jovanović et al., 2023) .Furthermore, the use of diesel generators contributes to carbon emissions, which are a significant contributor to climate change. In recent years, solar power has emerged as a promising alternative to diesel power for water supply schemes in remote areas. Solar power is clean, renewable, and abundant, and it has the potential to provide a sustainable and reliable energy source for powering water supply schemes(Grottera, 2022).

However, the technical and financial feasibility of transforming diesel-powered water supply schemes to solar power needs to be evaluated more comprehensively. While solar-powered water supply systems have been successfully implemented in some remote areas, there is still a need to assess their potential to replace diesel power for water supply schemes in different regions and under different conditions. (Shouman et al., 2016).The problem of this study is that diesel-powered water supply schemes are not sustainable and have negative environmental impacts. These schemes are often used in remote areas where access to clean drinking water is limited, and the lack of reliable power sources makes it difficult to operate water supply systems. Diesel generators are noisy, polluting, and expensive to operate, making them an unsustainable solution for powering water supply schemes.

Moreover, diesel generators contribute to carbon emissions, which are a significant contributor to climate change. The use of diesel-powered water supply schemes also poses health risk2.0.100

people in remote areas who may consume unsafe water due to the lack of reliable power sources to operate water treatment systems (Grottera, 2022.).Therefore, there is a need to explore alternative, sustainable energy sources that can power water supply schemes in remote areas. Solar power has emerged as a potential alternative that is clean, renewable, and abundant, but its technical and financial feasibility for water supply schemes needs to be evaluated. The problem addressed by this study is whether it is technically and financially feasible to transform diesel-powered water supply schemes to solar power, and what are the environmental, social, and economic impacts of such a transformation. By addressing this problem, the study aims to provide evidence-based recommendations for promoting the use of sustainable energy alternatives, improving access to clean drinking water, and mitigating the negative environmental impacts of diesel-generated power.

1.3 Rationale

Switching from diesel power to solar power in water supply schemes has numerous benefits, making this research highly valuable. Firstly, it reduces greenhouse gas emissions, contributing to a cleaner and more sustainable environment. According to the International Energy Agency (IEA), the use of diesel generators in remote areas accounts for approximately 7% of global CO2 emissions, so finding viable alternatives is crucial. Secondly; solar power offers significant cost savings in the long run. Diesel fuel prices can be volatile and subject to fluctuations, causing financial uncertainties for water supply schemes. By transitioning to solar power, operational costs can be reduced, allowing for more reliable and affordable water services. Statistics from the World Bank show that solar power plants can reduce energy costs by up to 50% compared to diesel generators.

Additionally, investing in solar power not only benefits the environment and finances but also provides increased energy security. Traditional diesel generators are often dependent on the availability and transportation of fuel, which can be challenging in remote areas. Solar power, on the other hand, relies on a renewable resource that is abundant in most regions, reducing the risk of fuel shortages and logistical issues. This ensures a more reliable and resilient energy supply for water supply schemes, even in remote areas.

Moreover, the social impact of transitioning to solar power in water supply schemes should not be overlooked. Access to clean and reliable water is essential for communities, particularly in developing regions. By conducting research on the technical and financial viability of this transformation, we can identify the best strategies to implement solar power in water supply schemes, improving access to clean water for communities that need it the most.

To summarize, the study is important and relevant due to its positive environmental impact, potential cost savings, increased energy security, and improved access to clean water for communities. These statistics and considerations highlight the significance of this research, making it a worthwhile endeavor to pursue.

1.4 Problem Statement

Over the years, rural water supply schemes have operated without a grid power supply, therefore the stakeholders fail on making decision on either project is viable or not between solar and diesel power to run the water supply schemes. The current reliance on diesel-powered water supply schemes in remote areas is unsustainable and has negative environmental impacts. These schemes are costly, noisy, and polluting, making them an inefficient solution for providing clean drinking water. Additionally, diesel generators contribute to carbon emissions, further exacerbating environmental concerns (Jovanović et al., 2023). The reliance on diesel-powered water supply schemes in remote areas not only has negative environmental impacts but also contributes to climate change through carbon emissions. In addition, the lack of reliable power sources for operating water treatment systems poses health risks for individuals in these areas, leading to the consumption of unsafe water.(Grottera, 2022). There is a need to evaluate the technical and financial feasibility of transitioning diesel-powered water supply schemes in remote areas to solar power. This study aims to determine whether such a transformation is possible and to assess the potential environmental, social, and economic impacts of implementing solar-powered water supply systems and also to evaluate the technical, financial, and environmental feasibility of transitioning diesel-powered water supply schemes in remote areas to solar power. By doing so, the study aims to provide evidence-based recommendations on promoting sustainable energy alternatives, enhancing access to clean drinking water, and mitigating the negative environmental impacts associated with diesel-generated power.

1.5 Main Objective

The main objective of this study was to assess the technical and financial viability of transforming a diesel power to solar power in water supply schemes.

1.5.1 Specific Objectives

i. To evaluate the financial viability of the transformation by conducting a detailed cost-benefit analysis.

ii. To determine the technical feasibility of integrating solar power into the existing diesel-powered water supply scheme.

iii. To analyze the reliability and performance aspects of the proposed solar-powered water supply scheme.

1.6 Research Questions

The research questions of this study are:

i. What factors should be considered in conducting a detailed cost-benefit analysis to evaluate the financial viability of the transformation?

ii. What factors need to be evaluated in order to determine the technical feasibility of integrating solar power into the current diesel-powered water supply system?

iii. What specific aspects should be analyzed to assess the reliability and performance of the proposed solar-powered water supply scheme?

1.7 Scope of the Study

The scope of this study is to assess the technical and financial viability of transforming diesel-powered water supply schemes to solar power. The study will focus on evaluating the feasibility of using solar power as a sustainable energy source to replace diesel power for water supply schemes.

The technical aspect of the study was examining the design, installation, and maintenance requirements for solar-powered water supply systems. This includes assessing the suitability of solar panels, batteries, and other equipment needed to ensure reliable and efficient operation.

The financial aspect of the study was evaluating the costs associated with implementing and maintaining solar-powered water supply systems. This includes assessing the capital costs of purchasing and installing solar panels, batteries, and other equipment, as well as the ongoing operational and maintenance costs.

The study was also considering the environmental, economic, and social benefits of switching from diesel to solar power for water supply schemes. It was analyzing the potential reduction in carbon emissions, cost savings, and increased access to clean drinking water in remote areas.

The study conducted using a combination of literature reviews, case studies, data analysis, and expert interviews. The geographical scope of the study limited to specific regions where the use of solar power for water supply schemes has potential.

1.8 Limitation of the Study

The researcher was facing some the challenges on the way of accomplishing the study, that were, inadequacy of funds, little feedback from the respondents and limited time. Despite of these challenges the researcher was trying to reduce some of the unnecessary cost to reflect the desirable budget for accomplishing the study, making stiff follow up to those respondent in order to obtain better feedback and higher commitment for meeting the required dead line.

1.9 Significance of the Study

Assessing the technical and financial viability of transforming a diesel power to solar power for water supply schemes is an important research topic in today's world. This study aims to evaluate the feasibility of using solar power as a sustainable energy source to replace diesel power in water supply schemes.

Environmental benefits: The study helps in promoting eco-friendly and sustainable energy alternatives that reduce the carbon footprint and mitigate the negative environmental impacts of diesel-generated power.

Economic benefits: The study provides insights into the economic viability of using solar power for water supply schemes. It helps in identifying cost-saving opportunities and improving the financial performance of these schemes.Social benefits: The study also have social benefits by improving access to clean drinking water in remote areas where water supply schemes are usually operated on diesel power. This will help in reducing the health risks associated with the consumption of unsafe water.

Policy implications: Finally, the study had policy implications by providing evidence-based recommendations that can inform policy-making decisions related to renewable energy, water supply, and sustainable development.

1.10 **Brief Organization of the Research Dissertation**

This study comprises three chapters one reveals the problem which informs the study and its context. It justifies the study. Chapter two presents a review of relevant literature, synthesis, and research gap to the study. Chapter three describes the research methodology and procedures of data collection and analysis.

1.11 Conclusion

This chapter provided the introduction, background, rationale of the study, and statement of the problem. In addition, it provided other elements such as the scope and limitations of the study. It may also provide an overview of the research methodology employed and the significance of the study.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

Renewable energy sources, particularly solar power, have emerged as a promising alternative to diesel power for water supply schemes in remote areas. The use of diesel generators for water supply schemes has several limitations, including high costs, carbon emissions, noise pollution, and environmental and health risks. In contrast, solar-powered water supply systems are clean, renewable, and abundant, and they have the potential to provide a sustainable and reliable energy source for powering water supply schemes(Bowden, 2021).

Several studies have evaluated the technical and financial feasibility of using solar power for water supply schemes in different regions. For instance, a study conducted in Nigeria evaluated the feasibility of using solar power for rural water supply schemes and found that solar-powered water supply systems were more cost-effective than diesel-powered one Similarly, a study in Egypt found that solar-powered water supply systems were technically and financially feasible and had the potential to provide a reliable source of power for water supply schemes in remote areas(Shouman et al., 2016).

Other studies have evaluated the environmental benefits of using solar power for water supply schemes. For example, a study conducted in South Africa found that solar-powered water supply systems reduced carbon emissions and noise pollution compared to diesel-powered ones(Podder et al., 2021). Additionally, solar-powered water supply systems have the potential to reduce the environmental impact of diesel generators, such as the disposal of used fuel and oil.

Social factors also play an important role in the feasibility of using solar power for water supply schemes. For instance, a study conducted in India found that solar-powered water supply systems had the potential to improve public health and promote gender equality by reducing the burden of collecting water on women and girls(Rocheat et al , 2018).

2.1 **Definition of Key Concepts**

2.1.1 **Technical Viability:** Technical viability refers to the feasibility and practicality of implementing a technical solution or project. In the context of transforming a diesel power to solar power for water supply schemes, it involves evaluating factors such as the availability of solar resources, the compatibility of existing infrastructure with solar technology, and the technical requirements for the conversion(*_Access_Study_Part I_Synthesis_Report.Pdf*, GIZ 2018.)

2.1.3 **Financial Viability**

Financial viability relates to the economic feasibility of a project or initiative. It includes assessing the potential costs, benefits, and risks associated with transforming a diesel power to solar power for water supply schemes. This assessment typically considers factors such as upfront investment, operational expenses, potential cost savings, and revenue generation (Hartung & Pluschke, 2018).

2.1.4 **Transforming a Diesel Power to Solar Power**

The process of transforming a diesel power to solar power involves replacing or supplementing the existing diesel-based power generation system with solar power. This includes installing solar panels, inverters, and related equipment to harness energy from the sun and convert it into electricity. The objective is to shift towards a more sustainable and environmentally friendly power source (Source: Renewable Energy Systems: A Smart Energy Systems Approach to the Choice and Modeling of 100% Renewable Solutions).

2.1.5 **Water Supply Schemes**

Water supply schemes encompass the infrastructure, systems, and processes involved in providing water to a specific area or community. They typically involve water sources (such as wells or reservoirs), treatment facilities, storage tanks, and distribution networks. The aim is to ensure a reliable and safe supply of water to meet the needs of the target population (Grottera, 2022)

2.2 Theoretical Literature review

By discussing some relevant theories in my study on the assessment of technical and financial viability of transforming a diesel power to solar power for water supply schemes. There were a few theories that might find useful in each specific objective;

2.2.1 To evaluate the financial viability of the transformation by conducting a detailed cost-benefit analysis. When evaluating the financial viability of transforming from diesel power to solar power, conducting a detailed cost-benefit analysis is crucial. Let's explore a theory that can support this objective: the Cost-Benefit Analysis (CBA) theory.

Theory: Cost-Benefit Analysis (CBA)

Cost-Benefit Analysis is a systematic approach used to assess the positives and negatives of a project or decision, considering both the costs and benefits associated with it.

Strengths: CBA provides a structured framework for evaluating the financial viability of a transformation. It allows for a comprehensive assessment of costs and benefits, including both monetary and non-monetary factors. By quantifying and comparing these aspects, CBA helps in making informed decisions.

Weaknesses: CBA relies on the accurate estimation and monetization of costs and benefits, which can sometimes be challenging. Non-monetary factors may be difficult to quantify, leading to potential biases in the analysis. Additionally, CBA does not consider distributional impacts, focusing primarily on overall net benefits rather than equity considerations.

Previous Usage: Cost-Benefit Analysis has been widely used in various fields, including energy projects, infrastructure development, and environmental assessments. It has been utilized by governments, financial institutions, and research organizations to evaluate the economic feasibility of different initiatives.

Relevance to the Study: The CBA theory is highly relevant to the objective of evaluating the financial viability of transforming from diesel power to solar power in water supply schemes. By conducting a detailed cost-benefit analysis, we can assess the economic feasibility of this transformation. The CBA framework will help us systematically analyze the costs associated with implementing solar power systems, such as equipment procurement, installation, and maintenance, as well as the benefits, such as reduced operational costs and potential revenue from excess power generation.

Furthermore, the strengths of the CBA theory, such as its ability to consider both monetary and non-monetary factors, make it well-suited to assess the financial viability of the transformation. We can quantify the benefits of reduced greenhouse gas emissions and environmental impact, which may have long-term economic implications. Additionally, the CBA approach will allow us to compare the costs and benefits of solar power against the existing diesel power systems, providing valuable insights into the potential cost savings and return on investment.

To summarize, the Cost-Benefit Analysis theory is a robust framework that supports the objective of evaluating the financial viability of transforming from diesel power to solar power. Its previous usage in various fields and its ability to consider both monetary and non-monetary factors make it suitable for this particular study. By utilizing the CBA theory, we can systematically assess the costs and benefits of the transformation, providing valuable insights into the economic feasibility of adopting solar power in water supply schemes. This will help inform decision-making processes and contribute to the overall understanding of the financial viability of such a transition.

2.2.2 To assess the technical feasibility of integrating solar power into the existing diesel-powered water supply scheme. Objective: To assess the technical feasibility of integrating solar power into the existing diesel-powered water supply scheme.

In this section, we will review the relevant theories and literature that support the objective of investigating the technical feasibility of integrating solar power into the existing diesel-powered water supply scheme. We will outline the theories, their strengths and weaknesses, previous usage, and their relevance to the study.

i. Theory of Photovoltaic Systems:

Description: The theory of photovoltaic systems focuses on the generation of electricity from solar energy using photovoltaic cells.

Strengths: This theory provides a comprehensive understanding of solar power generation and its technical aspects. It covers topics such as solar radiation, photovoltaic cell efficiency, system components, and sizing.

Weaknesses: The theory does not address specific integration challenges of solar power into existing diesel-powered systems.

Previous Usage: This theory has been extensively used in the field of solar energy research and engineering.

Relevance to the Study: The theory of photovoltaic systems will provide the foundation for understanding the technical aspects of solar power generation and its integration potential.

ii. Diesel-Powered Water Supply Systems:

Description: This theory focuses on the design, operation, and maintenance of water supply systems powered by diesel generators.

Strengths: This theory provides insights into diesel generator operation, fuel consumption, maintenance requirements, and associated costs.

Weaknesses: It lacks information on renewable energy integration and alternative power sources.

Previous Usage: This theory has been widely used in the field of water supply engineering, particularly in remote areas.

Relevance to the Study: Understanding diesel-powered water supply systems will help identify the limitations and potential areas for improvement through solar power integration.

iii. Hybrid Power Systems:

Description: Hybrid power systems combine multiple energy sources, such as diesel generators and solar panels, to optimize energy production and reduce reliance on a single source.

Strengths: This theory provides insights into the design, control, and optimization of hybrid power systems.

Weaknesses: It may require additional investment and technical expertise for integration.

Previous Usage: Hybrid power systems have been implemented in various applications, including off-grid energy systems and remote community electrification projects.

Relevance to the Study: Understanding hybrid power systems will offer guidance on the technical considerations and potential benefits of integrating solar power into existing diesel-powered water supply schemes.

By reviewing these theories and literature, we can gain a deeper understanding of the technical feasibility of integrating solar power into the existing diesel-powered water supply scheme. These theories provide insights into the technical aspects, previous usage, and potential challenges, which will assist in conducting a comprehensive feasibility assessment.

2.2.3 To analyze the reliability and performance aspects of the proposed solar-powered water supply scheme.

Supporting Theory: For this specific objective, need to identify a relevant theory One possible supporting theory could be the "Reliability Theory," which focuses on the assessment and prediction of system reliability.

Strengths of the Reliability Theory: It provides a systematic framework to evaluate the likelihood of failures and identify potential weak points in the system. It also allows for the calculation of various reliability metrics, such as Mean Time Between Failures (MTBF) and Mean Time to Repair (MTTR).

Weaknesses of the Reliability Theory: It relies on historical failure data, which may not always accurately reflect the performance of a new or unique system. Additionally, it may not account for external factors or unforeseen events that could impact reliability.

Related Studies: To support my research, explore previous studies that have used the Reliability Theory in similar contexts, such as solar-powered systems or water supply schemes. These studies can provide valuable insights, methodologies, and even potential limitations

2.3 Empirical Literature review

The empirical literature review of this study was focused on previous studies that have evaluated the feasibility, technical requirements, and impacts of using solar power for water supply schemes in remote areas. Several empirical studies have evaluated the technical feasibility of using solar power for water supply schemes. For example, a study conducted in Pakistan found that solar-powered water supply systems were technically feasible and had the potential to provide a reliable source of power for water supply schemes in remote areas. Similarly, a study conducted in Kenya found that solar-powered water supply systems were technically feasible and had significant potential for reducing the reliance on diesel generators(*World Document.Pdf*, 2022.).

Other empirical studies have examined the financial feasibility of using solar power for water supply schemes. For instance, a study conducted in India found that solar-powered water supply systems were more cost-effective than diesel-powered ones and had the potential to provide significant cost savings over the long-term. The environmental impacts of using solar power for water supply schemes have been evaluated in several empirical studies. For instance, a study conducted in Jordan found that solar-powered water supply systems reduced carbon emissions and noise pollution compared to diesel-powered ones. Similarly, a study conducted in Ethiopia found that solar-powered water supply systems had the potential to reduce the negative environmental impacts associated with diesel generators, such as the disposal of used fuel and oil(Admasu, 2018).

Social factors also play an important role in the feasibility of using solar power for water supply schemes. For example, a study conducted in Bangladesh found that solar-powered water supply systems had the potential to improve public health and promote gender equality by reducing the burden of collecting water on women and girls(Obaideen et al., 2021).

Overall, the empirical literature suggests that solar-powered water supply systems are technically and financially feasible and have significant environmental and social benefits compared to diesel-powered ones. However, the literature also highlights the need for further research to evaluate the best practices for designing, installing, and maintaining solar-powered water supply systems in different regions and to identify the barriers to implementation of such systems.

2.3 Knowledge Gap

In terms of the knowledge gap the stakeholders fail on making decision on either project is viable or not between solar and diesel power to run the water supply schemes, here are a few potential areas to consider:

Lack of Comprehensive Data: One possible knowledge gap could be the absence of comprehensive and accurate data regarding the current diesel power system, such as its performance, maintenance costs, and environmental impact. Without complete data, it becomes challenging to make informed decisions regarding the potential benefits and drawbacks of transitioning to solar power.

Limited Understanding of Solar Power Technology: Another knowledge gap may arise from a limited understanding of solar power technology and its implications for water supply schemes. This could include factors like solar panel efficiency, storage capacity, and reliability, which are crucial in determining the long-term feasibility and sustainability of a solar power-based system.

Insufficient Financial Analysis: Inadequate financial analysis can also contribute to the failure of decision-making. It is essential to conduct a thorough assessment of the costs associated with the conversion, including upfront investment, installation expenses, and ongoing maintenance. Additionally, evaluating potential revenue streams, such as excess energy generation or carbon credits, can provide a more accurate picture of the financial viability of the project.

Absence of Stakeholder Engagement: Failing to involve key stakeholders, such as local communities, utility providers, and experts in the field, can result in a significant knowledge gap. Their input is crucial in understanding the specific needs and challenges of the water supply schemes, as well as gaining insights into potential barriers, cultural considerations, and acceptance of the proposed transformation.

To address these knowledge gaps, it is essential to conduct comprehensive research, gather accurate data, engage relevant stakeholders, and employ robust analytical methods. This will help ensure a more informed decision-making process, mitigate risks, and increase the likelihood of successful transformations from diesel power to solar power for water supply scheme

2.4 Conceptual Framework

The conceptual framework of this study based on four main components:

Technical feasibility: This component was examining the technical requirements for using solar power for water supply schemes in remote areas. It was evaluating the different types of solar-powered water supply systems, their suitability for different regions, and their technical requirements such as energy efficiency, reliability, and durability.

Financial feasibility: This component was assessing the capital and operational costs of implementing and maintaining solar-powered water supply systems compared to diesel-powered ones. It will evaluate the potential for cost savings and revenue generation associated with switching to solar power, as well as the financial risks and uncertainties associated with such a transformation.

Environmental impact: This component was examining the environmental benefits of using solar power for water supply schemes, such as reduced carbon emissions and noise pollution. It will also evaluate the potential environmental risks associated with the manufacture, installation, and disposal of solar panels.

Social impact: This component was evaluating the social benefits of using solar power for water supply schemes, such as improving public health and promoting gender equality. It will also examine the factors that influence the success of solar-powered water supply systems in different regions, including cultural beliefs, social norms, and political stability.

The conceptual framework was incorporating theories and concepts related to sustainable development, renewable energy, water supply, and innovation systems to provide a comprehensive understanding of the potential of using solar power for water supply schemes in remote areas. It also be informed by the empirical and contextual literature reviews, which helps to identify the key factors that influence the feasibility, technical requirements, and impacts of using solar power for water supply schemes in different regions and under different conditions.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Introduction

The research methodology for this study was based on a mixed-methods approach, combining both quantitative and qualitative data collection and analysis methods.

3.2 Study of Area

The study area for this research methodology was Nyameni village, Zombo Lumbo Village, Zombo Madudumizi, Mwenda Ilakala, Kidui Kilangali, Twatwa Parakuyo in Kilosa District where the use of solar power for water supply schemes has potential. The location was selecting based on the availability of solar energy resources, the water supply challenges, and the socio-economic factors that influence the feasibility of using solar power for water supply scheme. Within this location, the study was focusing on different case study sites, including small villages, schools, health clinics, and other community centers that rely on water supply schemes powered by diesel generators. These sites were selected based on their characteristics, availability of data, and the potential for implementing solar-powered water supply systems.

3.3 Research Approach

The research approach for this study was mixed-methods research approach, which is a combination of quantitative and qualitative research methods. The mixed-methods approach will allow for a comprehensive evaluation of the feasibility, technical requirements, and impacts of using solar power for water supply schemes in remote areas.

Quantitative research methods used to collect and analyze numerical data on the technical and financial feasibility of using solar power for water supply schemes. This will include surveys that administered to water supply authorities, energy providers, and other stakeholders involved in the operation and maintenance of water supply schemes in remote areas. The surveys designed to collect data on the technical requirements, financial costs, and benefits associated with switching from diesel to solar-powered water supply systems. The quantitative data analyzed using descriptive statistics to evaluate the feasibility of using solar power for water supply schemes.

Qualitative research methods used to collect and analyze non-numerical data on the social, environmental, and policy implications of using solar power for water supply schemes. This includes interviews with key experts and stakeholders in the field of solar power and water supply, as well as case studies that examine the feasibility and impacts of using solar power for water supply schemes in different regions and under different conditions. The qualitative data analyzed using content analysis to identify key themes, patterns, and implications related to the use of solar power for water supply schemes.

3.4 Research design

The research design of this study was cross-sectional research design, where data collected at a single point in time. The study used both primary and secondary data sources to evaluate the feasibility, technical requirements, and impacts of using solar power for water supply schemes in remote areas. The primary data sources include surveys, interviews, and case studies that was conducted in different location to collect data on the technical requirements, financial costs, social and environmental impacts, and policy implications of using solar power for water supply schemes. The surveys administered to water supply authorities, energy providers, and other stakeholders involved in the operation and maintenance of water supply schemes in remote areas. The interviews were conducted with key experts in the field of solar power and water supply, and the case studies was examining the feasibility and impacts of using solar power for water supply schemes in different regions and under different conditions.

The secondary data sources were including existing literature, reports, and other relevant documents related to the use of solar power for water supply schemes in remote areas. The literature review provides a comprehensive overview of the existing knowledge and research on using solar power for water supply schemes in remote areas and was informing the methodology and analysis of the study.

3.5 Targeted Population

The targeted population in this study was 423 respondents based on Rural Water Supply Agency (RUWASA), Community owner water Organizations and other stakeholders involved in the operation and maintenance of water supply schemes in these villages. The population also include key experts in the field of solar power and water supply, such as researchers, academics, and policymakers. The study focus on Nyameni village, Zombo Lumbo Village, Zombo Madudumizi, Mwenda Ilakala, Kidui Kilangali, Twatwa Parakuyo in Kilosa District where the use of solar power for water supply schemes has potential. In this case, the sample size for Community beneficiaries was determined using Yomane's (1967) model, expressed as $n = N / (1 + Ne^2)$. This formula ensured an appropriate sample size considering the population size (N) and desired confidence interval (e). Consequently, 81 respondents were chosen from six villages using Yamane's (1967) formula to ensure statistical representativeness.

$n = N / (1 + Ne^2)$

$N = 422$ (population size)

$e = 10\%$ (confidence interval expressed as a decimal, so $e = 0.1$)

$$n = 423 / (1 + 422 * (0.1)^2) \text{ whereas } (0.1)^2 = 0.01$$

$$n = 423 / (1 + 422 * 0.01)$$

$$423 * 0.01 = 4.22$$

$$1 + 4.22 = 5.22$$

$$n = 423 / 5.22 = 81.03$$

$$n \approx 81$$

The population was selected based on their expertise and involvement in the operation and maintenance of water supply schemes in these villages, as well as their knowledge and experience with solar power and renewable energy sources. The surveys and interviews will be conducted with representatives from Rural Water Supply Agency (RUWASA), and other stakeholders involved in the operation and maintenance of water supply schemes in remote areas. The case studies will focus on different community centers, such as schools, health clinics, and other public facilities, where the transformation from diesel to solar-powered water supply systems is feasible and can have a significant impact on the community.

3.6 Sampling Strategies & Techniques

One common technique is random sampling, where select randomly a subset of water supply schemes from the larger population in Kilosa. This ensures that every scheme has an equal chance of being included in the study, which helps to minimize bias and increase representativeness. Another technique is stratified sampling, where the population is divided into distinct strata based on specific characteristics such as scheme size, location, or current power usage. Then, select samples from each stratum to ensure a representative sample is obtained from different subsets of the larger population. The specific sampling strategy and technique used in this study may depend on various factors such as the research objectives, available resources, and the characteristics of the population being studied (Shouman et al., 2016).

3.7 Data Collection method

The data collection methods for this study combine of surveys, interviews, and case studies.

Surveys: A survey questionnaire designed to collect quantitative data on the technical and financial feasibility of using solar power for water supply schemes. The survey administered to water supply agency, and other stakeholders involved in the operation and maintenance of water supply schemes in this villages. The survey was including questions on the technical requirements, financial costs, and benefits associated with switching from diesel to solar-powered water supply systems.

Interviews: Interviews conducted with key experts in the field of solar power and water supply to gather qualitative data on the technical requirements, social and environmental impacts, and policy implications of using solar power for water supply schemes. The interviews conducted either in person or through video conferencing and audio-recorded and transcribed for analysis. The interviews semi-structured, allowing for open-ended questions and follow-up questions to gather more detailed information.

Case studies: Case studies conducted in different regions to evaluate the feasibility, technical requirements, and impacts of using solar power for water supply schemes under different conditions and contexts. The case studies selected based on the availability of solar energy resources, the water supply challenges, and the socio-economic factors that influence the feasibility of using solar power for water supply schemes. The case studies was involving site visits, observations, and interviews with stakeholders and community members to collect data on the technical and financial feasibility of using solar power for water supply schemes, as well as the environmental and social impacts of such systems.

Overall, the data collection methods for this study was providing a comprehensive and systematic approach to evaluating the feasibility, technical requirements, and impacts of using solar power for water supply schemes in remote areas. The combination of surveys, interviews, and case studies allow for a balanced and nuanced perspective on the potential benefits and challenges associated with such systems and helps to identify the best practices for designing and implementing solar-powered water supply systems under different conditions.

3.8 Pilot Study

A pilot study may be conducted in this project to test and refine the research methodology, tools, and procedures before conducting the full-scale study. The pilot study involves a small-scale version of the data collection and analysis methods that used in the full-scale study.

For example, a pilot survey may be administered to a small sample of stakeholders to test the survey questionnaire and assess the clarity of the language, response options, and skip patterns. The pilot interviews may be conducted with a few key experts to test the interview protocol and identify any potential issues with the questions or procedures. The pilot case studies may be conducted in a small number of community centers to test the feasibility of collecting data in different settings and identify any logistical or technical issues that may arise during the site visits.

The pilot study identifies any potential challenges or issues with the research methodology, tools, and procedures and make necessary modifications before conducting the full-scale study. Additionally, the pilot study providing an opportunity to gather valuable feedback from the participants on the data collection instruments and procedures, which can be used to improve the quality and relevance of the data collected in the full-scale study.

3.9 Data Analysis

The data analysis in this study was involving a combination of quantitative and qualitative data analysis methods, depending on the specific type of data collected.For the surveys, the quantitative data analyzed using descriptive statistics, such as frequency distributions, measures of central tendency, and measures of variability. The survey data analyzed to identify the technical requirements, financial costs, and benefits associated with switching from diesel to solar-powered water supply systems in remote areas.

For the interviews and case studies, the qualitative data analyzed using content analysis, which involves identifying and coding key themes, patterns, and meanings in the data. The interview and case study data will be analyzed to identify the social and environmental impacts, as well as the policy implications of using solar power for water supply schemes in remote areas.The mixed-methods data analysis was involving integrating the quantitative and qualitative data to provide a comprehensive and nuanced understanding of the feasibility, technical requirements, and impacts of using solar power for water supply schemes in remote areas. The data triangulated to verify the findings and enhance the validity and reliability of the study.

3.10 Validity and reliability

Ensuring the validity and reliability of the study is essential to ensure the accuracy and credibility of the findings. Several measures taken to enhance the validity and reliability of this study, including:Use of mixed-methods: The study used a mixed-methods approach to ensure the validity and reliability of the findings. The combination of quantitative and qualitative data provides a more comprehensive understanding of the feasibility, technical requirements, and impacts of using solar power for water supply schemes in remote areas,Sampling techniques**:** The study used rigorous sampling techniques to select a representative sample of water supply authorities, energy providers, and other stakeholders involved in the operation and maintenance of water supply schemes in remote areas. The sample size determined based on the target population size and the desired level of precision, Data collection methods: Valid and reliable data collection methods used to gather relevant data. Surveys, interviews, and case studies conducted using well-designed, tested, and validated data collection instruments,Data analysis: The study used appropriate statistical and qualitative data analysis techniques to analyze the data collected. The data analysis conducted by experienced and trained researchers to ensure the accuracy and credibility of the findings, Triangulation: The study used triangulation to verify the findings and enhance the validity and reliability of the study. Triangulation involves comparing and contrasting different sources and types of data to identify similarities and differences and provide a more comprehensive understanding of the phenomena under investigation.

Overall, the study employs rigorous measures to ensure the validity and reliability of the findings. This will help to ensure that the results of the study are credible, accurate, and relevant, and can be used to inform policy and practice in the area of solar-powered water supply systems in remote areas.

3.11 Ethical Consideration

This study adheres to ethical principles and guidelines to ensure that the rights and welfare of the participants are protected. The following ethical considerations taken into account: Informed consent**:** Participants fully informed about the study objectives, procedures, and potential risks and benefits. Informed consent obtained from all participants before they participate in the study.Anonymity and confidentiality**:** Participants' anonymity and confidentiality protected throughout the study. Participants' names and any identifying information was not being used in any reports, publications, or presentations.Voluntary participation**:** Participation in the study voluntary, and participants can withdraw from the study at any time without any consequences.Data protection: All data collected stored securely and protected against unauthorized access, use, or disclosure.Respect for cultural and social norms: The study was respecting the cultural and social norms of the participants and ensure that their privacy, dignity, and autonomy are protected.Dissemination of the findings: The study findings disseminated to the participants, stakeholders, and relevant authorities in a manner that is clear, accurate, and accessible.

3.12 Conclusion

Overall, the research methodology employed in this study of assessing the technical and financial viability of transforming a diesel power to solar power in water supply schemes has provided valuable insights into the potential benefits and feasibility of such a transformation. These conclusions can serve as a foundation for future decision-making and implementation of sustainable energy solutions in similar contexts.

CHAPTER FOUR

4.0 PRESENTATION AND DISCUSSION OF RESEARCH FINDINGS

4.1 Introduction

This chapter provides a presentation of the findings from the field and offers clear, precise, adequate and in-depth discussions of the results concerning the research objectives and research questions.

4.2 Response rate

Out of 81 of the respondents were engaged in study where by 61 questionnaires distributed to the respondents in accordance to the University requirements were filled and 100% of them were returned, also 20 of the respondents were interview and 100% were interviewed. This implies that the information obtained were enough for proceeding with data analysis. According (Sunders et al., 2007). provides that, the researcher should struggle to attempt the number of respondents above 70% in order to have sufficient analysis of his/her stud.

4.3 Presentation of findings.

The data analysis will consider both data which were collected through interview and questionnaire. There for the interview data will be analyzed using content analysis and those comes from questionnaire were analyzed using descriptive analysis. The study descriptive analysis was included in the study to analyze all objects using frequency distribution table as included as follow

4.3.1 Evaluation of financial viability of the transformation by conducting a detailed cost-benefit analysis.

Out of 61 respondents from RUWASA 75.4% where aware with the potential financial incentives or grants available for transitioning to solar power and 24.6% were not aware with the potential financial incentives or grants available for transitioning to solar power as shown in table 4.1 bellow.

Table 4.1 Are you aware of any potential financial incentives or grants available for transitioning to solar power?

		Frequency	Percent
Valid	Yes	46	75.4
	No	15	24.6
	Total	61	100.0

Source: Analyzed data, 2023

The 83.6% of the respondents confirmed that there ongoing operational and maintenance costs associated with the solar-powered water supply scheme, and have these been considered in the analysis and 16.4% of the respondents were not confirmed there have been ongoing operational and maintenance costs associated with the solar-powered water supply scheme, and have these been considered in the analysis as indicated in a table below.

Table 4.2 Are there ongoing operational and maintenance costs associated with the solar-powered water supply scheme, and have these been considered in the analysis?

		Frequency	Percent
Valid	Yes	51	83.6
	No	10	16.4
	Total	61	100.0

Source: Analyzed data, 2023

Out of 61 respondents on the statement of "potential cost savings or benefits, such as reduced fuel expenses or maintenance costs, been identified as a result of the transformation" 67.2% were confirmed "Yes" and 32.8 were confirmed "No" to that statement. Since the large percent of the respondent they said yes it implies that in RUWASA maintain potential cost savings or benefits, such as reduced fuel expenses or maintenance costs, been identified as a result of the transformation diesel power to solar power in water supply schemes as indicated in table 4.3 below

Table 4.3 Potential cost savings or benefits, such as reduced fuel expenses or maintenance costs, been identified as a result of the transformation

		Frequency	Percent
Valid	Yes	41	67.2
	No	20	32.8
	Total	61	100.0

Source: Analyzed data, 2023

Also RUWASA on the way of transformation diesel power to solar power in water supply schemes they obtain the important advantages including reduction carbon monoxide gas to environment safe, reducing operation cost and maintenance cost and it gives the assurance for provision of water services the society.

As respondent state

> *In our area already foster a development to 80% in transformation from diesel power to solar power in water supply schemes through that operational cost and maintenance cost were reduces to our operation, environment is safety due to reduction of noise and emission of carbon monoxide gas and it make assurance of services provision to our schemes (respondent 5,8,6,14,19 and 20)*

On the statement of "payback period for the initial investment in solar power for your water supply scheme" 73.8% of the respondents confirmed that were less than 5 years while 26.2% of the respondents not confirmed payback period for the initial investment in solar power for your water supply scheme were 5-10 years as indicated in in a table 4.4 bellow. Since the lager number of the respondent were confirmed that payback period for the initial investment in solar power for your water supply scheme is less than 5 years, therefore, the payback period for the initial investment in solar power for your water supply scheme in RUWASA was less than 5 years this implies that, every investment for solar power for your water supply scheme their payback period is less than 5 years

Table 4.4 Payback period for the initial investment in solar power for your water supply scheme

		Frequency	Percent
Valid	Less than 5 years	45	73.8
	5-10 years	16	26.2
	Total	61	100.0

Source: Analyzed data, 2023

Out of 85.2% respondent from RUWASA Kilosa were confirmed that, there is potential sources of funding or financial support that could facilitate the transformation to solar power RUWASA Kilosa and 14.8% of the respondent did not confirmed there is potential sources of funding or financial support that could facilitate the transformation to solar power RUWASA Kilosa. Since the lager percent of the respondent were confirming that there is potential sources of funding or financial support that could facilitate the transformation to solar power this implies that, there was the financial support which help to facilitate transformation to solar power RUWASA Kilosa as indicated in the table 4.5 bellow.

Table 4.5 Are there potential sources of funding or financial support that could facilitate the transformation to solar power

		Frequency	Percent
Valid	Yes	52	85.2
	No	9	14.8
	Total	61	100.0

Source: Analyzed data, 2023

Also the most of the financial source to facilitate transformation to solar power RUWASA Kilosa were local and international donor, government subsidies and community contribution. From the international donor include word bank, USAID world vision and water development alliance and local private donor were private institution including PELUM.

As respondent state

In a process of transforming to solar power we receive various financial support from subsides provided by government, local donor and international donor and community contribution (respondent 2,8,11,15,19 and 20. 2023)

Donors including USAID, world bank, World vision, water development alliance and PELLUM (respondent 1,4,6,7,13 and 18)

Furthermore, the study revealed that apart from these sources of fund there were the risk for transforming to solar power including theft, absence of sunlight reduces production of electricity to foster the development operation from solar energy and managerial practice to ensure continuity of services.

As respondent state

There are different risk occurred on the way of transforming to solar power such as managerial issues for managing all issues related with solar power, theft from the community member and absence of sunlight become a merger challenge to grow in using solar power (respondent, 1,3,4,6,7,11 and 16)

4.3.2 Technical feasibility of integrating solar power into the existing diesel-powered water supply scheme

On the current energy source which were used use at RUWASA kilosa 68.9% were using solar power and 31.1% were using diesel power. This implies that the larger percent of the population of RUWASA kilosa were using solar power for water supply as indicated below.

Table 4.6 Which energy source is currently used in your water supply scheme?

		Frequency	Percent
Valid	Diesel	19	31.1
	Solar	42	68.9
	Total	61	100.0

Source: Analyzed data, 2023

Also through using this solar power the community obtain advantages to their organization development and environmental conservation including reduction of operational cost and maintenance cost, assurance of continuity of water supply due to consistence power supply and reduction of noise and carbon monoxide.

> *Transforming to solar power in water is important through operational cost and maintenance cost were reduces to our operation, environment is safety due to reduction of noise and emission of carbon monoxide gas and it make assurance of services provision to our schemes (respondent 5,8,6,14,19 and 20)*

Not only that, but also 62.3%, 27.9%, 8.2% and 1.6% of the respondent were confirming that transforming to solar power supply scheme from diesel power extremely important, very important, moderate important and not important at RUWASA Kilosa respectively on reducing carbon emissions for your water supply scheme. Since the lager percent were confirming therefore, transformation to solar power was very and extremely important for reducing carbon emissions for your water supply scheme.

Table 4.7 How important is reducing carbon emissions for your water supply scheme?

		Frequency	Percent
Valid	Not important	1	1.6
	Moderately important	5	8.2
	Very important	17	27.9
	Extremely important	38	62.3
	Total	61	100.0

Source: Analyzed data, 2023

Not only that, but also 68.9% were agreed that, technically feasible to integrate solar power into the existing diesel-powered water supply scheme it was feasible and 31.1% were not agree to that statement. Therefore, it is technically it is feasible to integrate solar power into the existing diesel-powered water supply scheme at RUWASA kilosa.

Table 4.8 Is it technically feasible to integrate solar power into the existing diesel-powered water supply scheme?

		Frequency	Percent
Valid	Yes	42	68.9
	No	19	31.1
	Total	61	100.0

Source: Analyzed data, 2023

The 82% of the respondent were agreeing that, there specific technical obstacles or constraints that may hinder the successful integration of solar power into the existing water supply system and 18% were not agreeing to that statement. Therefore, since the large respondent they agree, that implies there was technical obstacles or constraints that may hinder the successful integration of solar power into the existing water supply system at RUWASA Kilosa.

Table 4.10 Are there specific technical obstacles or constraints that may hinder the successful integration of solar power into the existing water supply system?

		Frequency	Percent
Valid	Yes	50	82.0
	No	11	18.0
	Total	61	100.0

Source: Analyzed data, 2023

4.3.3 Analyze the reliability and performance aspects of the proposed solar-powered water supply scheme

Out of 61 respondents 75.4% of them were agree that the proposed solar-powered water supply scheme reliable in providing a continuous and uninterrupted water supply and 24.6% were not agreed with that. Since the large respondent were agreeing, therefore, it is true that the proposed solar-powered water supply scheme reliable in providing a continuous and uninterrupted water supply scheme at RUWASA Kilosa.

Table4.11 Is the proposed solar-powered water supply scheme reliable

in providing a continuous and uninterrupted water supply?

		Frequency	Percent
Valid	Yes	46	75.4
	No	15	24.6
	Total	61	100.0

Source: Analyzed data, 2023

On the statement of "solar-powered water supply scheme performs efficiently in terms of energy conversion, water flow rates, and pressure levels" the 78.7% were agreed that, in solar-powered water supply scheme performs efficiently in terms of energy conversion, water flow rates, and pressure levels at RUWASA Kilosa and 21.3 were not agreed to that statement. Therefore, since the large percent of the respondent agree, this implies that, solar-powered water supply scheme performs efficiently in terms of energy conversion, water flow rates, and pressure levels at RUWASA as indicated in the table 4.9 bellow

Table 4.12 Does the solar-powered water supply scheme perform efficiently in terms of energy conversion, water flow rates, and pressure levels?

		Frequency	Percent
Valid	Yes	48	78.7
	No	13	21.3
	Total	61	100.0

Source: Analyzed data, 2023

The 62.3% respondent's on the statement of "solar panels and energy storage components efficient, contributing to the system's reliability and performance" were agreeing and 37.7% were not agreeing to that statement. Therefore, since the large percent were agreeing implies that, solar panels and energy storage components efficient, contributing to the system's reliability and performance.

Table 4.13 Are the solar panels and energy storage components efficient, contributing to the system's reliability and performance?

		Frequency	Percent
Valid	Yes	38	62.3
	No	23	37.7
	Total	61	100.0

Source: Analyzed data, 2023

The 72.1% of the respondents were agreeing that, at RUWASA Kilosa users satisfied with the reliability and performance of the solar-powered system compared to the previous system and 27.9% were not agreeing that, users satisfied with the reliability and performance of the solar-powered system compared to the previous system. Since the large respondent agreeing to that statement therefore, the users satisfied with the reliability and performance of the solar-powered system compared to the previous system as indicated as follow

Table4.14 Are users satisfied with the reliability and performance of the solar-powered system compared to the previous system?

		Frequency	Percent
Valid	Yes	44	72.1
	No	17	27.9
	Total	61	100.0

Source: Analyzed data, 2023

Out of 61 respondents 77% of them were agreeing that, solar-powered system contribute to environmental sustainability by reducing greenhouse gas emissions and conserving energy to RUWASA Kilosa and 23% of the respondent were not agreeing. Therefore, since the large percent agreeing implies that solar-powered system contribute to environmental sustainability by reducing greenhouse gas emissions and conserving energy to RUWASA Kilosa.

Table 1.15 Does the solar-powered system contribute to environmental sustainability by reducing greenhouse gas emissions and conserving energy?

		Frequency	Percent
Valid	Yes	47	77.0
	No	14	23.0
	Total	61	100.0

Source: Analyzed data, 2023

4.4 Discussion of the findings

4.4.1 Financial viability of the transformation by conducting a detailed cost-benefit analysis

Financial viability of the transformation by conducting a detailed cost-benefit analysis was the first objective included in the study in order to assessing the potential costs, benefits, and risks associated with transforming a diesel power to solar power for water supply schemes. The result revealed that, most of the community at RUWASA Kilosa aware with the potential financial incentives or grants available for transitioning to solar power and there ongoing operational and maintenance costs associated with the solar-powered water supply scheme, and have these been considered in the analysis as indicated in table 4.1 and 4.2 above.

Also study revealed that, in RUWASA maintain potential cost savings or benefits, such as reduced fuel expenses or maintenance costs were the advantages as a result of the transformation diesel power to solar power in water supply schemes as indicated in table 4.3 above. Not only that but also they obtain the important advantages including reduction carbon monoxide gas to environment safe, reducing operation cost and maintenance cost and it gives the assurance for provision of water services the society.

Furthermore, the study revealed that, after initial investment of transforming to solar power in water supply scheme the investors they experience a payback period for the initial investment in solar power for water supply in less than 5 years. Also there was potential sources of funding or financial support that could facilitate the transformation to solar power these including local and international donor, government subsidies and community contribution. From the international donor include word bank, USAID world vision and water development alliance and local private donor were private institution including PELUM.

Moreover, the study revealed that apart from these sources of fund there were the risk for transforming to solar power including theft, absence of sunlight reduces production of electricity to foster the development operation from solar energy and managerial practice to ensure continuity of services. There was financial feasibility of using solar power for water supply schemes. (World Document.Pdf, 2022.)

4.4.2 Technical feasibility of integrating solar power into the existing diesel-powered water supply scheme.

Technical feasibility of integrating solar power into the existing diesel-powered water supply scheme was the second objective included in the study in order to determine the technical feasibility of integrating solar power into the existing diesel-powered water supply scheme. The results revealed that, that the larger percent of the population of RUWASA kilosa were using solar power for water supply as indicated in table 4.6 above. Also the study found that, in using solar power the community obtain advantages to their organization development and environmental conservation including reduction of operational cost and maintenance cost, assurance of continuity of water supply due to consistence power supply and reduction of noise and carbon monoxide. Solar-powered water supply systems reduced carbon emissions and noise pollution compared to diesel-powered ones (Podder et al., 2021)

Not only that, but also transformation to solar power was very and extremely important for reducing carbon emissions for your water supply scheme and it is technically it is feasible to integrate solar power into the existing diesel-powered water supply scheme at RUWASA kilosa as indicated in table 4.7 and 4.8 above. Despite of these advantages there was technical obstacles or constraints that may hinder the successful integration of solar power into the existing water supply system at RUWASA Kilosa. Especially on implementing the projects as indicated in table 4.10 above. evaluate the best practices for designing, installing, and maintaining solar-powered water supply systems in different regions and to identify the barriers to implementation of such systems(Obaideen et al., 2021).

(World Document.Pdf, 2022.). found that, solar-powered water supply systems were technically feasible and had significant potential for reducing the reliance on diesel generators and financial feasibility of using solar power for water supply schemes. Also solar-powered water supply systems were technically and financially feasible and had the potential to provide a reliable source of power for water supply schemes in remote areas (Shouman et al., 2016).

4.4.3 Reliability and performance aspects of the proposed solar-powered water supply scheme

Reliability and performance aspects of proposed solar-powered water supply scheme was the third objective to include in the study with the aim of to analyze the reliability and performance aspects of proposed solar-powered water supply scheme and the result revealed that, the proposed solar-powered water supply scheme reliable in providing a continuous and uninterrupted water supply scheme at RUWASA Kilosa and solar-powered water supply scheme performs efficiently in terms of energy conversion, water flow rates, and pressure levels at RUWASA. Also the study revealed that, solar panels and energy storage components efficient, contributing to the system's reliability and performance of solar-powered water supply scheme and the users satisfied with the reliability and performance of the solar-powered system compared to the previous system.

Not only that, but also the study found that, solar-powered system contributes to environmental sustainability by reducing greenhouse gas emissions and conserving energy to RUWASA Kilosa. solar-powered water supply systems had the potential to reduce the negative environmental impacts associated with diesel generators, such as the disposal of used fuel and oil (Admasu et al., 2018). Solar-powered water supply systems had the potential to improve public health and promote gender equality by reducing the burden of collecting water on women and girls (Obaideen et al., 2021).Solar-powered water supply systems are clean, renewable, and abundant, and they have the potential to provide a sustainable and reliable energy source for powering water supply schemes (Bowden et al., 2021).

CHAPTER FIVE

5.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter covers summary of findings, conclusion, recommendation of the entire research as discussed above and area for further study. The summary of the findings was covering the short information discussed in chapter five, conclusion was drowned from what was founded in the study, recommendation was covered on the area that require to improve and area for further study was covered to the area there was a room for obtaining gap for further research for other researchers.

5.2 Summary of the findings

The main objective of this study is to assess the technical and financial viability of transforming a diesel power to solar power in water supply schemes at RUWASA Kilosa. This general objective was supported by the specific objectives which were to evaluate the financial viability of the transformation by conducting a detailed cost-benefit analysis, to determine the technical feasibility of integrating solar power into the existing diesel-powered water supply scheme and to analyze the reliability and performance aspects of the proposed solar-powered water supply scheme at RUWASA Kilosa. Their result included as follow

5.2.1 Technical feasibility of integrating solar power into the existing diesel-powered water supply scheme.

This was the first objective include in the study in order to evaluate the financial viability of the transformation by conducting a detailed cost-benefit analysis and the result revealed that RUWASA at Kilosa were using solar power for water supply and transformation to solar power had advantages to their organization development and environmental conservation including reduction of operational cost and maintenance cost, assurance of continuity of water supply due to consistence power supply and reduction of noise and carbon monoxide. Also transformation to solar power was very and extremely important for reducing carbon emissions for your water supply scheme and it is technically it is feasible to integrate solar power into the existing diesel-powered water supply scheme at RUWASA kilosa.

5.2.2 Technical feasibility of integrating solar power into the existing diesel-powered water supply scheme.

This was the second included in the study in order to determine the technical feasibility of integrating solar power into the existing diesel-powered water supply scheme and the study revealed that, larger percent of the population of RUWASA kilosa were using solar power for water supply and in using solar power the community obtain advantages to their organization development and environmental conservation including reduction of operational cost and maintenance cost, assurance of continuity of water supply due to consistence power supply and reduction of noise and carbon monoxide. Not only that, but also transformation to solar power was very and extremely important for reducing carbon emissions for your water supply scheme and it is technically it is feasible to integrate solar power into the existing diesel-powered water supply scheme at RUWASA kilosa.

5.2.3 Reliability and performance aspects of the proposed solar-powered water supply scheme.

This was the third objective included in the study in order to analyze the reliability and performance aspects of the proposed solar-powered water supply scheme and the study found that, the proposed solar-powered water supply scheme reliable in providing a continuous and uninterrupted water supply scheme at RUWASA Kilosa, performs efficiently in terms of energy conversion, water flow rates, and pressure levels at RUWASA. Also the study revealed that, solar panels and energy storage components efficient, contributing to the system's reliability and performance of solar-powered water supply scheme and the users satisfied with the reliability and performance of the solar-powered system compared to the previous system and study found that, solar-powered system contributes to environmental sustainability by reducing greenhouse gas emissions and conserving energy to RUWASA Kilosa

5.3 Conclusion

The main objective of this study is to assess the technical and financial viability of transforming a diesel power to solar power in water supply schemes. Three objectives were included in the study to evaluate the financial viability of the transformation by conducting a detailed cost-benefit analysis, to determine the technical feasibility of integrating solar power into the existing diesel-powered water supply scheme and to analyze the reliability and performance aspects of the proposed solar-powered water supply scheme at RUWASA Kilosa The population of the study was 423 people with the sample size of 81 which of the population were the sample that used to obtain data. the descriptive and content analysis techniques were employed for analyzing data and the result founded that, there is financial viability of the transformation by conducting a detailed cost-benefit analysis, technical feasibility of integrating solar power into the existing diesel-powered water supply scheme and reliability and performance aspects of the proposed solar-powered water supply scheme at RUWASA Kilosa.

5.4 Recommendation

After computing the discussion of the findings, analysis and conclusion, the study also provides the recommendation with the aim of improving performance of water solar-powered water supply scheme at RUWASA Kilosa. The recommendation was made through the area of analytical dimension over the whole objective as follow

5.4.1 Analytical dimension

The study found that, there were financial visibility and technical feasibility on the importance transforming from the diesel power to solar power water supply including advantages to their organization development and environmental conservation including reduction of operational cost and maintenance cost, assurance of continuity of water supply due to consistence power supply and reduction of noise and carbon monoxide and cost savings or benefits, such as reduced fuel expenses or maintenance costs. Therefore, the study recommends that, due to its importance to the community both private and public sectors should support through providing fund and technical skills in the development of transforming from diesel power to solar power to enhance efficiency water supply scheme at RUWASA.

5.5 Area for further study

The study was concerned with the assessment of technical and financial viability of transforming a diesel power to solar power of water supply schemes especially RUWASA Kilosa. Therefore, the study recommends that, there was a needs for conducting study on assessing the determinants of performance of solar power of water supply schemes in order to evaluate the factors that may contribute the development of solar power of water supply schemes at RUWASA.

References

Admasu, A. A. (2018). *SOLAR PV BASED RURAL ELECTRIFICATION IN REMA RURAL VILLAGE*.

Bowden, M. (2021). A Survay on Photovoltaics Technology for Water Pumping. *Journal of Machine and Computing*, 86–96. https://doi.org/10.53759/7669/jmc202101010

GIZ_2018_Access_Study_Part I_Synthesis_Report.pdf. (n.d.).

Grottera, C. (2022). *Reducing emissions from the energy sector for a more resilient and low-carbon post-pandemic recovery in Latin America and the Caribbean*.

Hartung, H., & Pluschke, L. (2018.). *The Benefits and Risks of Solar Powered Irrigation*.

Jovanović, N., Mpambo, M., Willoughby, A., Maswanganye, E., Mazvimavi, D., Petja, B., Molose, V., Sifundza, Z., Phasha, K., Ngoveni, B., Matanga, G., & Du Toit, D. (2023). Feasibility of Solar-Powered Groundwater Pumping Systems in Rural Areas of Greater Giyani Municipality (Limpopo, South Africa). *Applied Sciences*, *13*(6), 3859. https://doi.org/10.3390/app13063859

Obaideen, K., Nooman AlMallahi, M., Alami, A. H., Ramadan, M., Abdelkareem, M. A., Shehata, N., & Olabi, A. G. (2021). On the contribution of solar energy to sustainable developments goals: Case study on Mohammed bin Rashid Al Maktoum Solar Park. *International Journal of Thermofluids*, *12*, 100123. https://doi.org/10.1016/j.ijft.2021.100123

Podder, A. K., Habibullah, Md., Roy, N. K., & Pota, H. R. (2021). A chronological review of prospects of solar photovoltaic systems in Bangladesh: Feasibility study analysis, policies, barriers, and recommendations. *IET Renewable Power Generation*, *15*(10), 2109–2132. https://doi.org/10.1049/rpg2.12165

Roche, O. M., & Blanchard, R. E. (2018). Design of a solar energy centre for providing lighting and income-generating activities for off-grid rural communities in Kenya. *Renewable Energy*, *118*, 685–694. https://doi.org/10.1016/j.renene.2017.11.053

Shouman, E. R., Shenawy, E. T. E., & Badr, M. A. (2016). *Economics Analysis of Diesel and Solar Water Pumping with Case Study Water Pumping for Irrigation in Egypt*. *11*(2).

World document.pdf. (2022).

Appendices

a) Field Work Time table (Work plan)

S/N	ACTIVITY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV
1	Research dissertation writing									
2	Disertation Defense									
3	Pilot study									
4	Data Collection									
5	Data Analysis and Interpretation									
6	Report Compilation									
7	Final repots									

	presentation									
8	Report Submission									

b) Tentative Research Budget

Budget Category	Item Description	Units	Quantity	Unit Cost	Subtotal
Personnel Costs	Research Assistant	day	16	15,000	240,000.00
	Researchers' meals and accommodation	No	4	150,000	600,000.00
Types of Equipment and Supplies	Ream Paper	Pcs	4	20,000	80,000.00
	Flash Disk 16 GB	Pcs	2	20,000	40,000.00
	Printing & Photocopying	Lump Sum	1	500,000	500,000.00
	Binding of the final draft-books	Pcs	5	20,000	100,000.00

Budget Category	Item Description	Units	Quantity	Unit Cost	Subtotal
Communication, travel and transport	Travel cost between Kilosa to Dodoma-trip	Days	5	60,000	300,000.00
	Field transport cost-	Days	6	160,000	960,000.00
	Communication with the field assistant	No	16	2000.00	32,000.00
	Communication with the supervisor-months	Months	7	5000	35,000.00
Honoraria	Allowances for Interviewers Officials-days	days	7	5000	35,000.00
	Allowances for Interviewers beneficiary-Days	days	120	5000	600,000.00
	Refreshment and drinks-Month	months	6	100,000	600,000.00
Total Research Cost					**4,122,000**

c) Questionnaire for Household/Community Survey

NAME: SEBASTIAN L.NICODEM (MSC.PROJECT PLANNING & MANAGEMENT)

Research Title: Assessment of Technical and Financial Viability of Transforming a Diesel Power to Solar Power of Water Supply Schemes: A Case Study of Kilosa

Mob: 0753665401 Email: mtuimerhinho@gmail.com

Questionnaires for Households/Community.

Dear Interviewee,

My name is Eng. Sebastian L. Nicodem a Student from Arusha Institute of Accountancy, wishing to study on the contribution of Assessment of Technical and Financial Viability of Transforming a Diesel Power to Solar Power of Water Supply Schemes: A Case Study of Kilosa .Your households has been randomly selected among others to participate in this interview aiming to gather information which will help in carrying out this important study. Your participation as a beneficiary household head will be highly appreciated and your responses will be treated confidentially. This interview is designed to take 15 minutes for each respondent.

Here are research questions to evaluate the financial viability of the transformation from a diesel-powered water supply scheme to a solar-powered one through a detailed cost-benefit analysis, along with a "Yes" or "No" response option and space for open explanations:

1.0 Financial Viability Assessment:

1.0.1 Question: Is the transformation from a diesel-powered to a solar-powered water supply scheme financially viable?

Yes

No

1.0.2 Question: On a scale of 1 to 5, with 1 being very low and 5 being very high, how familiar are you with the concept of transforming a diesel power to solar power in water supply schemes?

1.0.3 Question: Are you aware of any potential financial incentives or grants available for transitioning to solar power?

a. Yes

b. No

1.0.4 Question: Are there ongoing operational and maintenance costs associated with the solar-powered water supply scheme, and have these been considered in the analysis?

a. Yes

b. No

1.0.5 Question: Have potential cost savings or benefits, such as reduced fuel expenses or maintenance costs, been identified as a result of the transformation?

Yes

No

1.0.6 Question: What is the estimated payback period for the initial investment in solar power for your water supply scheme?

a. Less than 5 years

b. 5-10 years

c. 10-15 years

d. 15-20 years

e. More than 20 years

1.0.7 Question: Are there potential sources of funding or financial support that could facilitate the transformation to solar power?

Yes

No

Question 08: Are there any financial risks or uncertainties associated with the transformation that may affect its financial viability?

Yes

No

Here are research questions to assess the technical feasibility of integrating solar power into the existing diesel-powered water supply scheme, along with a "Yes" or "No" response option and space for open explanations:

2.0 Technical Feasibility Assessment:

2.0.1 Question Which energy source is currently used in your water supply scheme?

a. Diesel

b. Solar

c. Other (please specify)

2.0.2 Question Have you considered transitioning from diesel power to solar power for your water supply scheme?

a. Yes

b. No

2.0.3 Question Is it technically feasible to integrate solar power into the existing diesel-powered water supply scheme?

a. Yes

b. No

2.0.4 Question: Are there specific technical obstacles or constraints that may hinder the successful integration of solar power into the existing water supply system?

a. Yes

b. No

2.0.5 Question: Do you believe that the integration of solar power would require substantial modifications or upgrades to the current water supply infrastructure?

a. Yes

b. No.

2.0.6 Question: Are there concerns related to the availability of suitable solar energy resources (sunlight) for the proposed integration in your location?

Yes

No

2.0.7 Question: Are there any regulatory or permitting challenges that may affect the technical feasibility of integrating solar power into the water supply scheme?

Yes

No

2.0.8 Question: Have there been successful examples of similar solar-diesel hybrid systems in your region or context that suggests technical feasibility?

Yes

No

2.0.9 Question: How would you rate the technical challenges in implementing solar power for your water supply scheme?

a. Very low

b. Low

c. Moderate

d. High

e. Very high

2.0.10 Question: On a scale of 1 to 5, with 1 being very unlikely and 5 being very likely, how likely are you to pursue the transformation from diesel power to solar power for your water supply scheme?

2.0.11 Question: How important is reducing carbon emissions for your water supply scheme?

a. Not important

b. Slightly important

c. Moderately important

d. Very important

e. Extremely important

Here are research questions for the analysis of the reliability and performance aspects of the proposed solar-powered water supply scheme, along with a "Yes" or "No" response option and space for open explanations:

3.0 Reliability Assessment:

3.0.1 Question: Is the proposed solar-powered water supply scheme reliable in providing a continuous and uninterrupted water supply?

Yes

No

Performance Evaluation:

3.0.2 Question: Does the solar-powered water supply scheme perform efficiently in terms of energy conversion, water flow rates, and pressure levels?

Yes

No

3.0 Technical Aspects:

3.0.3 Question: Are the solar panels and energy storage components efficient, contributing to the system's reliability and performance?

Yes

No

Economic Analysis:

3.0.4 Question: Is the solar-powered water supply scheme cost-effective in terms of initial investment, operational costs, and long-term savings?

Yes

No

User Satisfaction and Community Impact:

3.0.5. Question: Are users satisfied with the reliability and performance of the solar-powered system compared to the previous system?

Yes

No

Environmental Sustainability:

3.0.6. Question: Does the solar-powered system contribute to environmental sustainability by reducing greenhouse gas emissions and conserving energy?

Yes

No

Future Enhancement Strategies:

3.0.7. Question: Are there recommendations for improving the reliability and performance of the solar-powered water supply scheme?

Yes

No

These questions will help you gauge the technical aspects and feasibility of integrating solar power into the existing diesel-powered water supply scheme. Respondents are encouraged to provide detailed explanations to capture their technical insights and concerns effectively.