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Research Dissertation Title

ANALYSIS OF SOCIO-ECONOMIC IMPACT OF MINI- GRIDS FOR RURAL AREA DEVELOPMENT IN RWANDA.

Case of Mukungu Mini-hydropower Plant

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A Dissertation submitted in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE IN ENERGY ECONOMICS in the College of Science and Technology,

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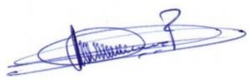
Co supervisor : Enock Chambile

November, 2021

DECLARATION

The study project reported is the results of my efforts and had never submitted in any other college or university for the same award

Student Name: **Marie Paule UWINEZA**

Signature  Date: October 22, 2021

I declare that the research project submitted was completed under my guidance

Name: **Dr. HAKIZIMANA Khan Jean de Dieu**

Signature  Date**:** October 22, 2021

DEDICATION

To Almighty God, to my husband, uncle, brothers and sisters, friends, lecturers at the University of Rwanda, college of Science and technology these works are dedicated.

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The present dissertation would not succeed without the strengths from other persons. My faithful gratitude goes to **Dr. HAKIZIMANA Khan Jean de Dieu** my supervisor for his continuous advice and his effort to transform me. I really appreciated the support and advice of other lecturers at University of Rwanda, College of science and technology especially my Co-supervisor Mr Enock Lumuliko Chambile. A special feeling of gratitude to my husband for his support and parental affection and my siblings for their tireless effort to make me who I am. Appreciation goes also to my relatives and my classmates for their inspirations and advice they gave me throughout this work. Lastly but not the least, thanks to my schoolmates for the wonderful cooperation we have had. May God bless you all.

ABSTRACT

Rwanda's hydropower sector has made a tremendous progress over the last decades. The total installed capacity of power is around 235.6 MW with hydropower contributing to 50.5 percent. Overall country's renewable energy consumption still having the low developed potentials, particularly in hydropower (300MW through micro generation but also the inter-boundary with Burundi and DRC, 145MW at Rusizi III, and with Burundi and Tanzania, 90MW at Rusumo fall), as well as geothermal between 170MW and 340MW, peat up to 1200MW, and solar 66.8Twh. The purpose of the study was to analyze the socio economic impact of that accessibility of electricity from off grid of rural area. Geographically the study was conducted in Mukungu village, Rwariro cell, Gitesi sector, Karongi District, in Western Province of Rwanda. The quantitative data were collected from 128 sampled respondents using a questionnaire. To avoid errors that can arise during data entry and minimize the time that was expected for data entry, the Computer Assisted Personal Interview (CAPI) was used. The questionnaire was developed, coded, and deployed across Kobbo toolbox server, an open-source tool for mobile data collection. The questionnaire was then deployed to the tablets of the enumerators. The study used a descriptive statistics, quantitative research design to explain, and comprehend the causal relationship between the study variables in education, health, and employment opportunities, as well as the country's power provision. Using SPSS, the dataset was analyzed and produce the output, and then the syntax has been saved for further reuse. The outcomes of the study showing that 80.5 percent of the respondents who have the access to Mukungu hydro-power plant agreed that the existence of mini-grid power plant has improved the employment sector while 87.6 percent improved the education sector. This relationship is statistically significant with Pearson Chi-Square of 13.666 and Asymptotic Significance (2-sided) of 0.000 which is lower than 0.5. The study recommends that the roadmap must be built upon by public actors (government and/or regulators) who must develop a clear and conducive policy environment that permits it to be implemented. This entails developing guidelines for the rules, conditions, and standards under which mini-grids should be developed and operated, such as licensing regimes, tariff regulation, subsidy and cross-subsidy schemes, power-purchase agreements, grid extension and integration uncertainty, environmental mandates, and access to finance.

TABLE OF CONTENTS

OPERATIONAL DEFINITIONS OF KEYS TERMS

Mini-grid: a mini-grid is a collection of small-scale electricity producers and maybe energy storage systems coupled to a distribution network that provides electricity to a small, localized group of customers while remaining independent of the national transmission system grid.

Energy Access: a household with reliable and cheap access to both clean cooking facilities and power, which is sufficient to provide a minimal bundle of energy services at first, and then gradually increases to reach the regional average.

Electrification: refers the process of replacing fossil-fuel-based technology (coal, oil, and natural gas) with energy-based systems that use electricity as a source of energy.

LIST OF ABBREVIATIONS AND ACRONYMS

DRC	: Democratic Republic of Congo
WB	: World Bank
RDB	: Rwanda Development Board
RBF	: Result Based Financing
SDGs	: Sustainable Development Goals
KPI	: Key Performance Indicators
EUCL	: Energy Utility Corporation Limited
MINECOFIN	: Ministry of Finance and Economic Planning
OBA	: Output Based Aid
MINIFRA	: Ministry of Infrastructure
UNDP	: United Nations Developments Programme
REG	: Rwanda Energy Group

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

1.1. Background of the Study

During the first decade, Technical constraints were a big stumbling block. The distribution of power was maintained local due to the modest size of the generation units and the physical limitations of transmitting electricity. Electricity demand was likewise in its infancy, with only a few services, primarily public lighting, catering to it. Furthermore, electric power systems required (and still require) a significant amount of cash. To put it another way, maximizing power generation, sales, and consequently earnings has been critical to recouping early investment expenditures (Williams, 1988).

Technology has advanced over time. Electricity could be transmitted over greater distances, and larger generators could be built (taking advantage of economies of scale) (McDonald, 2004). At the same time, demand diversified and increased, while policy and regulatory systems remained stable. Because of these factors, centralized utilities have emerged (either privately or publicly owned) (Bhattacharyya & Ohiare, 2013). Mini-grids typically merged to form the core of a larger centralized system, or they were absorbed by a larger grid system as it grew. The natural monopoly component of electricity distribution should not be underestimated, as it has had a significant impact on power system evolution.

This study investigates the impact of mini-grids on rural socioeconomic development. Focusing on mini-grids, the researchers were given various discussions on the impact of mini-grids, and the majority of them attempted to investigate the impact of mini-grids on socio-economic and renewable energy stability systems, an issue that has not been addressed in the literature. According to the World Bank (WB), mini-grids are the least-cost solution for half a billion people by 2030 (WorldBank, 2019).In fact, African countries are still facing the challenge of lacking enough electricity. This problem causes economic and productivity decline in some African countries, where the grid lines are few compared to the demand for electricity in different beneficially indicators households, social infrastructure institutions, and small businesses, especially in rural area (Olivier, 2019).

Rwanda’s hydropower sector has made a tremendous progress over the last decades. The total installed capacity of power is around 235.6 MW with hydropower contributing to 50.5 percent (REG, 2021). However, Rwanda's renewable energy consumption still having the low developed potentials, particularly in hydropower (300MW through micro generation but also the inter-boundary with Burundi and DRC, 145MW at Rusizi III, and with Burundi and Tanzania, 90MW at Rusumo fall), as well as geothermal between 170MW and 340MW, peat up to 1200MW, and solar 66.8Twh. (Manfred Hafner, 2019).

Due to the insufficient hydropower, Rwanda energy sector has planned with setting goals and targets of achieving 512MW installed capacity from 216MW power generation by empowering its power sector especially to renewable sources, where hydropower takes high generator of 46.8% of its generation; the main sources of electricity in Rwanda are Hydro-electricity, Solar, Methane gas and Biomass. The dominate source of electricity is Hydro-power with 47%, Thermal sources with 25.74%, Methane gas with 13.04%, Solar with 5.28% and Peat with 7% respectively. In addition to this Government has target of reducing biomass usage from 79.9% in 2020 to 42% in 2024 (MINIFRA, 2021).

Mini grids have emerged as a potential approach for managing local energy supply and improving electrical power system efficiency. The need to satisfy the diverse needs of end users for higher-quality power supplies, the transformation of the electric power sector, and limitations on the expansion of power transmission and distribution facilities are all reasons to consider Mini grids as viable solutions (Athila Quaresma Santos, 2018)**.** Most African governments have made a good climate on energy investments activities and different mini grids used to improve people’s standard of living through electrification and creation of job opportunities especially in productive activities in remote area (Bronckaers, 2012).

The Rwanda’s electrical system is rapidly expanding, with numerous new facilities proposed or under construction. The government of Rwanda intends to increase its grid electricity capacity to 556MW by 2024 (MINIFRA, 2021).

1.2. Problem Statement

Most African countries are still facing a challenge of the lower level of electricity access considering that the grid lines are few compared to the demand for electricity. Electricity is a basic input in production process in all different sectors. Thus, inadequate electricity supply, cause a continuing (BOP) Balance of Payment problem (Seng, 2020). It was the fact that through the Ministry of Infrastructure, government targeted 100% of electricity access by 2024 from 59.7% in 2020 (MINIFRA, 2021). The Electricity generated in Rwanda was 228.2MW in 2020, government target generation capacity of 556MW in 2024. Rwandan households have access to electricity at 54%, either connected to the national grid (39%) or through off-grid systems (15%). As the target is 100% access to electricity, a national electrification plan has been elaborated to ensure that this target is reached by 2024.

The electrification primarily reflects grid-connected users in urban areas and remains largely concentrated in the top quintile, with almost negligible coverage in the bottom 40 % of the population (Manfred Hafner, 2019).

The level of the socio-economic impact of off-grids to the society especially in remote area, qualitatively and quantitatively may change time to time depending on different factors affecting supply that is why we do not know if the expectation of increasing them in the area may be a way of satisfying and achieving the projection. (Lenz, 2017) . Benefits of electrification access of off grid to different stakeholders (schools, households, hospital the owner of mini-hydro power plant, officers) and a number of challenges to the grid, However, they fail to show the socio economic problems of off grid electricity accessibility to stakeholder in the area, and their benefits from it (Ngowi, Lennark, & Alhlgren, 2019).

Different researchers did not show both positive and negative impacts of access to electricity in rural area. Although the past researchers have explained socio-economic impact of mini grids in rural development. They did not cover the entire context of showing how these two variables are linked from one to another. Thus, the aims of this study are to analyze the socio economic impact of that accessibility of electricity from off grid of rural area. This study will use a descriptive statistics, quantitative research design to explain, and comprehend the causal relationship between the study variables in education, health, and employment opportunities, as well as the country's power provision.

1.3. Research objectives

In this research project, there are both general and specific objectives.

1.3.1. Main Objective

The main objective of this study is to analyse the socio-economic effects of mini- grid for rural areas in Rwanda. Case Study of Mukungu Mini-hydropower Plant.

1.3.2. Specific Objectives

Specifically, the study will focus on the following specific objectives:

i. To assess the contributions of mini grids to education system improvement.
ii. To assess the influence of mini grids to health services.
iii. To examine the contribution of electricity access to social status of the household.
iv. To truck the contribution of having electricity from mini-grid and improved economic sector.

1.4. Research questions

With taking into account the research objectives of the study, the below questions have been asked:

- ❖ Do mini grids contribute to education system in the village?
- ❖ How the mini grids influence of mini grids in adopting new health services in the health centres to the patients?
- ❖ Is mini grids playing a role in improving the economic status of the family member?
- ❖ Does mini-grid power play a key role social status Household member?

1.5. Scope of the study

This study will cover a small Rwandan rural area where the case study of MUKUNGU Hydropower Plant provides power supply of 16 KW to customer base that include health centers, market, offices, sector offices, schools, churches and households.

The examination findings of this study will benefit the management of Energy and water organizations, as their findings will establish whether sophisticated mini-grids are a solution of rural areas solution by accessing the electricity... Investors will also profit from the results in the research as it will identify the current pros and cons of mini-grids as a means to deepen rural development.

Finally, the study results will provide extra literature to academics that plan to analyse the socio-economic effects of mini- grids for rural areas in Rwanda.

1.6. Geographical Scope

This study will be conducted in Rwanda and does not go beyond it, one of the East African countries near the equator with a total area of 26338 km^2 and the capital city of Kigali. The data to be used will be available in West Province, Karongi District, Mutuntu Sector, Gasharu Cell, Mukungu village.

1.7. Content Scope

This research takes an emphasis on the analysis of social economic impact of Mini grid in rural areas in Rwanda. Therefore, the research considers the available methods, feasible technologies and how the rural areas in Rwanda will benefit through the access in mini-grid energy. The availability in electricity for consumption either for the households, in investments and the rest of community will ensure the development of rural area in Rwanda.

1.8. Time Scope

This research project will consider December 2018 to 2020 data which are used in relation to distribution and consumption of electricity from Mukungu hydro-power plant.

1.9. Expected outcomes of the study

Basing on the case study as representation of the whole country, the study aims at providing the socio economic impact of the mini grid access on the nation's economic growth. And also providing guidance towards planning of the improvement and development of mini grid in the country

Thus overall expected outcome of this study is the efficient and productive use of renewable energy based on mini grid because they are familiar to humans and cannot be depleted from their extraction source. Renewable energy also contributes to economic growth through the process of research and development, which can influence the use of manpower in some way to ensure that the use of renewable energy becomes the solution to the energy use problem, which is sometimes associated with the problem of storability on the case of electricity.

1.10. Significant of the study

This study will help the researcher to gain more knowledge, skills and experience of how the accessibility to the mini-grid will ensure the energy security of small community in Rwanda. Moreover, the completion of this research will permit the researcher to be graduated in the Master's Degree in Energy Economics. For the community's perspective, this research will help the community through the policy and planning of affordable and dependable electricity through use of renewable energy by mini-grids.

As a result, the community will benefit from the current study by matching their living conditions with the world of energy and environmental safety. To University, the research will provide a researcher report available to the library of the University of Rwanda and also this research will be used as references to other future researchers who wish to carryout similar study in their study area which will be helping in energy sector improvement enhance the economic development.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

This chapter describes the evaluation of the literature and the contribution of mini-grids on socio-economic development in the empirical literature review plus the review summary.

2.2. Theoretical Literature Review

This section reviews different scientific papers and reports related to the present study. From the inspiration of authors searching on Benefits and challenges to productive use of off-grid rural electrification, the case of mini-hydropower in Bulongwa - Tanzania in 2019**;** where were focused on productive use of electricity, and by applying both qualitative and quantitative approaches the analysis showed results (outcomes) both challenges and benefits; certain entrepreneurial activities and electrification access to different stakeholders (schools, households, hospital the owner of mini-hydro power plant, officers) as positive results and as challenges, the study showed the number of problems related only to operational, technical and management mainly regards the mini hydro power plant and its owner yet, they did not examine socio economic problems relations from the accessibility of electricity to stakeholder in the area, and their benefits from such energy accessibility (Ngowi, Lennark, & Alhlgren, 2019).

2.2.1. Electricity Access

The lack of access to electricity in Africa is viewed as a big stumbling block to economic development. It is estimated that about 600 million people lack access to electricity in sub-Saharan Africa (Ngowi, Lennark, & Alhlgren, 2019). In the past, energy sector investment was limited, with a slow reform where Rwanda has been implementing energy supply development either by allowing private sector on mini -grid energy investment to account for electricity poverty to the affected agents households applications, social infrastructure and productive activities in remote areas in Rwanda since mid-2006, where 1% of the rural population is connected where 70% is occupied only by Kigali city, with raise in consumption from 30 kwh per year to 100 kwh per year in 2020 (MINECOFIN, 2000) .

2.2.2. Electricity access and household

In sub-Sahara Africa, there is an extreme low electricity access of household in rural area with the range of 50-200 kwh/ capita per year and with a low level of connectivity, most household hardly use electricity at residential and productive use for income generation ((Ngowi, Lennark, & Alhlgren, 2019).

In Rwanda both urban and rural areas, household benefits to electricity access by improving their quality of life and subsistence production. According to (Lahmeyer, 2004), household occupy 5% of electricity supply access. One of Rwanda's strategies to achieve the SDGs (Sustainable development Goals) where among its top priorities is to focus on the energy sector, and the government has set a target of increasing access to electricity from 42 percent to 100 percent by 2025 by promoting the use of renewable energy (Mudaheranwa, 2010).

2.2.3. Electricity access and infrastructure development for rural area.

According to the world bank, many people live in expensive live due to the lack or unaffordable electricity which means that electricity is the key for the developments of the infrastructure which help to easy lives and making it cheap (Bank, 2018) the access to the electricity is the key driver for the economic and socio-economic development. The access to the electricity enhances the access to the modern technology (MININFRA, 2020). The above literature dramatically showcased the relationship between access to the electricity and infrastructure development mainly due to the modern technology and the innovations.

2.2.4. Electricity access and economic activities.

The electricity is considered as a driving force of economic growth in rural areas. This is due to the fact that the economic activities are mostly associated with enhanced energy sector (For instance: commerce, manufacturing, iron making, transport, hospitalization, modern agriculture and irrigation). Because the population is so young, nearly 40% of it is still in formal education, such as school, vocational training, or university. A relatively high proportion of 21 percent of the adult population in the non-electrified project villages lacks basic education, which equates to six years of primary school. In the electrified village, things are better. Only one-fourth of the population has health insurance, and only 5% live more than a 90-minute walk from the nearest health center (Nieuwenhout, 1998).

Though electric lighting has completely replaced traditional lighting sources in three out of every four connected households, the more relevant to indoor air quality electric cooking will not find significant demand or be desirable. The widespread use of electric stoves would put a strain on both local grids and MHPs. Access to infrastructure (other than health) and information remains limited or unequally distributed. Only 14 percent of the project village households own any mode of transportation, with only 13 households, or 3.5 percent, owning a motor vehicle. Radios are ubiquitous in both project and control villages. (Prahalad, 2004). Connected households possess slightly more and listen more to the radio. The development of economic activities is the key for the role that is played by electricity access hence the benefit for the population and for the entire country as well (Prahalad, 2004).

2.3. Critical Review and Research Gap identification

According to National Energy Policy, Rwanda had recognized the important role of the electricity in accelerating the development of the area by improving the living standards of the population and bringing healthy conditions and Rwanda has made a lot to speed up the access to the electricity to the community where statistics showed that 59% of the households have the access to the electricity both off and on grids by 2020 where the target were 100% in 2020 (MINIFRA, 2021). This were proving that the electricity has the remarkable impact on the socio-economic factors for the household level as well as at the country level. By the target of reaching the target of 100% electricity access, Rwanda has developed Mini-grids based on range of technology.

although the significant role of the Mini-grids on socio-economic development in rural area, there are still few to generate incredible role for everywhere around the country mainly due to the lack of the capital. And a gap in literature to explain the relationship quantitatively. That’s why the study had been conducted.

2.4. Empirical literature review

Power systems were first developed in the second half of the nineteenth century. Many sections of the world were enthralled by the prospect of electricity, and its adoption was marked by disruptive innovation. It was the outcome of a variety of factors(Westrum, 1989). Systemically endogenous were technological advances, innovation, and/or entrepreneurial drive(Hughes, 1983) Exogenous factors such as economic principles, legislative support and barriers, institutional structures, historical events, and other geographical aspects all had a part (Westrum, 1989). In numerous cases, mini-grids were a crucial beginning point for the creation of national electricity systems. Areas with a lot of socioeconomic activity were among the first to adopt. Electricity was viewed as a terrific means to increase common operations, efficiency, and profit in cities and manufacturing businesses. Pearl Street Station in New York City was the first electric utility and mini-grid. It operated a coal-fired thermal power plant that supplied electricity for lighting to approximately 80 different clients via a short direct current (DC) distribution system. (Hughes, 1983).

Small electrical generation and distribution units began to appear and operate practically concurrently in cities all over the world, from New York and Chicago in the United States of America (USA) to Godalming, London, and Berlin in Europe, and Kimberly in South Africa(Hughes, 1983) Similar systems were developed in other countries to power industrial loads, such as Sweden(Bladh, 2011).

Technical constraints were a major impediment during the first decade. Due to the small size of the generation units and the physical constraints of transmitting electricity, power distribution was kept local. Electricity demand was also in its early stages, with only a few services catering to it, primarily public lighting. Furthermore, electric power systems cost a lot of money (and still do). To put it another way, increasing power generation, sales, and thus earnings has been critical to recouping initial investment costs. These systems were designed from the start to improve load factor and economic performance, such as the rapid expansion of hydropower in eastern California in the early twentieth century(Williams, 1988).

Technology has advanced over time. Electricity could be transmitted over longer distances, and larger generators could be developed (to capitalize on economies of scale) (McDonald, 2004). At the same time, demand diversified and increased, while policy and regulatory systems remained stable. Because of these factors, centralized utilities have emerged (either privately or publicly owned) (Bhattacharyya & Ohiare, 2013). Mini-grids typically merged to form the core of a larger centralized system, or they were absorbed by a larger grid system as it grew. The natural monopoly component of electricity distribution should not be overlooked because it has had a significant impact on power systems throughout their evolution. This procedure, however, was not always simple. Isolated mini-grids with varying frequencies and voltage levels were common due to a lack of coordination. As a result, integrating them into a centralized grid proved difficult and costly. The initial and ongoing costs of connecting were simply too high to justify, particularly in sparsely populated areas with low population density (Villalobos Melendez, 2012)

Electrification procedures vary depending on the case and context, and they represent the society's technical, scientific, economic, political, and organizational resources at the time of creation. (Hughes, 1983). The historical assessment of the cases investigated reveals that electrification occurred in four loosely defined phases. Phase 1 is characterized by small creative pilot initiatives supported by new business models that demonstrate the promise of new technology. Phase 2 entails the deployment of technology to anchor customers willing to pay a premium for specific electricity services, demonstrating the economic viability and breadth of electric power applications. Phase 3 is the expansion of the mini-economic grid into larger and more frequently interconnected networks that capitalize on economies of scale and reach areas where economic opportunity encourages further development. Finally, Phase 4 is characterized by social scale-up, in which public actors intervene, regulate, and supplement the market in order to achieve electrification of the last mile.

As electrification progressed, these phases frequently occurred sequentially, with larger systems dominating smaller ones. Changes in circumstances, however, may cause these to no longer be sequential, resulting in the eventual development of interconnected grid systems. The fact that these phases previously existed in a completely Greenfield setting with no electric power system is an important distinction. These phases are still relevant today for mini-grid developments that supplement existing grid systems that typically serve only a portion of the population. Significant progress in electrification has been made in a number of countries (for example, Kenya, Rwanda, Bangladesh, Myanmar, and Sri Lanka) through economic growth or social scale-up (phases 3 and 4) of mini-grid systems rather than grid-based systems (Korkovelos, et al., 2020). Nonetheless, each phase shares some characteristics and challenges, which are discussed in greater detail in the following paragraphs.

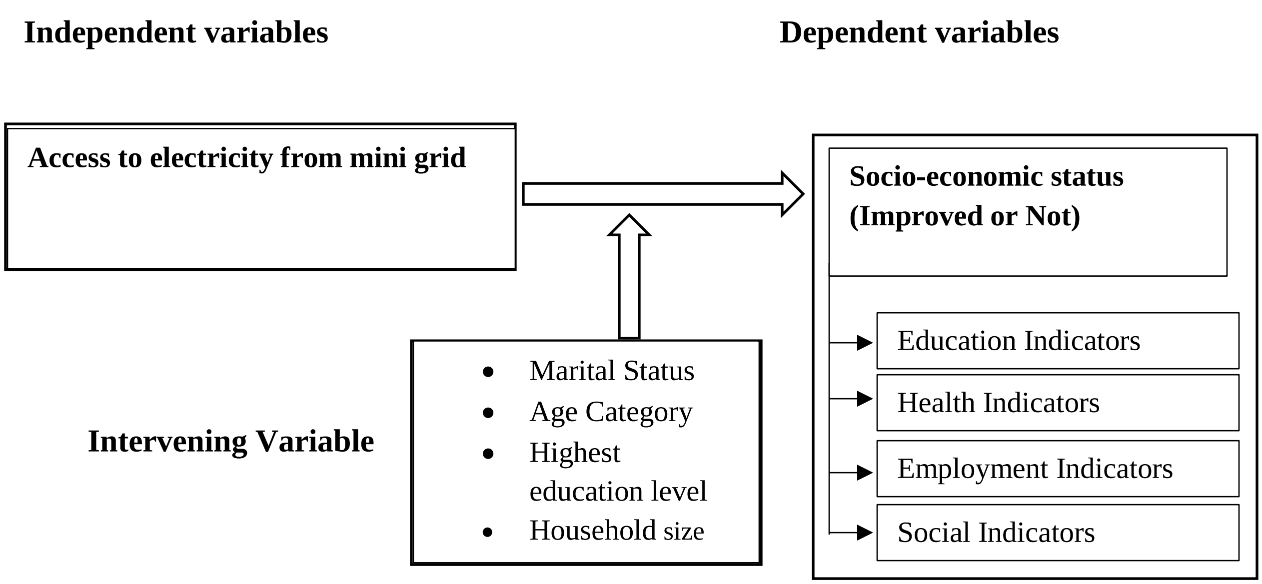
Phase1: Electrification started with small-scale test installations, or pilot projects. These were carried out by early adopters and developers who believed in the economic potential of the projects.

In 1878, arc lights illuminated sections of Chicago (Platt, 1991), Following Edison's commercialization of the light bulb in 1879, New York City developed a limited distribution and lighting network (Andersson, Batten, & Karlsson, 1989). The streets of Godalming, England, got electric lighting in 1881, thanks to a hydro-generator (Weightman, 2011). Following that, in 1882, the Pearl Street Harbour power plant in New York powered the world's first low voltage DC distribution network, which covered nearly half a square kilometer (Andersson, Batten, & Karlsson, 1989).

Phase2: technological roll out; Numerous breakthroughs and unique concepts laid the groundwork for a quick rollout of electricity-related technologies following the initial experimental era. The early systems technical characteristics (DC-based distribution, modest producing capacity), (Andersson, Batten, & Karlsson, 1989) and limited demand (for starters, illumination), (Weightman, 2011).

2.4.1. Conceptual framework

The chart below highlighted the leading variables that build up the research topic. It is made of the variables that make up the topic and how these variables are to be linked one another. Moreover, the researcher tried to develop other related variables as shown below.



Source: Author

Figure 1: Conceptual Framework

The figure 1 is scheduling the relationship between variables dependents, independent and intervening variables and how they are connected among them. The part of the independent variable is made of factors such as Provision of electricity, Development of infrastructure, Energy market availability and Development of research and development. Moreover, the part of dependent variable is made of factors such as education, Health care, social development, Household income and housing or settlement improvement.

CHAPTER 3: METHODOLOGY OF THE STUDY

3.1. Introduction

Methodology of the study is stand for the set of the principals and methods which are used to conduct the controlled study or any other type of work or research related to the mathematical, or statistical which are analyzing the data (Fred, 1986). This chapter contained the research design including the sample size and statistical methods that are used to collect, processing and analyzing data from the field and then interpretation of the results.

3.2.Data Source

To assess the socio-economic impact of mini-grid to the rural population, primary data were collected from a selected sample and analyzed. To ensure the accuracy of the analysis, both quantitative and qualitative data were collected. One of the most prominent advantages of using primary data is to provide precise and row data without any kind of dilution. Primary, the quantitative data were collected, and qualitative data were collected to a specific group of population in the sample size to supplement the quantitative data.

Though the data collection phase took during COVID-19 pandemic, the researcher avoided collecting primary data using online method to improve the quality and reliability of dataset and the study. This study also ignored any sort of secondary research methodology. This study also used qualitative data collected from specific population group for supplementing the quantitative data. This is because most of qualitative methods indulge highly interactive process, while the researcher is much focused on the statistical result than the interactive one.

Another reason why the study much focused on the use of quantitative method is that the qualitative method does not provide a single reality. It is highly subjective and it only depends on the observer’s reference. According to (Cardno, 2018), the qualitative method does not provide a basic sample from the large scale of data. On the other sight, the quantitative method used in this study was aimed to deliver accuracy on the data collection, thus it is the most fitted method. According to (Shannon & Christina, 2018), a quantitative method of data collection focuses more on life experience and perceptions. Statistic and results from quantitative method helped to provide useful information to take pinpointed decisions, establish data summary, and achieve pattern description. They also provided the reference for existing link and connection between data.

3.3.Area Coverage

In this section, area coverage outlines the geographical region or location in which the study will be conducted. Geographically the study was conducted in Mukungu village, Gasharu cell, Mutuntu sector, Karongi District, in Western Province of Rwanda; a land rocked country located in East Africa. Its political boundaries are Uganda (in North), Burundi (in South), Tanzania (in East), and Demographic Republic of Congo (in West). Rwanda has 30 districts divided into four provinces and Kigali City.

3.4.Target Population

The target population is defined as a group of potential participants to whom the researcher wants to generalize the results of the study. The population encompasses the collection of all units of the analysis for which the researcher wishes to make conclusion (Colligan & Higgins, 2005).This study based on quantitative primary data which were collected from a sample selected from two main population groups:

a) **Beneficiaries of Mukungu hydro power plant:** these are the households that have access to the electricity provided by Mukungu hydro power plant.
b) **Neighboring households:** these are the households that may not have the access to the electricity supplied by Mukungu hydro power plant, but we thought might have benefited from the plant as they reside nearby.

Furthermore, the researcher collected qualitative data which were to supplement the quantitative data. These data were extracted from the interviews given to private business operators, plant representative, representative of beneficiary school, and a representative from one health facility.

3.5.Sampling

According to Watkins, a sample is defined as a smaller set of data that a researcher chooses or selects from a larger population by using a pre-defined selection method (Watkins, 2021). During sampling, the researcher used probability sampling technique. Sample size calculation was based on Cochran formula of sample size calculation with population proportion (Cochran, W. G., 1963). Using a 95 percent confidence interval and 7.5 percent margin of error, a sample size was calculated as follows:

The sample size for this study was calculated, and the formula is:

Estimated sample size $= \frac{Z^2P(1-P)}{C^2} = \frac{(1.645)^2 * 0.5 * 0.5}{(0.075)^2}$

Estimated sample size $= \mathbf{121}$

Due to COVID-19 pandemic which we initially thought might infringe with data collection process, a 5 percent non response rate was assumed, and the final sample size was calculated.

Final sample size = $\frac{121}{0.95} = 128$

3.6.Variables of Interest

To assess the role played by mini-grids to socio-economic development in rural area, different variables were extracted from the dataset and analyzed to help the researcher answer the research questions. The demographic data were collected on the following variables.

Variable name	Variable label	Values
V01	Sex of respondent	1. Male 2. Female
V02	Marital status	1. Single 2. Married/Cohabitation 3. Divorced/Separated
V03	Highest education level attained by any household member	1. Primary 2. Secondary 3. Bachelors and above
V04	Age category of the respondent	1. Less than 18 2. 18-25 3. 25-35 4. 36-50

		5. Above 50
V05	Income category of the respondent	1. Less than RWF 30,000 2. RWF 30,001 – 100,000 3. RWF 100,001 – 300,000 4. Above 300,000
V06	Household size	Integer value

Table 1: Demographic variables

Different questions were asked concerning the role the power plant might have played in social economic development. The key variables include:

- **Employment**: Did the power plant provide job opportunity to any member of your household or neighbor?
- **Education**: Did the power plant contribute to success rate at school? (This could be either through increased revision time reserved for the pupils/students, improved infrastructure at school such as ownership and use of IT equipment, or improved infrastructure at home such as availability of internet and smartphone that can help the student to do some research).
- **Health**: did the healthcare system improved in your village due to availability of the electricity?
- **Social life**: (a) Did the power plant increased service availability in your village? (b) Did the plant contribute to the availability of street lights? (c) Did the power plant helped you acquire some appliances in your household?

Index calculation:

We calculated the proportion of respondents selecting each response and point-biserial correlations between each response on an item with the overall score on the assessment using the item-analysis of SPSS package. To calculate the overall score for this analysis; we used the same 5-category scoring method as (W. K. Adams, et All, 2006) in their psychometric evaluation of the CLASS in which the range of answers from strongly disagree to strongly agree. we reassigned a value of 1-5. In our comparison of the impact of different scoring methods, we score each assessment using both the 5-category method and the 2-category method recommended by Adams et al. (W. K. Adams, et All, 2006) in which answers of strongly disagree to N are scored as a 0 and A and strongly agree are scored as a 1.

The researcher employed multiple variables to measure the impact of mini grid hydro power plant, the composite measure of items was employed by the researcher to compute the index that is accurately measure these concepts. There are many variables that can be measured using just a single questionnaire (Babbie, 2008).

The data analysts have developed the specific techniques for calculating an index or scale for composite measures constructed from multiple questionnaire items. Indices and scales are both used frequently in terms of combining the multiple items into single informative and descriptive construct (Babbie, 2008). These composite measures are also likely to be more reliable which means that the questions must be providing the same answers within the time and valid which means that a question or construct is measuring what it is intended to measure. (Radhakrishna, 2007), and those qualities are more important for accurately measuring the impact of mini-grid to different sectors of socio-economic in rural areas.

The researcher constructed the index by combining the question's answers that are assessing the effect that mini-grids contributed to the socioeconomic factors and the questions were scored according to the level of agreement of the respondents. And each item were measured using a five-point Linkert scale (1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree, 5 = I don't know). The combined agreement score for all statements by each Extension client would then be used to represent the clients' overall agreement with the effect in socio-economic factors.

According to (Jeong HJ, Lee WC, 2016) the data has prepared to fit analysis. we first tri-chotomized the original 5-point scale of responses (1 = strongly disagree, 2 = disagree, 3 = I don't know, 4 = agree, 5 = strongly agree) by collapsing responses for 1 and 2 into a disagree category and 4 and 5 into an agree category, yielding a 3point scale: 1=disagree, 2= agree, and 3=I don't know. Then, dichotomized scale responses were generated by collapsing responses for collapsed 1 and 3 to 0=disagree and collapsed 2 to 1=agree. The rationale of changing collapsed 3 into 0 is that the percentage of participants in this group is few from the original dataset (Jeong HJ, Lee WC, 2016).

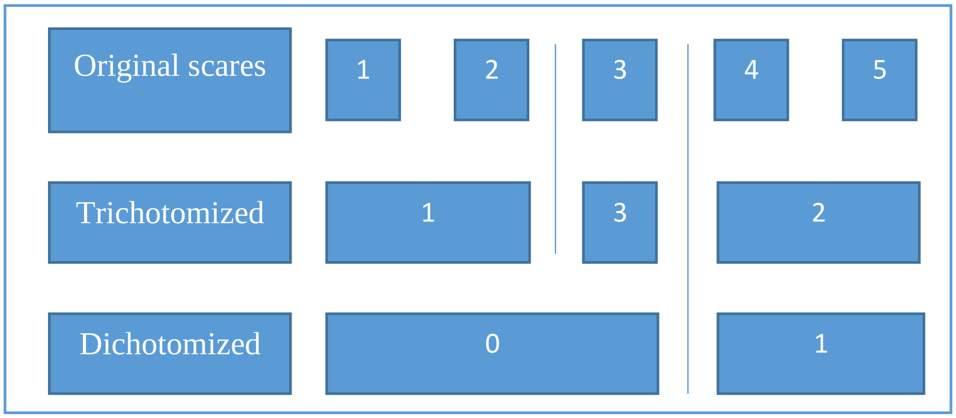


Figure 2: Scale collapsing scheme to generate trichotomized and dichotomized response data.

Validation of Index

The composite measure was computed through three steps which have to be validated by checking the validity and reliability within the internal validation. This internal validation measures how well the items are connected or joined to the index (Santos, 1999). From the Cronbach's alpha value of 70% and above is accepted.

3.7. Data collection and Data Processing

The quantitative data were collected from 128 sampled respondents using a questionnaire. Most of the questions in the questionnaire were open-ended questions which give options for respondent to choose from. Quantitative data were collected from the beneficiaries of Mukungu hydro power plant and population residing nearby. To avoid errors that can arise during data entry and minimize the time that was expected for data entry, the Computer Assisted Personal Interview (CAPI) was used. The questionnaire was developed, coded, and deployed across Kobbo toolbox server, an open-source tool for mobile data collection. The questionnaire was then deployed to the tablets of the enumerators.

The quantitative data collection was followed by data cleaning aimed to improve data quality to meet the objectives of the study. Initially, the dataset was downloaded from Kobbo server in CSV format and labels in SPSS format. The data cleaning and analysis was done using SPSS.

Unlike for quantitative method, the qualitative data were collected through interviews. The interview guides were prepared and the enumerators conducted the interviews by recording using voice recorders. The qualitative data collected were initially saved as audio files. Thereafter, the transcription of the audio files took place, followed by translation. This is because the interviews were recorded in Kinyarwanda as most of the respondent in this study do not speak English. The translation of qualitative data was followed by coding, summarizing and analysis to supplement the quantitative data analysis.

3.8. Data analysis

Different data analysis techniques were employed to examine socio-economic impact of mini grid to population in rural area. The descriptive analysis, test of association, and linear probability model were used.

3.8.1. Descriptive Analysis

The researcher conducted descriptive analysis to describe the respondents. This included describing the demographic characteristics as well as other socio-economic indicators. The descriptive analysis is meant to summarize the dataset, measure the central tendency, and variability across different variables.

3.8.2. Tests of Association

To assess the impact of mini grid on each single variable, different tests of association were conducted. The Chi-Square test was used to test the significance of statistical relationship between various socio-economic variables and the availability or use of mini grid power plant. Furthermore, the study compared the impact of mini grid across different levels such as the comparison between educated and non-educated, low-income earners and high-income earners, comparison per different marital status, and others. The student t-test (or simply t-test) will be used to test the significance between two different levels, while analysis of variance (ANOVA) will be employed for multi-levels variables.

3.8.3. Linear Probability Modal

To access the impact of the impact of Mini-Grid to the social economic factors, the linear probability model was used to shape the relationship. The linear probability model is used when the independent variable has qualitative outcome variable. The independent variable was computed from the aggregation of the employment opportunities to the household or the neighbor, success of the schools in the village, improvement of the healthcare services and the availability of the services offered in the village. The coefficients of the independent variable(s) in the model, explain the variation in the social economic variables with respect to the changes from the Mini-Grid effect.

Using SPSS, the dataset was analyzed and produce the output, and then the syntax has been saved for further reuse. During the analysis, the linear probability Model was used to capture the contribution of mini grid on socio-economic status of respondents. The following linear probability model was used.

$$\boldsymbol{logit[Y = 1] = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3}$$

Where:

$\boldsymbol{Y}$: The variable indicating the improvement in socio-economic conditions, which will be generated using composite measures for the variables of interest and called an index or scale.

$\boldsymbol{X_1}$ = Access to electrical grid

$\boldsymbol{X_2}$ = Are you employed?

$\boldsymbol{X_3}$ = The sex of respondents

$\boldsymbol{\beta_i}$: Is the effect if X_i on the odds that **Y=1** at a fixed levels of$\boldsymbol{X_j}$;

3.9.Ethical consideration

The term research Ethics refers to a wide variety of values, norms, and institutional arrangements that help constitutes and regulate scientific activities. The research ethics are the key factors that govern the research activities and have to be applied from the starting of the project until to the presentation of the research output. (Torp, 2019)

- By anonymizing the data, the rights to privacy of the individuals involved are protected.
- The nature of study involvement must be voluntary, and participants must have the option to withdraw partially or totally from the process.
- Participation is voluntary.

- The information provided by the researcher was kept confidential by the researcher.

And all other ethical considerations were taken into account.

CHAPTER 4: DATA ANALYSIS, RESULTS AND INTERPRETATION.

4.1.Introduction

This chapter provides an analysis of the study findings and presents the results obtained. This chapter presents the descriptive statistics, test of association to assess the impact of mini grid on each single variables and, correlation analysis and the interpretation of findings.

4.2.Descriptive statistics

This research was about the effect of mini-grids on socio-economic development in rural areas in the 2021, and the primary data were conducted by a researcher in the study area. During the research time, 113 respondents agreed to participate and being interviewed. The following tables are representing the output of the research:

Table 2 Descriptive Statistics.

Variables	Frequency (n)	Percent (%)
Sex		
Female	47	41.6
Male	66	58.4
Total	113	100.0
Marital status		
Divorced/separated	6	5.3
Married/cohabitation	75	66.4
Single	19	16.8
Widowed	13	11.5
Total	113	100.0
The size of your household		

1	2	1.8
2	3	2.7
3	29	25.9
4	23	20.5
5	25	22.3
6	21	18.8
7	4	3.6
8	4	3.6
9	1	.9
Total	112	100.0

Source: Primary data (2021)

The total participants of the research were 113 which are 100%. The Female participants were 41.6% and 59.4% were Male's participants. 5.3% were Divorced/Separate, with 66.4% were Married participants, where 16.8% of the respondents were Single and then 11.5% were Widowers.

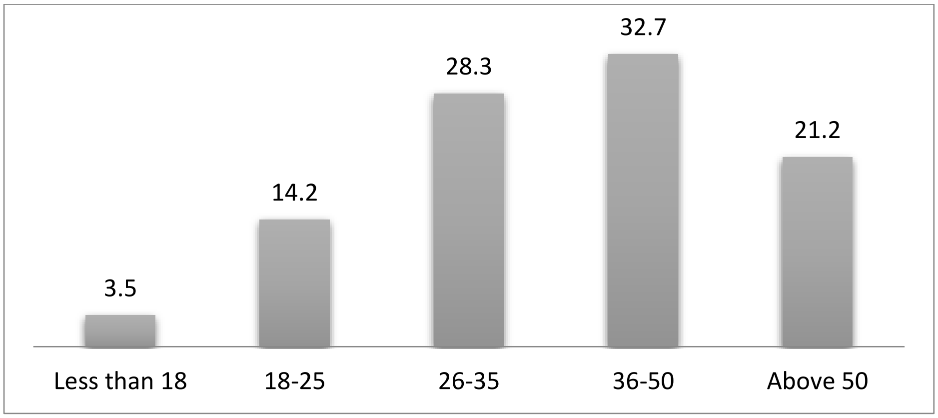


Figure 3 : The respondents' age category

About age categories, 14.2% were in age group of 18-25years, 28.3% were in age group of 26-35 years, 32.7% were in age group of 36-50, while 21.2% were belong in 50 years and above, and the small percentage of 3.5% were the participants below 18 years.

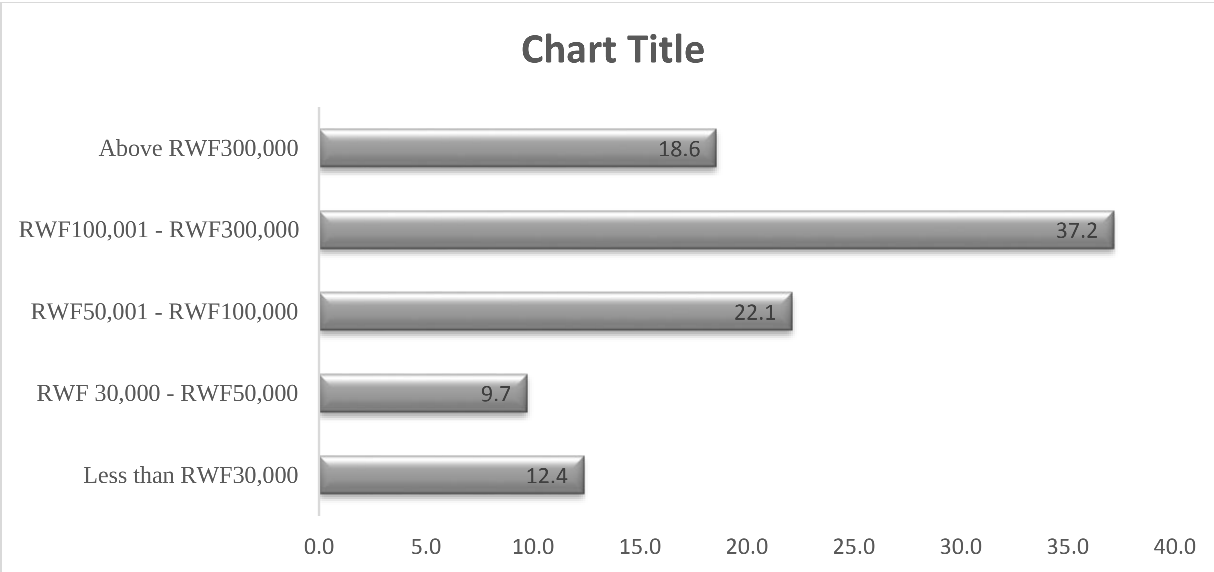


Figure 4 : The respondents ‘average monthly household income (%)

The figure 4 concerning the average monthly household revenue, 12.4% were belong to the below RWF30,000, 9.7% were belong to RWF 30,000 – RWF 50,000, 22.1% of the respondents were belonging to the range of RWF 50,000 – RWF100,000, while 37.2 % of the respondents were belong into RWF100,001 - RWF300,000, and then 18.6% of respondents were belong to the range of above RWF300,001.

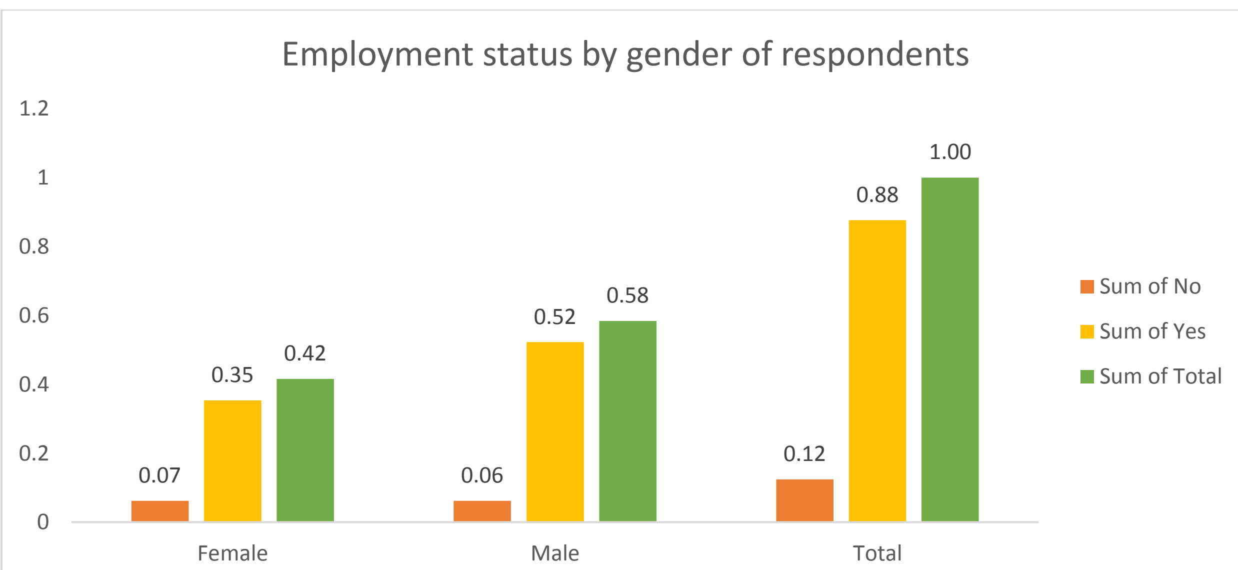


Figure 5 : Employment status by gender of respondents

The above figure 5 is showing the distribution of the respondents' employment status rendering to the sex of respondents, where among the total respondents 42% were female and 58% were male. Among the female, 35% stated that they were employed and 0.06% of the women testified that they were not employed. Their counter part of men 52% stated that they were employed and 0.06% of the sampled men testified that they were employed.

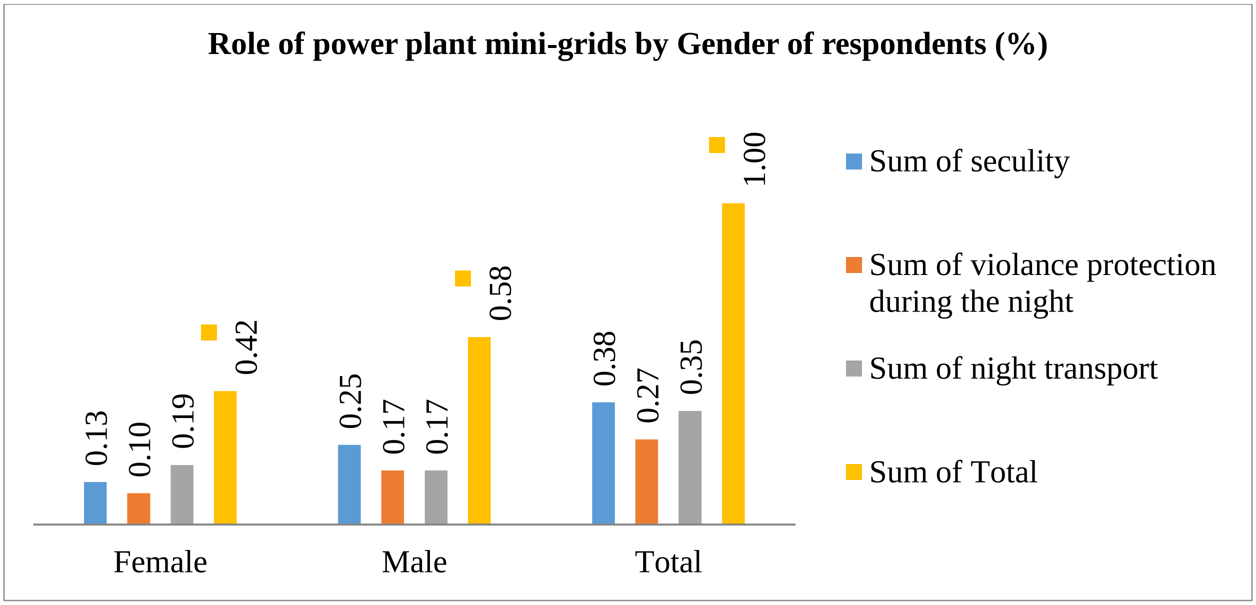


Figure 6 : Role of power plant mini-grids by Gender of respondents

The above figure 6 is showing the respondents' perceptions about the effect of existence of mini-grids on the socio security according to their sex where among the total respondents 42% were female and 58% were male. Among the female, 13% stated that the existence of the electricity increased the security in the village, 10% of the women testified that electricity increased the violence protection during the night while 19% affirmed that the night transport has increased especially for the women in time of going to the health center or to the hospitals. Their counter part of men 25% stated that the existence of the electricity increased the security in the village, 17% of the sampled men testified that electricity increased the violence protection during the night while 17% of the questioned men affirmed that the night transport has increased.

Though the education level, 39% had primary education, 31% they had secondary education 27% were Bachelor's degree holders, and then 3% were the Master's degree and above in the time of research as presented in the following chart

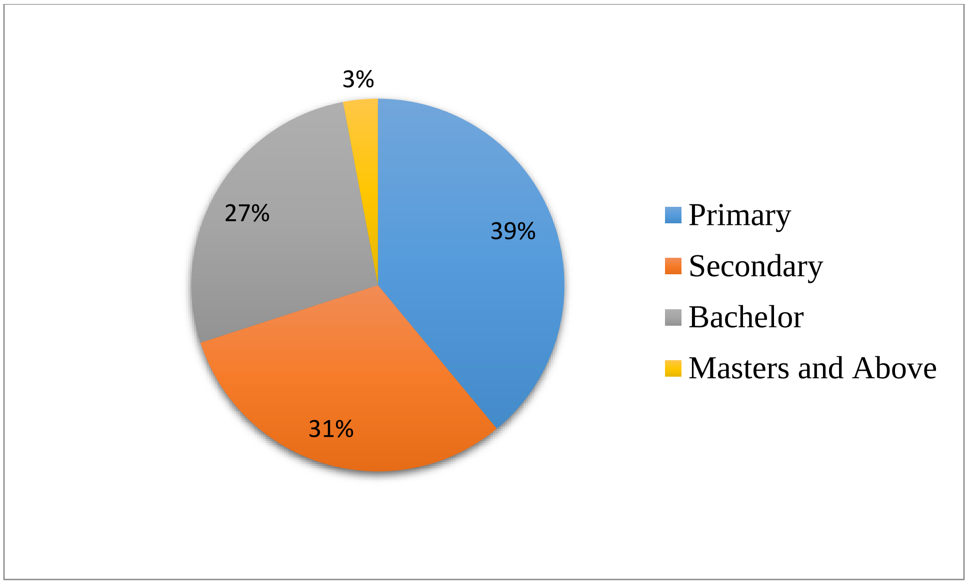


Figure 7 : The respondents 'highest education level attained

The figure 7 is representing the education level, 39% had primary education, 31% they had secondary education 27% were Bachelor's degree holders, and then 3% were the Master's degree and above in the time of research as presented in the following chart

4.3.EDUCATION SECTOR

4.3.1. The respondents's perception on the contribution of access to electricity in education sector.

To understand the effect of mini-grids on Education sector in rural areas especially in Mukungu there are some questions that the research had asked and the answers were as follow:

Table 3 is showing that 71.4% there were agreeing and 28.6% were strongly agreeing that there was any positive change observed in teaching methodology at school due to the electricity supplied from the power plant. 72.6% of the respondents were agreeing and 3.5% were strongly agreeing that the power plant leads to increase of revision time (night self-study) for pupils/students at home while 0.9% did not know about that. 87.6% were agreeing and 11.5% were strongly agreeing with the statement which said that the power plant improved the ownership/access to IT infrastructure at home that can facilitate students/pupils (eg: use of internet over smartphone or computers to make online research) while 0.9 did not know about that. 90.3% were agreeing and 8% were strongly agreeing with the statement which was saying that there was any improvement in performance of student comparing before and after introduction of Mukungu hydro power plant while 1.8% did not know.

Table 3: The respondent's perception on the contribution of access to electricity in education sector

The power plant lead to increase of revision time (night self-study) for pupils/students at home		
	Frequency	Percent
Agree	82	72.6
I don't know	1	.9
Strongly Agree	30	26.5
Total	113	100.0
The power plant improve ownership/access to IT infrastructure in schools		
	Frequency	Percent
Agree	108	95.6
I don't know	1	.9
Strongly Agree	4	3.5
Total	113	100.0
The power plant improved ownership/access to IT infrastructure at home that can facilitate students/pupils (eg: use of internet over smartphone or computers to make online research,…)		
	Frequency	Percent
Agree	99	87.6

I don't know	1	.9
Strongly Agree	13	11.5
Total	113	100.0
There any improvement in performance of student compared before and after introduction of Mukungu hydro power plant		
	Frequency	Percent
Agree	102	90.3
I don't know	2	1.8
Strongly Agree	9	8.0
Total	113	100.0

Source: Primary data (2021)

4.3.2. Education improved by the access to Mukungu hydro-power plant.

The table 4 revealed that 87.6% of the respondents who have the access to Mukungu hydro-power plant agreed that the existence of mini-grid power plant has improved the education even though 11.5% of the respondents without the access to the power also agreed that education has improved whereas only 0.9% of the respondents who do not have the access to the power have disagreed the improvement in education and this relationship is statistically significant with Pearson Chi-Square of 7.135 and Asymptotic Significance (2-sided) of 0.008 which is lower than 0.05 then conclude that there is sufficient evidence to reject null hypothesis.

Table 4: Respondents' perception on education improvement

			Access to Mukungu hydro-power plant.		
			Yes	**No**	**Total**
Education sector improved	**Disagree**	**Count**	0	1	1
		% of Total	0.0%	0.9%	0.9%
	Agree	**Count**	99	13	112
		% of Total	87.6%	11.5%	99.1%
Total		**Count**	99	14	113
		% of Total	87.6%	12.4%	100.0%

Ho (Null hypothesis): Education improvement is independent from access to Mukungu power plant.

Ha (Alternative hypothesis): Education improvement and access to Mukungu power plant are dependent.

4.4 HEALTH SECTOR

4.1.1The respondents' perception on the contribution of access to electricity on health sector

Table 5: The respondents' perception on the contribution of access to electricity on health sector

	Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**	**I don't know**
Statement	**n(%)**	**n(%)**	**n(%)**	**n(%)**	**n(%)**
The healthcare system improved service delivery due to Mukungu hydro power plant	6(5.3)	102(90.3)	4(3.5)	0(0.0)	1(0.9)
The electricity produced by Mukungu power plant lead to increased operating hours in health facilities	16(14.2)	97(85.8)	1(0.9)	0(0.0)	0(0.0)
The electricity produced by the power plant lead to increase of services delivered in health facilities	2(1.8)	106(93.8)	0(0.0)	0(0.0)	5(4.4)

Source: Primary data (2021)

To better capturing the general picture of the understanding the effect of a mini power plant on the Health sector in the rural areas, the researcher proposed the statements that the respondents had to react about and 90.3% were agreeing and 5.3% were strongly agreeing that the health care system improved service delivery due to Mukungu hydropower plant, while 3.5% disagree and 0.9% did not know. 77.9% were agreeing, 21.2% were strongly agreeing with the statement which was saying that The electricity produced by the Mukungu power plant lead to increased operating hours in health facilities, while 0.9% were disagreeing with the statement. 93.8% of the respondents were agreeing and 1.8% were strongly agreeing with the statement which is the electricity produced by the power plant lead to an increase of services delivered in health facilities while 4.4% did not know about that situation.

1.1.1. The respondents' perception on the of health sector by access to electricity

Table 6: The perceptions of respondents on improvement on health sector

			Do you have access to Mukungu hydro-power plant?		
			Yes	**No**	**Total**
Health sector improved	**Disagree**	Count	2	2	4
		% of Total	1.8%	1.8%	3.5%
	Agree	Count	97	12	109
		% of Total	85.8%	10.6%	96.5%
Total		Count	99	14	113
		% of Total	87.6%	12.4%	100.0%

Ho (Null hypothesis): Health improvement is independent from access to Mukungu power plant.

Ha (Alternative hypothesis): Health improvement and access to Mukungu power plant are dependent.

The outcomes of the study exposed that 85.8% of the respondents who have the access to Mukungu hydro-power plant agreed that the existence of mini-grid power plant has improved the health even though 1.8% of the respondents with the access to the power disagreed that health sector has improved whereas only 10.6% of the respondents who do not have the access to the power have agreed that there is improvement in health sector while 1.8% of the respondents without the access to the power disagreed that health sector has improved and this relationship is statistically significant with Pearson Chi-Square of 5.404 and Asymptotic Significance (2-sided) of 0.020 which is lower than 0.5 then conclude that there is sufficient evidence to reject null hypothesis.

1.2.ECONOMIC SECTOR

1.2.1. The perceptions of respondents on the role of access to electricity on job opportunities

Table 7: The perceptions of respondents on the role of access to electricity on job opportunities

	Strongly Agree	**Agree**	**Disagree**	**Strongly disagree**	**I don't know**
Statement	**n(%)**	**n(%)**	**n(%)**	**n(%)**	**n(%)**
The power plant provide job opportunities to any member of your household or neighbor hood	1(0.9)	102(90.3)	8(7.1)	0(0.0)	2(1.8)
There are new businesses established due to electricity produced by Mukungu hydro power plant	16(14.2)	97(85.8)	0(0.0)	0(0.0)	0(0.0)
The existing businesses improved their productivity/services due to electricity produced by Mukungu hydro power plant	6(5.3)	97(85.8)	0(0.0)	0(0.0)	10(8.8)
The electricity produced by Mukungu hydro power plant lead to increase in sales or expansion of businesses in the area	1(0.9)	98(86.7)	1(0.9)	0(0.0)	13(11.5)
The electricity produced by Mukungu hydro power plant bring modern technology in production process of business	2(1.8)	109(96.5)	0(0.0)	0(0.0)	2(1.8)
Mini grid lead to increased working hours	35(31.0)	77(68.1)	1(0.9)	0(0.0)	0(0.0)

Source: Primary data (2021)

A great part of the respondents which were about 90.3% agreed and 0.9% were strongly agreeing that the power plant provides job opportunities to any member of their households or neighborhood even though 7.1% disagree and 1.8% did not know. 85.8% of the respondents were agreeing and 14.2% were strongly agreeing that there are new businesses established due to the electricity produced by the Mukungu hydropower plant. 85.8% of the respondents were agreeing and 5.3% were strongly agreeing that the existing businesses improved their productivity/services due to electricity produced by the Mukungu hydropower plant while 8.8% of the respondents did not know about the statement's information. 86.7% of the respondents were agreeing and 0.9% was strongly agreeing that the electricity produced by the Mukungu hydropower plant lead to an increase in sales or expansion of businesses in the area however 0.9% was disagreeing with the statement and 11.5% did not know about the statement. 96.5% were agreeing and 1.8% was strongly agreeing that the electricity produced by the Mukungu hydropower plant brings modern technology in the production process of business through 1.8% did not know about the idea. 68.1% were agreeing and 31.0% were strongly agreeing that the Mini-grid lead to increased working hours even though 0.9% was disagreeing.

1.2.2. Employment and having access to Mukungu hydro-power plant

Table 8: The perceptions of respondents on having access to electricity to employment

			Do you have access to Mukungu hydro-power plant?		
			Yes	**No**	**Total**
Improved Economic sector	**Disagree**	Count	8	6	14
		% of Total	7.1%	5.3%	12.4%
	Agree	Count	91	8	99
		% of Total	80.5%	7.1%	87.6%
Total		Count	99	14	113
		% of Total	87.6%	12.4%	100.0%

Ho (Null hypothesis): Economic sector improvement is independent from access to Mukungu power plant.

Ha (Alternative hypothesis): Economic sector improvement and access to Mukungu power plant are dependent.

The outcomes of the study showing that 80.5% of the respondents who have the access to Mukungu hydro-power plant agreed that the existence of mini-grid power plant has improved their economic status even though 7.1% of the respondents with the access to the power disagreed that economic status has improved whereas only 7.1% of the respondents who do not have the access to the power have agreed that there is improvement in economic sector while 5.3% of the respondents without the access to the power disagreed that employment sector has improved and this relationship is statistically significant with Pearson Chi-Square of 13.666 and Asymptotic Significance (2-sided) of 0.000 which is lower than 0.5 then conclude that there is sufficient evidence to reject null hypothesis.

1.3.SOCIAL SECTOR

1.3.1. The respondents' perceptions on having access to electricity contribute to the social life

Table 9: The respondents' perceptions on having access to electricity contribute to the social life

	Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**	**I don't know**
Statement	**n(%)**	**n(%)**	**n(%)**	**n(%)**	**n(%)**
The electricity access help household to access to some modern equipment like telephone, iron sheet, electrical cooker equipment, refrigerator…	36 (31.9)	77(68.1)	0(0.0)	0(0.0)	0(0.0)
The power plant contributed to increased income and/or reduced expenditure in your household	6(5.3)	101(89.4)	5(4.4)	0(0.0)	1(0.9)
The power plant contributed to access to news through radio and TV in your community	39(34.5)	73(64.6)	1(0.9)	0(0.0)	0(0.0)

Source: Primary data (2021)

68.1% of the respondents agreed and 31.9% were strongly agreeing that electricity access helps the households access some modern equipment like telephone, iron sheet, electrical cooker equipment, and refrigerator. 89.4% of the respondents were agreeing and 5.3% strongly agreed that the power plant contributed to increased income and/or reduced expenditure in your household while 4.4% were disagreeing and 0.9% did not know. 64.6% of the respondents were agreeing and 34.5% were strongly agreeing that the power plant contributed to access to news through radio and TV in their community where 0.9% were Disagreeing with the statement.

1.4.Analysis of the effect of mini grid on socio economic in the rural areas

This section provides descriptive statistics and the steps involved in logistic regression model. Descriptive statistics allow the reader to get an understanding of important socio-economic characteristics and conditions of households in the study area. Moreover, it also contains information regarding the socio-economic status and the cross tabulation with the demographic indicators before the logistic regression model started. The logistic regression model identify the relationship between the socio-economic effect index computed from combining different variables which tackle the socio-economic status in the rural area under the study and the independent variables that are relevant and meaningful to the model (statistically significant).

Before computing socio-economic index, the test for reliability were conducted by putting together 8 variables in form of the questions that are found in the questionnaire which express the socio-economic factors in the rural area, and the value of Cronbach's Alpha were:

1.4.1. Reliability test statistics

Table 10: Reliability Statistics test

Cronbach's Alpha	**Variance**	**N of Items**
0.846	14.951	18

0.846 (84.6%) witch is greater than 70% with the variance of 14.951 which is good and give the green right for further steps.

The next step were to compute the socio-economic index which were computed by making the mean of the responses of the questions which were representing the socio-economic effect and then after decomposed into dichotomous variable which served as the dependent variable, the two categories are: Disagree with value 0 and Agree with values 1.

The logistic regression was adopted and forward method of adding explanatory variables to a basic model (which includes only the constant, B_0) were preferred for tracking the variables that are fitting the model. The results were in three steps with different R-squares. The additional predictor variable makes the significant improvement on the coefficient of determination (R-square) otherwise the variable removed from model.

Table 11: Classification Table a, b

Observed			Predicted		
			Socio economic index		Percentage Correct
			Disagree	Agree	
Step 0	Socio economic index	Disagree	0	15	0.0
		Agree	0	98	100.0
	Overall Percentage				86.7

a. Constant is included in the model.
b. The cut value is .500

With predictors in the model, the results above showcased that within the 86.7% of respondents who were expected to agree in their responses, have agreed.

1.4.2. Omnibus Tests of Model Coefficients

Table 12: Omnibus Tests of Model Coefficients

		Chi-square	**df**	**Sig.**
Step 1	Step	41.640	17	.0007
	Block	41.640	17	.0007
	Model	41.640	17	.0007

The significance of the model at confidence level of 95% is P-value equal to 0.0007 which is the probability of getting chi-square value of 41.640 with degree of freedom of 17 while the model is significant, and is less than the critical value of 0.001 then reject the null hypothesis which said that the model is not statistically significant and conclude that there is sufficient evidences to conclude that the model is statistically significant.

1.4.3. Model Summary

Table 13: Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	46.854[a]	.308	.568

a. Estimation terminated at iteration number 20 because maximum iterations has been reached. Final solution cannot be found.

The above Model summary table indicate the measures of goodness of the fit of the model where Nagelkerke R square is 56.8.4% which means that the variance in the dependent variable were explained by the predictors at the extent of 56.8%.

According to the investopedia.com R-Square value will depend on the context. In some fields, such as social sciences, even a relatively low R-Square such as 0.5 could be considered relatively strong (FERNANDO, 2021).

1.4.4. Variables in the equation

Table 14: Variables in the equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	Sex of Respondent(1)	.480	.928	.267	1	.605	1.616	.262	9.967
	Marital status of respondent			2.277	3	.517			
	Marital status of respondent (1)	-.567	1.725	.108	1	.742	.567	.019	16.681
	Marital status of respondent (2)	-2.650	2.116	1.568	1	.211	.071	.001	4.473
	Marital status of respondent (3)	-1.043	1.948	.287	1	.592	.352	.008	16.034
	Access to use of grid power (1)	2.505	1.102	5.167	1	.023***	12.249	1.412	106.259
	Employment status (1)	4.501	1.673	7.239	1	.007***	90.064	3.394	2389.789
	Education level			8.796	2	.012***			
	Education level(1)	3.256	1.229	7.018	1	.008***	25.940	2.333	288.459
	Education level(2)	3.957	1.460	7.348	1	.007***	52.295	2.992	914.087
	Working experience			5.056	4	.282			
	Working experience (1)	2.825	1.989	2.017	1	.156	16.867	.342	832.394
	Working experience (2)	.540	1.182	.209	1	.648	1.715	.169	17.385
	Working experience (3)	3.126	1.452	4.637	1	.310	22.790	1.324	392.251
	Working experience (4)	21.178	14952.066	.000	1	.999	15.208	0.000	
	Age category			6.138	4	.189			
	Age category (1)	-.919	3.393	.073	1	.786	.399	.001	308.199
	Age category (2)	-5.064	3.769	1.805	1	.179	.006	.000	10.218
	Age category (3)	-3.624	3.767	.926	1	.336	.027	.000	42.926
	A Age category (4)	-3.229	3.747	.743	1	.389	.040	.000	61.251

	Size of House Hold	.107	.319	.113	1	.737	1.113	.596	2.078
	Constant	-3.876	4.389	.780	1	.377	.021		
a. Variable(s) entered on step 1: SEX1, MARTALSTATUS1, ACCESS_POWER, EMPLOYMENT, Education level, WORKING_EXPER1, AGECATEGORY1, SIZE_HH.									

****: showing that the variable is statistically significant at 95% of Confidence Level.*

We start off by discussing the results from outputs of the model provide information about the general objective of the study which what we can expect and we have interpreted the variables which were statistically significant (***). The odds ratio estimate in Table above is showing that the person who has the Access to the use of grid power is more likely to have improved socio-economic status than who do not have the access with the odd ratio of 12.249 and is statistically significant with sign value of 0.023 less than α= 0.05.

The person who is Employed is more likely to have improved socio-economic status than who is not employed with the odd ratio of 90.064 and is statistically significant with sign value of 0.007 less than α= 0.05.

The person who is educated at secondary level is more likely to have improved socio economic status than who has educated at primary level with the odd ratio of 25.940 and it is statistically significant with a sign value of 0.008 less than α=0.05.

The person who is educated at bachelor level and above is more likely to have improved socio economic status than who has educated at primary level with the odd ratio of 52.295 and it is statistically significant with a sign value of 0.007 less than α= 0.05.

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1.Introduction

This section shows the short form of results from study about the socio-economic effects of mini-grid for rural areas in Rwanda. Case Study: Mukungu Mini-hydropower Plant., measures and suggestions are taken. It is made up of summary from findings, ending remarks, recommendations and fields for more researches.

5.2. Summary of findings

This part details the enquiry discoveries on each objective and the inhabitant situation of participants to the research has good impact on results. The total participants of the research were 113 which are 100%. The Female participants were 41.6% and 58.4% were Males participants. The highest participant's age category was in age group of 36-50 with 21.2% while their highest average monthly income relies from RWF100, 001 up to RWF300, 000 with 37.2 %.

The researcher constructed the index by combining the question's answers that are assessing the effect that mini-grids contributed to the socioeconomic factors and the questions were scored according to the level of agreement of the respondents. And each item were measured using a five-point Linkert scale (1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree, 5 = I don't know). The combined agreement score for all statements by each Extension client would then be used to represent the clients' overall agreement with the effect in socio-economic factors.
Analysis of the effect of mini grid on socio economic in the rural areas contains the information regarding the socio-economic status and the cross tabulation with the demographic indicators before the logistic regression model started. The logistic regression model identify the relationship between the socio-economic effect index computed from combining different variables which tackle the socio-economic status in the rural area under the study and the independent variables that are relevant and meaningful to the model.

The outcomes of the study showing that 87.6% of the respondents who have the access to Mukungu hydro-power plant agreed that the existence of mini-grid power plant has improved the employment sector while 87.6% improved the education sector. This relationship is statistically significant with Pearson Chi-Square of 13.666 and Asymptotic Significance (2-sided) of 0.000 which is lower than 0.5 then, we conclude that there is sufficient evidence to reject null hypothesis.

A great part of the respondents which were about 90.3% agreed that the power plant provides job opportunities to any member of their households or neighborhood after having the access to electricity while 85.8% of the respondents were agreeing that the existing businesses improved their productivity/services due to electricity produced by the Mukungu hydropower plant. Meanwhile, 96.5% were agreeing that the electricity produced by the Mukungu hydropower plant brings them the modern technologies in the production process of business and also 68.1% were agreeing that the working hours have been increased respectively.

The significance of the model at confidence level of 95% is P-value equal to 0.000 which is the probability of getting chi-square value of 17.902 with degree of freedom of 3 while the model is significant, and is less than the critical value of 0.001 then reject the null hypothesis which said that the model is not statistically significant and conclude that there is sufficient evidences to conclude that the model is statistically significant. The odds ratio estimate in our model is 10.908, which is statistically significant with sign value of 0.023 less than $\alpha = 0.05$, for the Access to the mini-grids hydropower which means that holding those who have the access to the power plant are more likely to Agree that there is an effect of mini-grids to the socio-economic factors in rural areas.

5.3.Conclusion

The case study of Mukungu Mini-hydropower Plant provided a comprehensive understanding of the socio-economic implications of mini-grids in rural Rwanda. According to the findings, mini-grids have a significant positive socio-economic influence on Rwandan rural development. Despite recent progress, ubiquitous electrification is still a major issue in many countries today. Decentralized electrification, particularly mini-grids, has been gaining traction as part of the solution in the electricity sector.

Despite their potential, including them in electrification planning initiatives raises the risk of failure because new actors, business models, technical standards, and regulations must be amended or built from the ground up. We looked at the history of electrification in this essay to understand what makes mini-grids such a viable electrification solution. According to our research, mini-grids have always been a part of power infrastructure in many countries. Their expansion was gradual, owing to a mix of local demand, available technology, and existing legislation. In a number of geographical and socio-political circumstances, mini-grids fulfilled a variety of functions. In many countries, mini-grids have played a role in the development of today's modern electricity grid, with some succeeding and others failing.

Our findings, which are based on previous experience, confirm that mini-grids can play a critical role in achieving universal energy access today. However, it is vital that all parties (e.g., developers, government, regulators, planners, investors, and aid) participating in the creation of contemporary mini-grids have a clear and supportive regulatory framework, particularly with regard to all stakeholders' roles, duties, and obligations (e.g., developers, government, regulators, planners, investors, and aid).

My research shows that by promoting innovation and developing locally relevant mini-grid business models, the private sector may play a substantial role in accelerating deployment and lowering societal costs for obtaining universal access to electricity. However, relying entirely on the private sector to offer universal energy access will eventually result in subsidies and cross-subsidies at multiple levels.

That is, the government's participation is vital in providing needed financial support, assuring consumer safety, and ensuring equity and inclusion in areas where the private sector cannot reach. Foreign help and a social scale-up method are also required in some places where neither private investors nor public utilities can provide quick assistance. Finally, we believe that the historical review and retrospective analysis offered in this work will assist to better inform policies aimed at guaranteeing universal access to affordable, dependable, and contemporary energy services for all.

5.4.Recommendations of the study

First, while historical analogies might help shed light on policy issues, it's worth noting that today's energy access challenges are strikingly similar to those of the past. To begin with, the population of today's un-electrified people is concentrated in low-income rural areas. In contrast to most past periods of electrification, when expanding energy consumption was concentrated in industrial and urban areas with wealthy clients, this is a significant change. In truth, there was enormous unmet demand and a population wanting power in rural, low-income areas even in the past, but these were often disregarded in favor of urban, wealthier customers, as is the case now.

Second, electrification takes place within existing centralized grid systems, with grid and mini-grid competition driven by economics, location, demand, institutional structure, and other variables. Un-electrified areas with a high population density can now bypass or skip separate power systems, which were frequent in early power systems around the turn of the century. On the other hand, centralized systems aren't always the ideal choice. Some areas are suitable for the centralized grid to grow into, while others may prefer decentralized alternatives (based on population density, demand, resources, and distance from grid among others).

Third, the distinction between centralized and mini-grid systems does not hold up over time. Mini-grids may be cost-effective in some locations right now, but in the long run, a centralized grid may be preferable. It's also likely that areas that would benefit the most from grid connectivity would not be able to get it in time, making mini-grids a potential intermediate solution. Mini-grids, on the other hand, may (and already are) becoming competitive even within a linked grid, and can be used as backup power sources in areas where grids are weak and unreliable. In addition, customized legislation may make grid extension versus mini-grid building more financially advantageous to private players and consumers.

Fourth, technology has progressed to the point where it is technically and financially viable in a range of scenarios. Mini-grids nowadays are available with a variety of AC and DC transmission options, as well as a variety of primary energy sources (oil, biomass, hydro, wind, solar, hydrogen, or hybrids among others) Businesses can utilize monitoring systems to acquire massive volumes of data about how their systems are used, allowing them to improve their business models and technology solutions.

Finally, smart grids have increased their efficiency by enhancing automation and communication between supply and demand-side technology.

Regardless of the setting, the researcher believes that reading history exposes a few key signals that can help better integrate mini-grids into current planning efforts aimed at universal power access. The following are some of them:

1. Community involvement and a sense of ownership, particularly in rural regions, can help to improve mini-grid functionality over time. This may demand participatory governance approaches and/or an open discussion regarding critical design and operational features such as construction, maintenance, expansion, and tariffs, among other things. In addition, it is self-evident that end users should be excited to obtain electricity and understand the cost-benefit ratio. The challenge is doing so for the vast number of communities that would benefit from mini-grids in order to accomplish SDG7, especially because such processes can be time-consuming and labor-intensive.
2. Mini-grids should be constructed for both economic and engineering success, independent of their form or scale. That is, they should be constructed around technologies that make the most use of existing local resources, ensure long-term supply chains, and consider local specificities and desires, all of which contribute to profitability and competitiveness. For mini-grids, it is advised that productive anchor loads be prioritized first. Increasing the productivity and revenues of local economic activity motivates both mini-grid developers and end-users alike. Simultaneously, economic expansion encourages further socio-economic activity in the surrounding area, potentially leading to new clients and diversification of the business model over time.

Finally, there is no "one-size-fits-all" option for successful mini-grid deployment. Legislation, public vs. private ownership, and regulated monopolies vs. free markets could all have an impact on best practices. According to this premise, planning authorities must develop electrification master plans that clearly define the role of mini-grids in providing universal energy access, quantify their contribution to the electrification mix to the extent possible, and lay out a roadmap for their integration into the country's/energy region's system planning.

Public actors (government and/or regulators) must build on this roadmap by developing a clear and favorable policy environment that allows it to be implemented. This includes developing guidelines for the rules, conditions, and standards under which mini-grids should be developed and operated, such as licensing regimes, tariff regulation, subsidy and cross-subsidy schemes, power-purchase agreements, grid extension and integration uncertainty, environmental mandates, and access to finance (for example, grants, no-interest loans, impact investment funds, output based aid (OBA), or result based financing (RBF), to name a few examples.

5.5.Areas for further studies

This study took place in Rwanda's Western Province, in Mukungu village, Rwariro cell, Gitesi sector, Karongi District.

i. As a result, it is advised that a similar study be carried out in other parts of the country where mini-grids are present.

ii. Further research into the effectiveness and efficiency of access to power in rural areas should be conducted, according to the report. The study also recommended that more research be conducted on the tactics used to ensure efficient electricity distribution in rural areas.

iii. More research on government intervention and development partners in implementing construction projects of idle resources that can generate power in Rwanda is recommended.

iv. It is also suggested that further research can be conducted on understanding of the impact foreigner aids have on local community during implementation of construction projects across the diverse communities in Rwanda.

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APPENDICES

APPENDIX I: CONSNT LETTER

University of Rwanda

College of Science and Technology

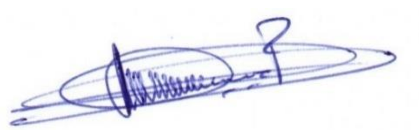
Dear all

REF: CONSENT LETTER

I am **Marie Paule UWINEZA,** a master's student at University of Rwanda, College of Science and Technology. I am currently conducting a research for the Masters of Science in Energy Economics degree. The research objective is to assess **the socio-economic impact of mini- grid for rural areas in Rwanda. Case Study of Mukungu Mini-hydropower Plant**. I kindly request you to participate in this study by honestly and accurately responding to all items in data collection materials. The information you provide will be used for the purposes of the research and will be held in strict confidence. You may ask the researcher to inform you about the findings of the study.

Thank you very much for participating in this study.

Yours faithfully,



Marie Paule UWINEZA

MSc Student at University of Rwanda

APPENDIX II: QUESTIONNAIRE FOR RESPONDENTS

Socio-economic impacts of mini-grid for rural areas in Rwanda. Case Study: Mukungu Mini-hydropower Plant.

Hello!

My name is Marie Paule Uwineza, Masters Student in Energy Economics at University of Rwanda. I'm currently conducting a survey on socio-economic impacts of mini-grids to rural population, with case study of Mukungu hydro-power plant. You have been randomly selected to voluntarily participate in this survey. You may refuse to take part in the survey or exit the survey at any time. You are free to decline to answer any particular question you do not wish to answer for any reason.

Do you consent to participate in this survey?

Yes

No

Section A: Demographic information

1. Sex

1. Female

2. Male

2. Marital Status

Single

Married/cohabitation

Divorced/separated

Widowed

3. Age category of the respondent

Less than 18

18-25

26-35

36-50

Above 50

4. What is the size of your household?

5. What is your highest education level attained?

Primary

Secondary

Bachelor

Master and above

6. Are you a beneficiary of Mukungu hydro power plant?

Yes

No

7. Are you employed?

Yes

No

8. Choose your employment sector

Agriculture

Self employed

Public servant

Employed in private sector

Retired

Student

Other (specify)

9. What is your working experience?

1. Less than 1 year

2.1-2 years

3.2-3 years

4.3-5 years

5. More than 5 years

10. What is the average monthly household revenue?

Less than RWF30, 000

RWF 30,000 - RWF50, 000

RWF50, 001 - RWF100, 000

RWF100, 001 - RWF300, 000

Above RWF300, 000

Section B: Socio-economic impact of Mini – Grid

Using a 4 point Linkert scale, indicate your level of agreement with the following statements relating to the assessment of the impacts of mini grids to social and economic conditions in rural area, case of Mukungu hydro power plant project.

1. Do you have access to Mukungu hydro-power plant?

Yes

No

2. In your opinion, did the mini grid improve the local productivity?

1. Strongly Disagree
2. Disagree
3. Agree
4. Strongly Agree
5. I don't know

3. Did the power plant increase the number of households, businesses, and community connected to electricity?

1. Strongly Disagree
2. Disagree
3. Agree

4. Strongly Agree
5. I don’t know

4. Did the power plant contributed to increased income and/or reduced expenditure in your household?

1. Strongly Disagree
2. Disagree
3. Agree
4. Strongly Agree
5. I don’t know

5. Did the power plant contributed to increase of street lights?

1. Yes

2. No

6. How did the power plant contribute to access to news through radio and TV in your community?

1. Strongly Disagree
2. Disagree
3. Agree
4. Strongly Agree
5. I don’t know

7. Did the power plant provide job opportunities to any member of your household or neighborhoods?

1. Strongly Disagree
2. Disagree
3. Agree
4. Strongly Agree
5. I don’t know

8. Are there new businesses established due to electricity access from Mukungu hydro power plant?

1. Strongly Disagree
2. Disagree
3. Agree
4. Strongly Agree
5. I don’t know

9. Did the existing businesses improve their productivity/services due to electricity access from Mukungu hydro power plant?

1. Strongly Disagree
2. Disagree
3. Agree
4. Strongly Agree
5. I don't know

10. Did electricity access from Mukungu hydro power plant lead to increase in sales or expansion of businesses in the area?

1. Strongly Disagree
2. Disagree
3. Agree
4. Strongly Agree
5. I don't know

11. Did electricity access hydro power plant bring modern technology in production process of business?

1. Strongly Disagree
2. Disagree
3. Agree
4. Strongly Agree
5. I don't know

12. Did electricity access lead to increased working hours?

1. Strongly Disagree
2. Disagree
3. Agree
4. Strongly Agree
5. I don't know

13. The electricity access help household to access to some modern equipment like telephone, iron sheet, electrical cooker equipment, refrigerator…

1. Strongly Disagree
2. Disagree
3. Agree
4. Strongly Agree
5. I don't know

Section C: Impact in education sector

Using a 4 point Linkert scale, indicate your level of agreement with the following statements relating to the assessment of the impacts of mini grids to education sector in rural area, case of Mukungu hydro power plant project.

1. Did the power plant lead to increase of revision time (night self-study) for pupils/students at home?

1. Strongly Disagree
2. Disagree
3. Agree
4. Strongly Agree
5. I don't know

2. Did the power plant improve ownership/access to IT infrastructure in schools?

1. Strongly Disagree
2. Disagree
3. Agree
4. Strongly Agree
5. I don't know

3. Did the power plant improve ownership/access to IT infrastructure at home that can facilitate students/pupils? (eg: use of internet over smartphone or computers to make online research,…)

1. Strongly Disagree
2. Disagree
3. Agree
4. Strongly Agree
5. I don't know

4. Is there any improvement in performance of student compared before and after introduction of Mukungu hydro power plant?

1. Strongly Disagree
2. Disagree
3. Agree
4. Strongly Agree
5. I don't know

Section D: Impact in health sector

Using a 4 point Linkert scale, indicate your level of agreement with the following statements relating to the assessment of the impacts of mini grids to health sector in rural area, case of Mukungu hydro power plant project.

1. Did the healthcare system improved service delivery due to electricity hydro power plant?

1. Strongly Disagree
2. Disagree
3. Agree
4. Strongly Agree
5. I don't know

2. Did electricity power plant lead to increased operating hours in health facilities?

1. Strongly Disagree
2. Disagree
3. Agree
4. Strongly Agree
5. I don't know

3. Did the electricity plant lead to increase of services delivered in health facilities?

1. Strongly Disagree
2. Disagree
3. Agree
4. Strongly Agree
5. I don't know

Section E: Challenges concerning to electricity access

1. Does the generation supplied satisfy electricity demand in your community?

1. Strongly Disagree
2. Disagree
3. Agree
4. Strongly Agree
5. I don't know

2. How expansive is it to acquire electricity of Mukungu hydro power plant?

1. Much expensive

2. Less expensive

3. Not expensive

3. What are the barriers that hinder the access to Mukungu plant electricity? (Identify at least 2)

……………………………………………………………..

…………………………………………………………..

……………………………………………………………..

4. In your opinion, what can be done to increase the contribution of Mukungu hydro power plant in your village?

……….

APPENDIX III: DATA COLLECTION RECOMMENDATION LETTER.

UNIVERSITY of RWANDA College of Science and Technology

ACE-ESD AFRICAN CENTER OF EXCELLENCE IN ENERGY FOR SUSTAINABLE DEVELOPMENT

Kigali,11th / August/2021

MUTUNTU SECTOR
RECEPTION
Date: 13./10./2021
Signature:

To Whom It May Concern

Dear Sir/Madam,

RE: <u>Data Collection Recommendation Letter for Research –Academic use only</u>

This is to certify that **Mrs. Uwineza Marie Paule** enrollment №: **220000142** is our Masters student at the African Center of Excellence in Energy for Sustainable Development (ACE-ESD) hosted by College of Science and Technology-University of Rwanda (CST-UR). She is pursuing Masters of Science in Energy Economics. As part of her graduation requirements, she is conducting research titled "Analysis of social economic effects of Mini-Grid for Rural Area" under supervision of Dr.Hakizimana Jean De Dieu.

She needs to collect primary data from your organization/institution/company/plant for her research project, strictly for academic purposes. We highly request your assistance in this regard. Please do not hesitate to contact us for any clarification needed.

Your cooperation will be highly appreciated.

Sincerely,

Dr. Charles Kabiri

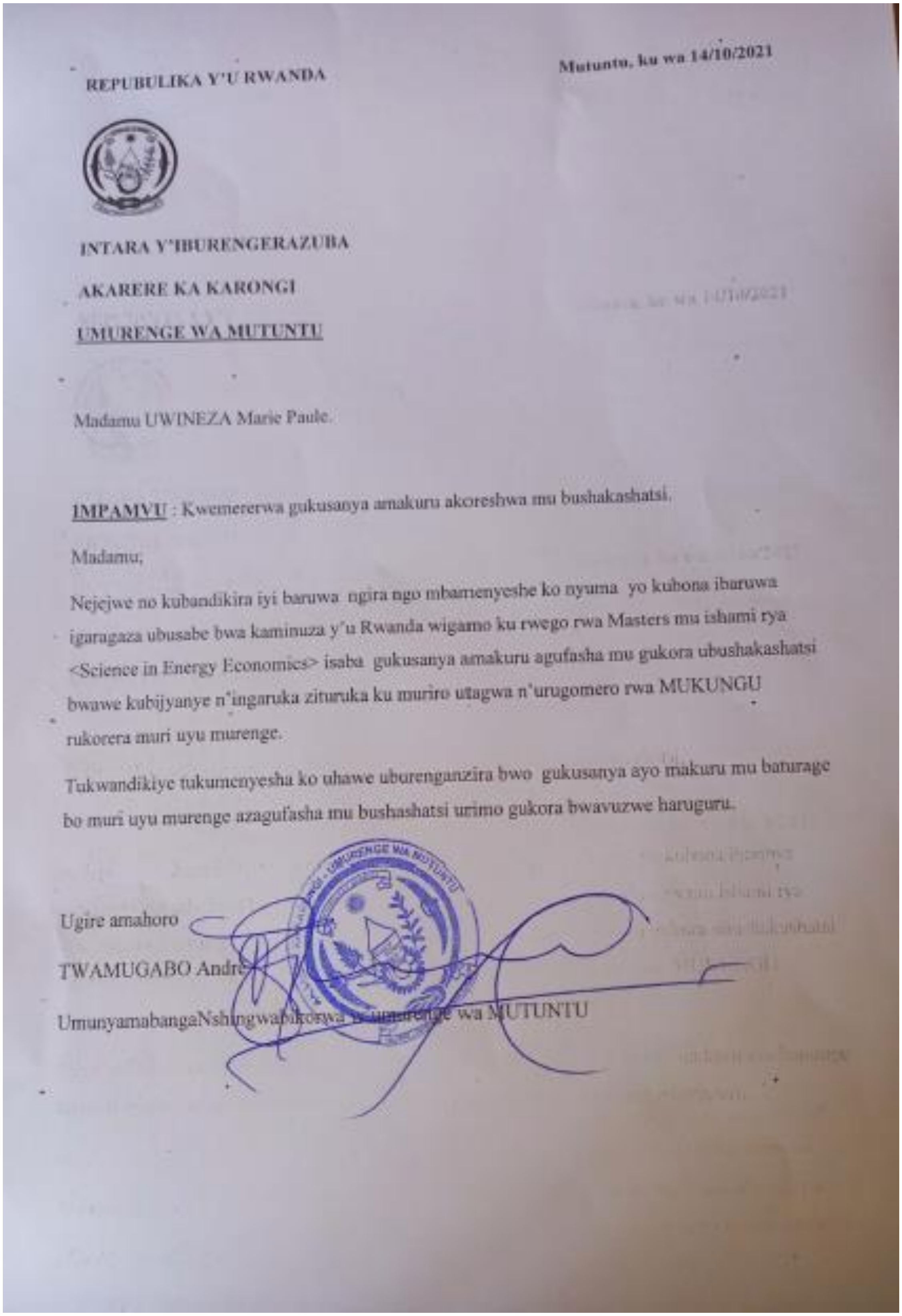
Ag. Center Director (ACE-ESD)

c.kabiri@ur.ac.rw

P.O. Box 4285 Kigali, Rwanda

Website: www.aceesd.ur.ac.rw

APPENDIX III: AUTORIZATION LETTER FROM LOCAL GOVERNMENT FOR DATA COLLECTION ACTIVITIES.



REPUBULIKA Y'U RWANDA

Mutuntu, ku wa 14/10/2021

INTARA Y'IBURENGERAZUBA

AKARERE KA KARONGI

UMURENGE WA MUTUNTU

Madamu UWINEZA Marie Paule.

IMPAMVU : Kwemererwa gukusanya amakuru akoreshwa mu bushakashatsi.

Madamu,

Nejejwe no kubandikira iyi baruwa ngira ngo mbamenyeshe ko nyuma yo kubona ibaruwa igaragaza ubusabe bwa kaminuza y'u Rwanda wigamo ku rwego rwa Masters mu ishami rya <Science in Energy Economics> isaba gukusanya amakuru agufasha mu gukora ubushakashatsi bwawe kubijyanye n'ingaruka ziturukaku muriro utagwa n'urugomero rwa MUKUNGU rukorera muri uyu murenge.

Tukwandikiye tukumenyesha ko uhawe uburenganzira bwo gukusanya ayo makuru mu baturage bo muri uyu murenge azagufasha mu bushashatsi urimo gukora bwavuzwe haruguru.

Ugire amahoro

TWAMUGABO André

UmunyamabangaNshingwabikorwa w'Umurenge wa MUTUNTU