

**UNIVERSITY OF GHANA
COLLEGE OF HUMANITIES**

**ASSESSMENT OF THE USE OF LIQUEFIED PETROLEUM GAS (LPG) AS A
COOKING ENERGY SOURCE AMONG HOUSEHOLDS IN THE WA
MUNICIPALITY, GHANA**



INSTITUTE OF STATISTICAL, SOCIAL AND ECONOMIC RESEARCH

JANUARY 2023

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MUNICIPALITY, GHANA**

BY

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**THIS DISSERTATION IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON
IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF M.A IN
DEVELOPMENT STUDIES DEGREE.**


INSTITUTE OF STATISTICAL, SOCIAL AND ECONOMIC RESEARCH

INTEGRI PROCEDAMUS

JANUARY 2023

DECLARATION

This thesis is my independent work produced from research undertaken under supervision and submitted in partial requirement for an award of a Master of Arts in Development Studies degree and does not contain materials previously published by any other person or group of persons towards the award of a degree except where due acknowledgment has been made.

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Signature..... DATE
DR. ABA OBRUMAH CRENTSIL DATE
(SUPERVISOR)



DEDICATION

I dedicate this work to my parents Mr. and Mrs. Nibenang and my siblings Mabel and Millicent for their unwavering support and love.



ACKNOWLEDGEMENT

I am thankful to God for journeying with me through this phase of my academic endeavor. I am extremely grateful to my supervisor, Dr. Aba O. Crentsil, who guided and supported me during the entire study. This research would not have been possible without her professional and intellectual contributions. My sincere appreciation goes to Dr. Kofi Takyi Asante and Dr. Simon Bawakyillenuo for their encouragement and continuous show of interest in the progress of my work. Furthermore, my heartfelt thanks to Basil Tungbani who constantly availed himself to my aid, and gave insightful advice on how to proceed with the study. Finally, I acknowledge the efforts and unwavering support of my friends; Modesta Abungba, Robert Ansuura Bapuli, Pascal Nibenang, Prosper Gbiengu, Prince Henry Nibenang, Emmanuel Samba, and Selorm Segbedzi for their contribution to the success of this dissertation.



ABSTRACT

The persistent use of traditional cooking fuels in many developing countries, including Ghana, poses significant health and environmental concerns. More than half of households in Ghana rely on biomass as their primary cooking fuel. Although the government of Ghana launched the National LPG Promotion Campaign to increase access to cleaner cooking fuels, adoption rates have been slow, particularly in the Wa municipality where households continue to practice fuel stacking. Therefore, the study sought to assess the dynamics in the adoption and use of LPG as an energy source for cooking among households within the Municipality.

A total of 220 households within three selected communities in the study area were sampled to take part in the study survey. Furthermore, key informant interviews were conducted with relevant stakeholders to gain an in-depth understanding of the quantitative data analysis. The findings reveal that most LPG users in the study area adopted the fuel as a secondary cooking fuel. Additionally, fuel stacking was widespread with households using both traditional and modern fuels simultaneously, indicating a non-linear transition in fuel use. A chi-square test of association and a binary logistic regression model further showed a significant relationship between the use of LPG and some selected sociodemographic characteristics of households within the study area.

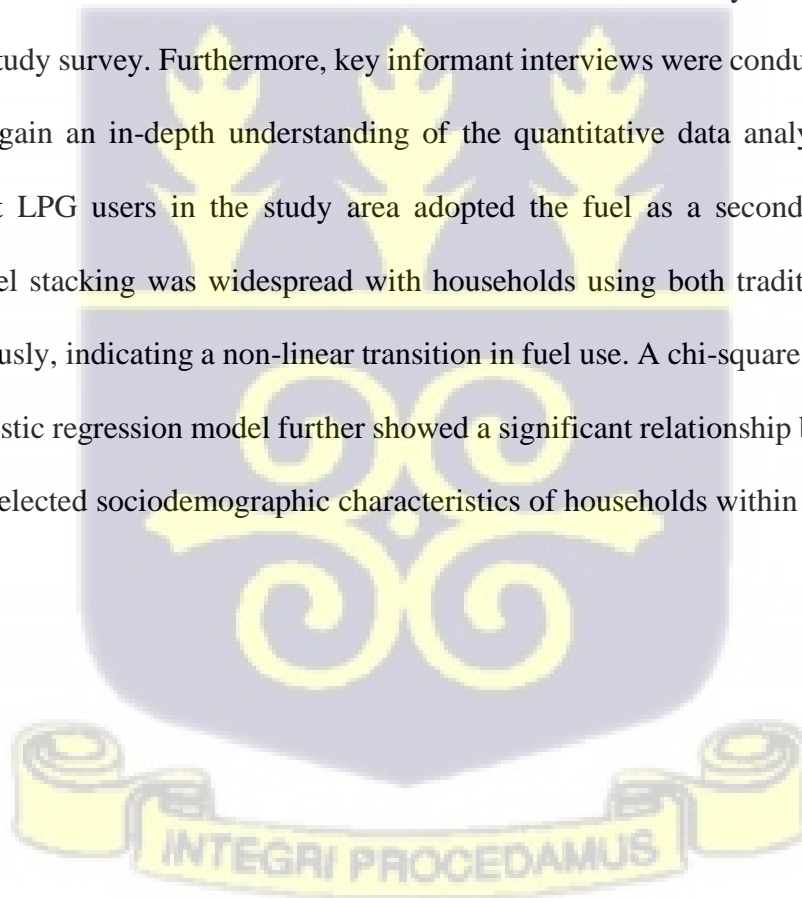
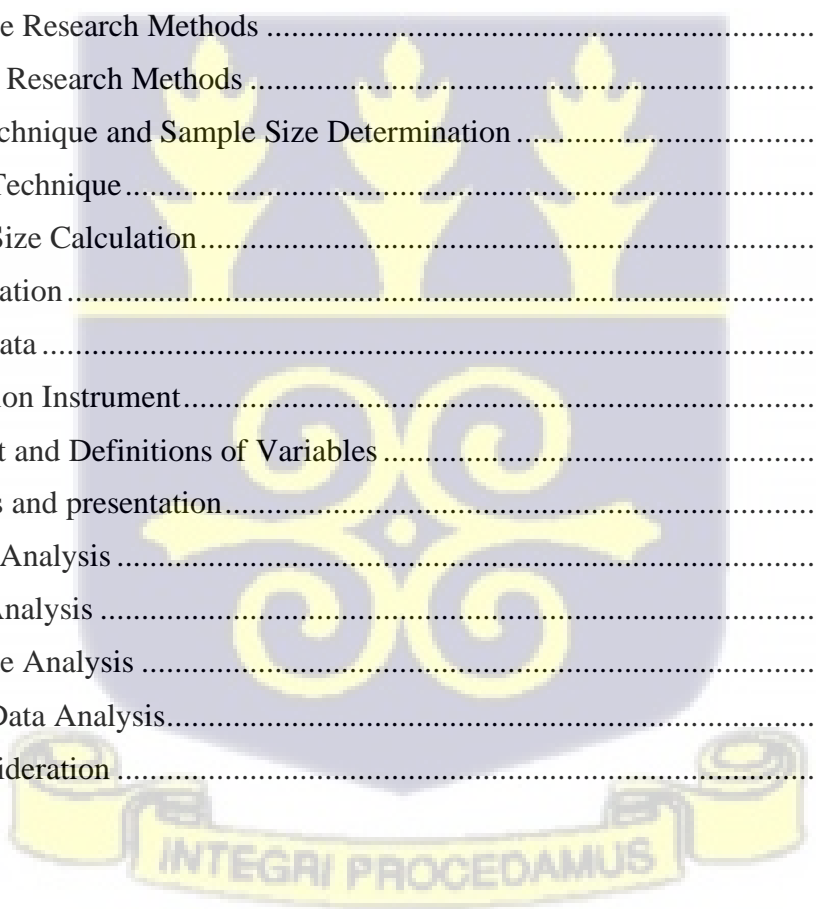


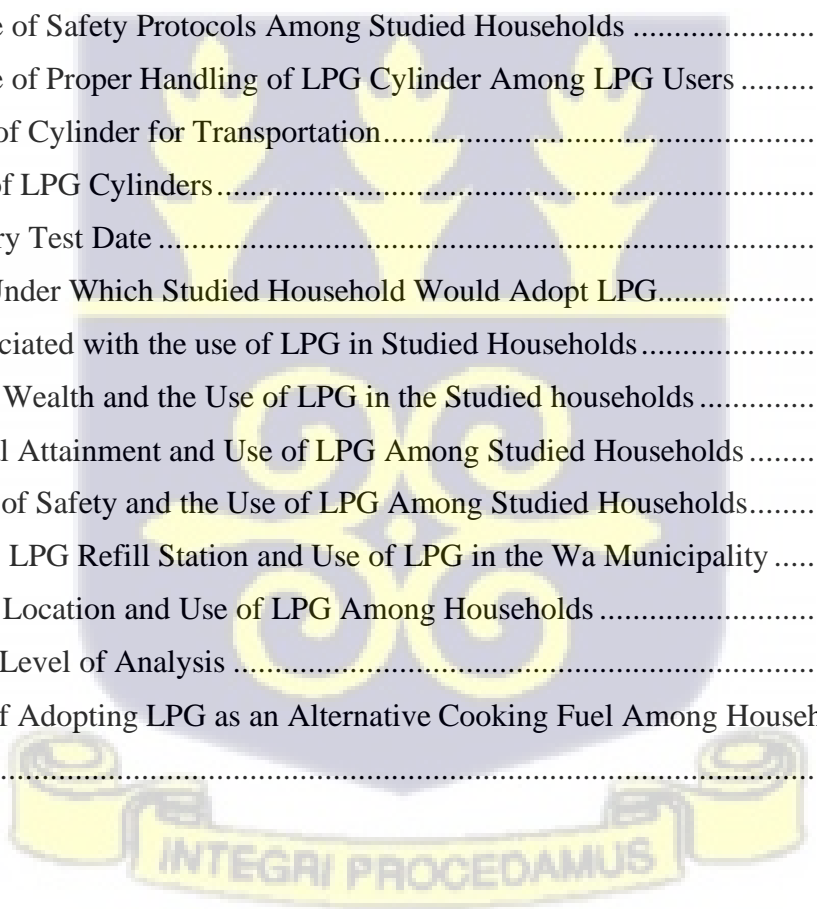
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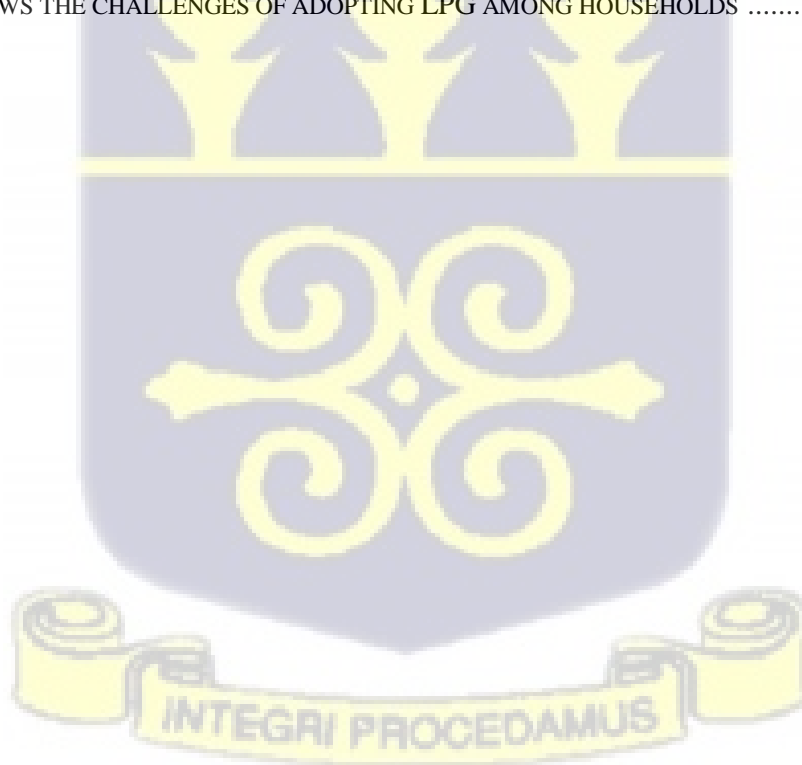
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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

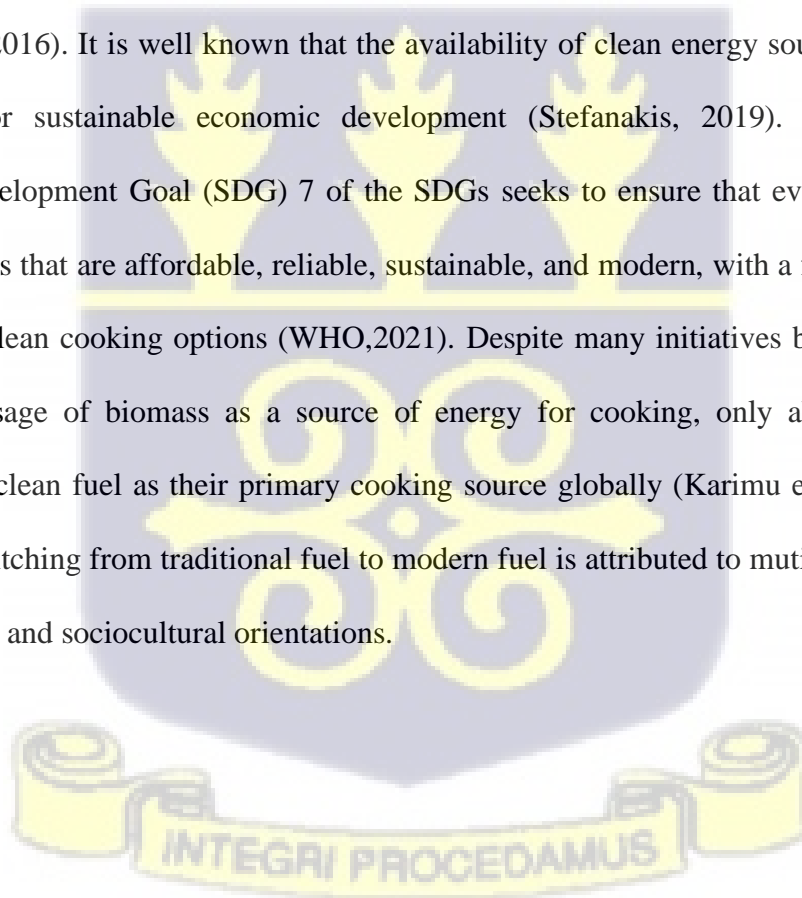
Domestic fuel is required to meet different human needs, including heating and cooking in many households around the world. Domestic energy sources range from biofuel including firewood and charcoal to modern fuel types such as Liquefied Petroleum Gas (LPG) and electricity (Behera et al., 2015). According to Mocumbi (2019), more than 60% of the global population still uses traditional fuels as a source of cooking fuel in a significant number of countries, most of which are in sub-Saharan Africa. Thus, the use of biomass for cooking is still pronounced in developing countries like Ghana. Although there is a steady reduction in the use of firewood for cooking, this trend is countered by a rise in the use of charcoal and an exponential increase in population, primarily in Sub-Saharan Africa. Elum et al., (2017) reported that the growth of urban cities in Africa will potentially increase the use of traditional fuels. The study further projects that a one percent increase in the urban population would lead to a fourteen percent upsurge in charcoal consumption.

This widespread production and use of biomass for cooking and heating are worrying because of the substantial health and environmental repercussions. According to the World Health Organisation (2019), air pollution from household fuel combustion is one of today's most important global health risks. This is because biomass combustion emissions are linked to a higher prevalence of respiratory infections, predominantly among women and children (Taylor & Nakai, 2012).

Furthermore, the direct carbon dioxide (CO₂) emissions from traditional fuel consumption are said to constitute 18% of global CO₂ emissions which is detrimental to our health (Nejat et al., 2015).

Another harmful effect of the use of biomass is deforestation and desertification. This is a result of the felling of trees for firewood or charcoal. Obiri et al., (2014) estimate that 60% of all wood harvested from forests and areas outside of forests is used for energy. This makes the use of traditional biomass a threat to forest cover and afforestation efforts around the world.

As a result of the environmental and health risk connected with the use of biomass, governments, environmentalists, and policymakers all over the world have increased the promotion of the use of improved and “cleaner” cooking fuels such as electricity and liquefied petroleum gas (LPG) (Karimu et al., 2016). It is well known that the availability of clean energy sources is one of the requirements for sustainable economic development (Stefanakis, 2019). As a result, the Sustainable Development Goal (SDG) 7 of the SDGs seeks to ensure that everyone has access to energy sources that are affordable, reliable, sustainable, and modern, with a focus on access to electricity and clean cooking options (WHO,2021). Despite many initiatives by governments to minimise the usage of biomass as a source of energy for cooking, only about a quarter of households use clean fuel as their primary cooking source globally (Karimu et al., 2016). This slow pace of switching from traditional fuel to modern fuel is attributed to multi-factors including levels of income and sociocultural orientations.



1.2 Statement of the Problem

According to the World Health Organization, more than a quarter of the global population lack access to clean domestic fuel (WHO, 2020). In Africa, energy from traditional fuels makes up the majority of the energy portfolio. Conventional biomass constitutes nearly 75 percent of the overall energy consumption in sub-Saharan Africa, primarily utilized for cooking purposes. This proportion has remained relatively stable over the previous 25 years (IEA, 2019). By 2030, the continent's consumption of wood fuel, particularly charcoal, is expected to reach 46.1 million tons (Tassie et al., 2021).

In West Africa, Ghana is reported to be the second-highest consumer of charcoal, after Nigeria, and is one of the top ten global producers of charcoal (Aabeyir et al., 2016). Research carried out by Bawakyillenuo et al., (2021) reported that Ghana's household sector consumes roughly 20 million tons of biomass fuel each year, with the majority of the supply coming from the natural forest. Furthermore, the 2021 population and housing census report that the usage of wood or charcoal as the primary cooking fuel among households stood at 54.3% as of 2021. The report further states that in all 16 regions, over six in every ten households, still use traditional fuel for cooking and heating (GSS, 2021). With reference to the use of LPG, preliminary data from the 2021 population and housing census indicate that the use of gas (LPG) as the main cooking fuel has also increased from 18.2% in 2010 to 36.9% in 2021 (Ghana Statistical Service, 2021). However, the rate of adopting clean cooking fuels is not rapid enough to mitigate the impact of using biomass and to meet SDG 7 which aims at making clean cooking fuels accessible to all. The dependence on traditional fuels for cooking is worrying and poses a risk to public health and the environment. Pillarisetti & Chowdhury (2022) reported that these household energy practices can result in extremely high levels of household air pollution leading to loss of life.

For instance, the use of biomass is said to be responsible for approximately 4.2 million deaths yearly among children and adults from respiratory and cardiovascular ailments globally (Zhou,2019). In Ghana, where charcoal and firewood are the predominant fuels for close to 70% of households, prolonged exposure to indoor air pollution is said to be the cause of death of about 16,600 people and the loss of 502,000 disability-adjusted life-years annually (Inkoom & Crentsil, 2015). Furthermore, the burning of charcoal is acknowledged as one of the leading causes of desertification and forest degradation. Aabeyir et al., (2016) reported that a majority of charcoal-producing regions in Ghana are exhibiting evidence of forest degradation as a result of excessive forest exploitation without enough replacement. According to Lurumuah (2012), more than 75% of Ghana's 8.2 million hectares of forest cover have disappeared as a result of indiscriminate logging activities. Although the direct link between charcoal production and forest loss has not been explicitly established, it is said to be a contributing factor.

The adverse environmental and health effects associated with using traditional biomass energy sources like charcoal have sparked a global search for 'cleaner' alternative sources of cooking fuels (Ajibola et al., 2020). One common clean cooking fuel that has become an alternative for households is liquified petroleum gas (LPG). Liquefied petroleum gas, also known as, LP gas, or condensate, is a type of fuel gas that typically consists of combustible propane mixtures, butane, and propylene. LPG is utilized as a fuel gas in cars, kitchen appliances, and heaters (Thompson et al., 2021). It is widely recommended for household cooking due to its inherently clean characteristics. LPG burns cleanly in stoves with very low levels of emission. Research shows that the use of LPG helps to reduce indoor air pollution therefore reducing health risks and environmental degradation related to the use of traditional biomass.

As a strategic approach, the government of Ghana began promoting the use of LPG as an alternative cooking fuel to charcoal and firewood through the National LPG Promotion Campaign. The goal was to position LPG as a viable alternative to biomass as an energy source. The government gave away free gas cylinders and created the Unified Petroleum Price Fund (UPPF) to compensate oil marketing companies that transport petroleum products like LPG to rural and remote areas. This was done to persuade rural households to use LPG (Karimu et al., 2016).

With all the efforts put in place to help the country switch from the use of firewood, charcoal, and other traditional fuels, little success has been achieved. A survey conducted in 2019 by the Ghana Statistical Service observed that the use of traditional fuels for cooking in Ghana decreased from 72.8% to 67% between the period 2013 and 2017 (Bawakyillenuo et al., 2021). Despite a positive dip, the use of biomass in Ghana is still high. Additionally, although the percentage of people who use LPG as their primary cooking fuel increased from 22.3% to 24.5% over the period between 2013 and 2017, it represents a negligible increase of 2.2% (Bawakyillenuo et al., 2021).

The recent 2021 Population and Housing Census reported that the use of LPG as the main source of cooking fuel increased from 18.2 percent in 2010 to 36.9 percent in 2021. The report also noted that the use of LPG is significantly lower in rural areas (14.8%) than urban areas (51.3%), with Greater Accra Region having the highest use (68.2%) and North East Region having the lowest use (4.2%) (GSS, 2021). While some parts of the country have made headway toward the target of transitioning from using traditional biomass to using LPG and electricity, the use of biomass for cooking is still minimal in the northern parts of Ghana (Dalaba et al., 2018).

According to Braimah (2012), Ghana's savannah regions, particularly the Upper West region produces the majority of the charcoal in Ghana, which is primarily derived from the Savannah woodland ecology. The region according to data from the 2021 Population and Housing Census has close to 90% of its population using biomass for cooking with less than 20% using clean energy sources for cooking. Also, the region is reported to be among the top 5 LPG access-deficient regions in Ghana, with less than 20% of households using LPG as their main source of cooking fuel (Ghana Statistical Service, 2021).

These findings necessitate further research into the sociodemographic and sociocultural factors impeding the transition from traditional fuels to modern cooking fuels such as LPG. Although some studies on cooking fuel in the Upper West region have been conducted (see Agyeman et al., 2012; Issahaku et al., 2013), the majority of these studies focused on the use of traditional fuels and their environmental implications. There has been little research into the conditions that lead to individual households adopting and maintaining the use of clean fuel, particularly LPG, in the Wa Municipality of the Upper West region. The research study, therefore, aims to comprehend the motivating factors that drive the use of LPG among households within the municipality. More importantly, the study explores how household economic conditions and the sociodemographic features of the household affects the use of LPG as an alternative cooking fuel and the knowledge level of the use of LPG as a source of cooking fuel among households. The Wa Municipality was chosen because it has the largest number of LPG users among the 11 municipal and district assemblies within the Upper West region. This makes the Municipality a viable option since the study seeks assess the pattern of usage of LPG as a source of cooking fuel among households.

1.3 Research Objectives

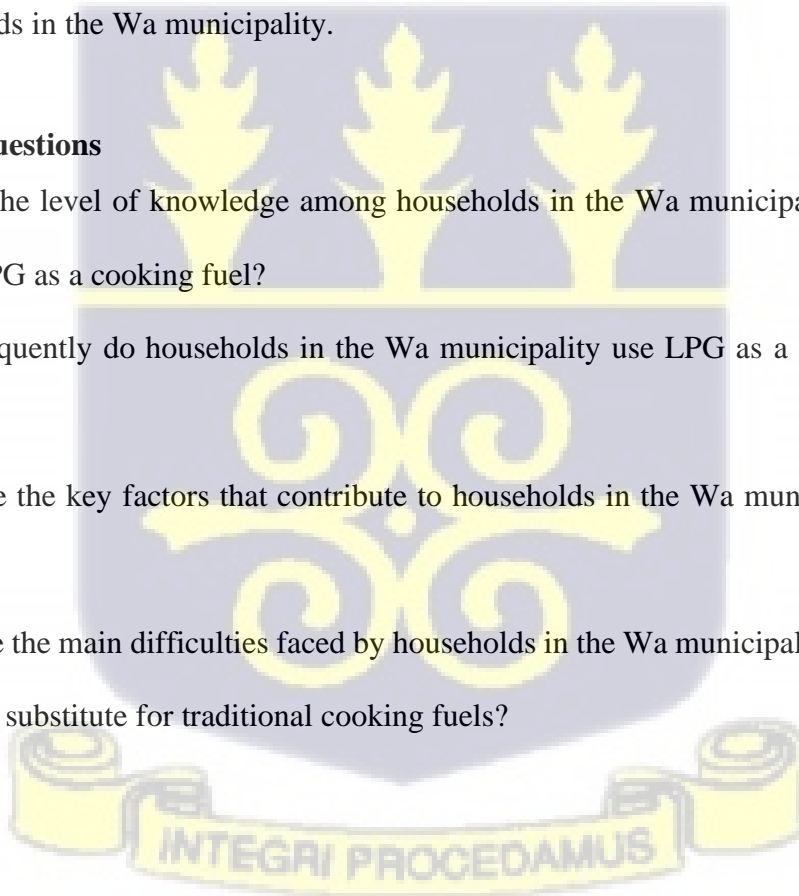
The key aim of the study is to assess the pattern of usage of LPG as a source of cooking fuel among households in the Wa Municipality.

The research is informed by the following specific objectives:

1. To assess the knowledge level of households on the use of LPG in the Wa municipality.
2. To determine the level of use of LPG as cooking fuel among households in the Wa municipality.
3. To assess the factors influencing the relative utilization of LPG in the Wa municipality.
4. To interrogate the challenges of using LPG as an alternative cooking fuel among households in the Wa municipality.

1.4 Research Questions

1. What is the level of knowledge among households in the Wa municipality regarding the use of LPG as a cooking fuel?
2. How frequently do households in the Wa municipality use LPG as a source of cooking fuel?
3. What are the key factors that contribute to households in the Wa municipality choosing LPG?
4. What are the main difficulties faced by households in the Wa municipality when adapting LPG as a substitute for traditional cooking fuels?



1.5 Hypotheses of the Study

Null Hypothesis (Ho): There is no significant association between socio-economic factors and the use of LPG as a source of cooking fuel.

Alternative Hypothesis (Ha): There is a significant association between socio-economic factors and the use of LPG as a source of cooking fuel.

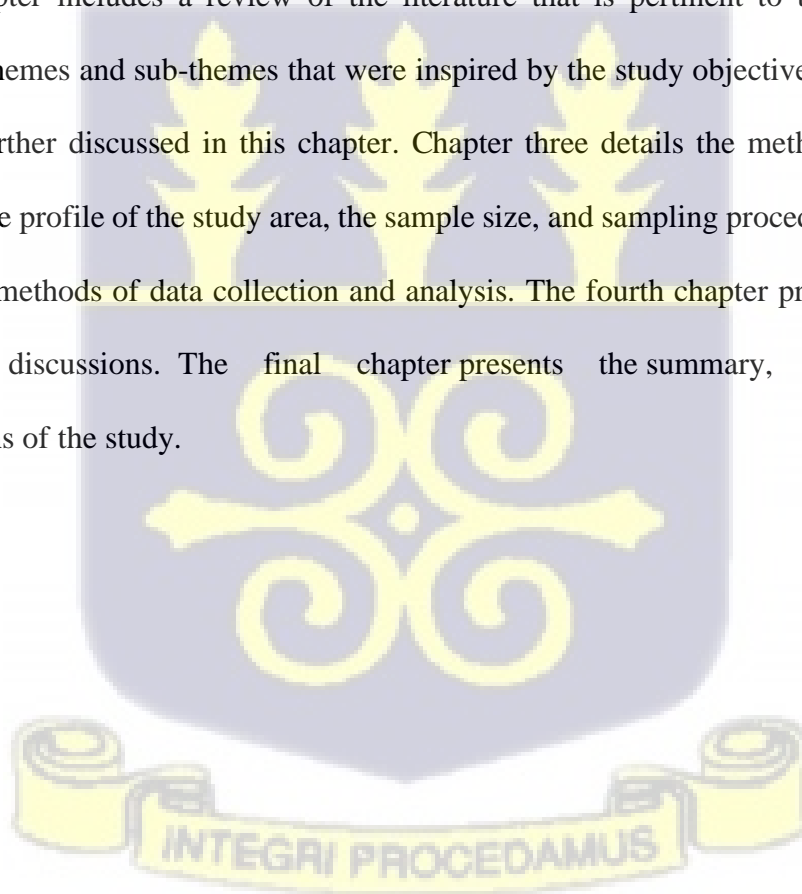
1.6 Rationale of the Study

Due to the detrimental effects of using biofuels, modern fuel sources like LPG and electricity are being promoted by governments, legislators, and environmentalists. Since 1989, the Ghanaian government has promoted LPG as an alternative to wood and charcoal, mainly to reduce deforestation. As a result, the National LPG Promotion Campaign was created to persuade households that still use traditional fuels for cooking to switch to using modern cooking fuels like LPG. Despite the advancement and promotion of alternate domestic fuel sources such as LPG and electricity, households continue to utilize charcoal and firewood as domestic fuel. According to Mensah & Adu (2015), the percentage of households cooking with modern fuels rose from 10.8% to 23.6% between 2005 and 2013. However, the majority of this growth occurred in metropolitan areas. As of 2021, just 25.5% of Ghanaian households used LPG as their primary cooking fuel (GSS, 2021). Fuel switching patterns are quite stiff, owing to non-economic considerations like preference, supply reliability, and distance to refill, among others (Karimu et al., 2016). Given these complexities, it is critical to understand and identify the elements that influence household's preference for traditional biomass versus modern cooking fuels like LPG. With this context, the research intends to investigate the determinants influencing the use of LPG among households in the Wa municipality.

The findings of the study will serve as reference material for key policy formulators who intend to promote the adoption and use of Liquefied Petroleum Gas (LPG) among households. Understanding the barriers to switch from traditional biomass to LPG will help stakeholders enhance the enrolment of programmes targeted at promoting the use of LPG. Also, the study will serve as a referencing document for academics and researchers.

1.7 Organisation of the Chapters

This dissertation is structured into five chapters. The background, the problem statement, and the objectives of the study are all presented in chapter one along with the significance of the study. The second chapter includes a review of the literature that is pertinent to the study. This is organized into themes and sub-themes that were inspired by the study objectives. The conceptual framework is further discussed in this chapter. Chapter three details the methods of the study. These include the profile of the study area, the sample size, and sampling procedures, the research design, and the methods of data collection and analysis. The fourth chapter presents the study's findings and discussions. The final chapter presents the summary, conclusion, and recommendations of the study.



CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter examines the pertinent literature relating to the study which is structured into various themes and sub-themes. Some of the thematic areas elaborated upon in this chapter are the concept of household cooking fuel, trends in the use of LPG, the promotion of the use of LPG in Ghana, factors that determine the choice of household cooking fuel, and challenges facing the use of LPG as an alternative cooking fuel. The second section of the chapter examines the theoretical literature on household fuel choice, with a focus on household energy transition theories such as the Energy Ladder Model and the Fuel Stacking Model. These models form the bases for the conceptual framework of the study.

2.1 Household Cooking Fuel

The use of energy among households is an important and prevalent characteristic of society. Household cooking fuels are used for numerous purposes including cooking, space heating, lighting, and various household duties (WHO, 2019). Two broad categories of cooking fuel can be identified; traditional fuels and modern fuels. These categorizations are mainly based on the emission levels of the cooking fuel.

2.1.1 Traditional Fuels/Biomass

Traditional fuels/Biomass denote cooking fuels that are in their compact state and release toxic smoke during combustion. They include wood, charcoal, and animal dung, among others. These traditional fuel sources are widely available and play an important role in providing cooking fuel to over two billion people in developing countries (Zhou,2019). Furthermore, biomass-based industries contribute significantly to job creation, and income generation (Vijay et al., 2022).

The sales of charcoal, firewood and other traditional cooking fuels are a source of income for some households in most developing countries. However, smoke from biofuel comprises numerous toxic elements, such as respirable suspended particulates and carbon monoxide, and hence prolonged exposure to these pollutants indoors can have detrimental effects on one's health (Zhang et al., 2021). The levels of these pollutants are primarily determined by cookstoves, fuels, and housing designs (ventilation). Many households have poorly ventilated cooking areas, and approximately 50% of all households lack a designated kitchen (Zhang et al., 2021). Women and children are primarily involved in the collection and combustion of traditional fuel, and as a result, they are highly exposed to biomass smoke and thus fall into the category of people who face a higher health risk as a result of pollutant cooking fuels. Figure 2.1 shows the degradation of a forest area due to the harvesting of wood for the production of charcoal.

Figure 2. 1 A Charcoal Burning Site



Source: Alex Baluku/Rwenzori Daily, 2022.

2.1.2 Modern Fuels

Cleaner fuels are those that produce low levels of gaseous emissions. The terminology “modern fuel” relates to electricity, gaseous fuels such as liquefied petroleum gas (LPG), and natural gas, and excludes traditional biomass (Adam et al., 2013). Access to clean fuel is a critical part of any country’s development aim, especially in low-income countries. Modern cooking fuels are defined as having a high energy density, a high combustion efficacy, and the efficiency to transfer high heat and adequate heat control characteristics. Some examples include biogas, LPG, and electricity. Figure 2.2 show an LPG gas stove and cylinder use as a source of clean cooking fuel.

Figure 2. 2 LPG Stove and Cylinder



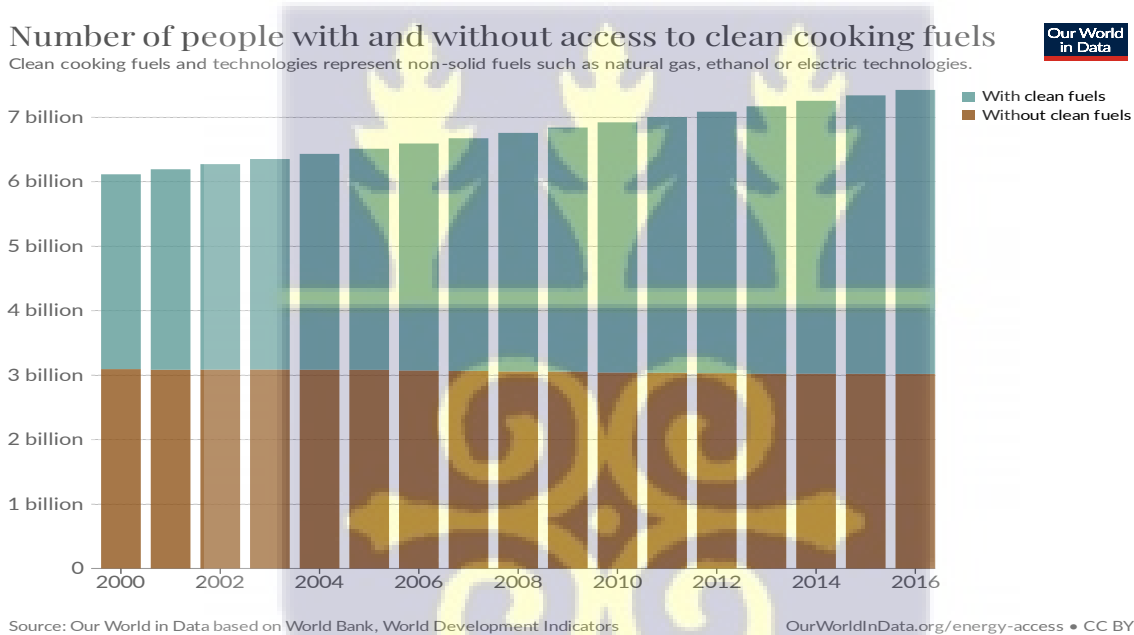
Source: Hilary Kimuyu/Paygo Energy, 2020.



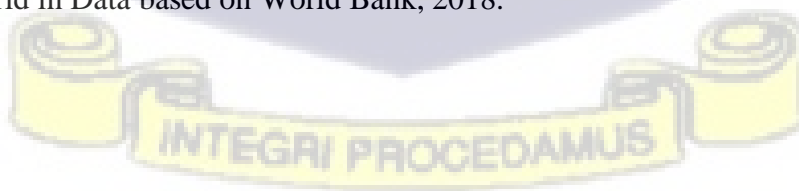
2.2 Trends in the Use of Traditional Fuels at Global and Regional Levels

Globally, a quarter of the population continues to rely on biofuels, whose combustion is one of the leading causes of respiratory-related deaths, primarily among women and children (Wei & Liao, 2018). Over the last three decades, the share of the world’s population that cooks primarily using polluting fuels has progressively declined. Even though the number of people who have access to clean fuel has improved greatly, exponential population growth has increased the total number of people with no access to clean fuel. From Figure 2.3, the proportion of persons using biomass decreased at a low pace from 3 billion people in 1990 to a little below 2.8 billion people in 2016.

Figure 2. 3 Number of People With and Without Access to Clean Cooking Fuels



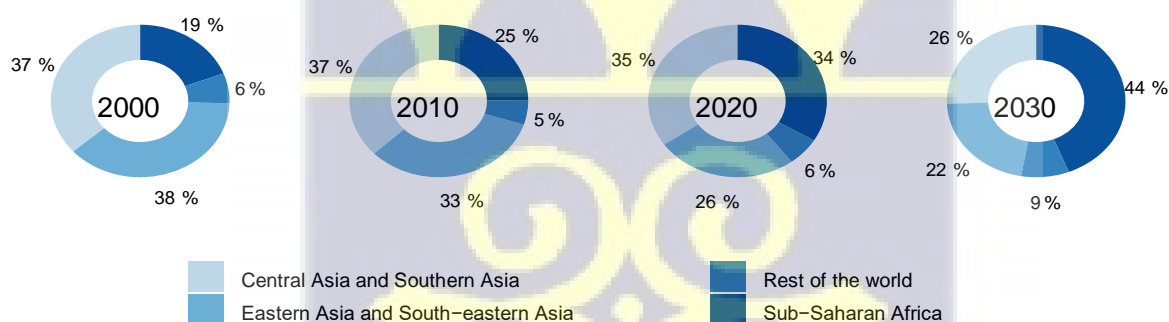
Source: Our World in Data based on World Bank, 2018.



By 2030, it is projected that around 2.7 billion people will lack access to clean and efficient cooking fuels and technology, which means they will cook using inefficient stoves and fuels such as fuelwood, charcoal, coal, and agricultural residue. Hence although the rate of adaption of clean cooking fuel among households is increasing globally, the trend is not rapid enough to attain sustainable development goal 7, which seeks to ensure access to clean cooking fuel for all.

Data on the regional use of biomass as depicted in figure 2.4 illustrates that in 1990, the majority of individuals in the Asian regions primarily utilized polluting fuels for cooking. Over the last three decades, these regions have made significant progress in transitioning towards the use of clean fuels. Eastern Asia and South-eastern Asia regions are projected to have less than 10% of their population using biomass by 2030.

Figure 2. 4 Regional Populations Mainly Using Polluting Fuels for Cooking



Source: Nature Communications (*Nat Commun*) ISSN 2041-1723

In 2000, only 19% of people who cooked primarily with polluting fuels lived in Sub-Saharan Africa, with 75% of them living in either Central Asia and Southern Asia or Eastern Asia and South-eastern Asia. However, in 2020, around 1 in 3 (34%) persons living in Sub-Saharan Africa used biomass and this is projected to increase by 2030. Thus, in Sub-Saharan Africa, the number of people primarily using polluting fuels for cooking is increasing and is expected to surpass 1 billion by 2025 (Stoner et al., 2021).

Traditional biomass energy systems are extensively employed, primarily due to their affordability and the absence of viable alternatives, particularly in rural regions in Africa (Hafner et al., 2018). If current trends continue, four out of every five Sub-Saharan Africans will continue to bear the health and socioeconomic costs of using polluting fuels for cooking (Lambe et al., 2015). These projections have implications for both the environment and the quality of health.

2.2.1 Trends in the Use of Traditional Biomass in Ghana

According to the GLSS 7 undertaken in 2016/2017, an estimated 70% of Ghanaian households use traditional fuels as their primary cooking fuels, together with traditional cookstoves. These polluting fuels used in cooking were mainly firewood (33.3%) and charcoal (34.1%) (GSS, 2017).

The trend in using biomass is still pronounced in the country although more households are beginning to adopt clean fuels such as LPG and electricity for cooking. The 2021 population and housing census reports that biomass is Ghana's primary energy source, accounting for approximately 64% of the country's primary energy supply. According to the report, the percentage of households using wood or charcoal as their main source of cooking fuel has decreased over the past ten years, from 73.9% in 2010 to 54.3% in 2021. More than six out of ten households in all 16 regions are still reported to use wood or charcoal as cooking fuel. Thus, most Ghanaians still rely on traditional fuel sources, particularly firewood and charcoal, to meet their cooking needs (GSS,2021).



2.3 Trends in the Use of LPG at the Global and Regional Level

Due to the numerous health and environmental implications of using biomass, there has been much attention drawn toward finding solutions to lowering exposure to Household Air Pollution (HAP). It is now widely recognized that providing clean energy sources is a prerequisite for achieving this goal and sustainable development goal 7 which seeks to provide universal access to adequate, dependable, sustainable, and efficient energy services, with a focus on access to electricity and clean cooking alternatives (Stefanakis, 2019). This quest for clean energy has resulted in several projects ranging from the development of better stoves to the usage of LPG and electricity for cooking. On a global scale, the use of LPG as a fuel source is by far one of the most common clean cooking fuels (Gould & Urpelainen, 2018).

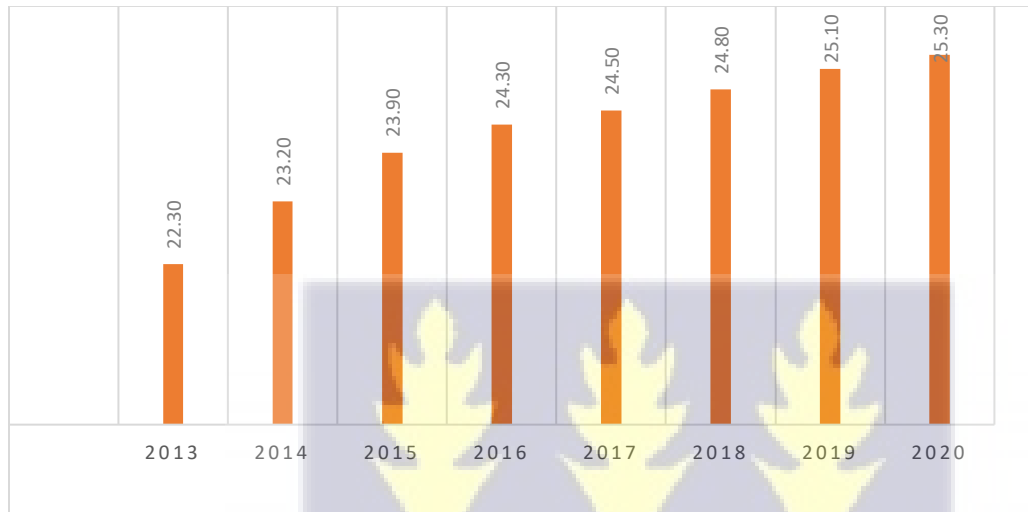
According to WHO (2020), in low- and middle-income countries, the use of LPG and biomass has exceeded the use of unprocessed biomass as the major fuel since 2010, demonstrating its dominance in urban areas. In Africa, the uptake of cleaner fuels has been seen to be slow, largely due to issues with affordability and supply (Ravindra et al, 2021). The use of wood is likewise seen to be steadily falling in most access-deficient locations, but this trend is countered by a rise in the use of charcoal, particularly in Sub-Saharan Africa (Afrane et al, 2022).

2.3.1 Trends in the Use of LPG in Ghana

With the immense benefits that come with the use of LPG, the government of Ghana and other stakeholders began the promotion of the use of LPG as an alternative cooking fuel to other biomass fuels (Charcoal, firewood, cow dung). This led to the implementation of price subsidies, the establishment of the Ghana Cylinder Manufacturing Company (GCMC), and the creation of LPG promotion campaign messages, all to hasten the transition to the use of cleaner fuels for cooking (Energy Commission Ghana, 2021). An analysis of the data on the use of clean fuel for cooking in Ghana is encouraging although there is much more to be desired.

There have been some recorded improvements in the switch to the use of clean energy due to multiple factors such as the aforementioned government inventions, increase in household income and improve the supply of LPG (Energy Commission Ghana, 2021). The share of the population using LPG as primary cooking fuel appears to be increasing, albeit slowly as shown in figure 2.5.

Figure 2. 5 Share of Population Using LPG as a Primary Cooking Source in Ghana



Source: Energy Commission of Ghana, 2021.

From figure 2.5, it can be observed that 22.3 percent of the country’s population in 2013 used LPG as their primary cooking fuel. There is an annual rise in the proportion of the country’s population who adopt LPG as their primary cooking fuel. In 2020, approximately 25% of Ghana’s population used LPG as their primary source of cooking fuel which is less than a 1% increase since 2018. The minimally increasing trend in the use of clean cooking fuels that had been observed since 2013 affects the country’s prospects of attaining SDG goal 7 which emphasis making clean energy accessible (Energy Commission Ghana, 2021); Ghana Statistical Service, 2021).

The last decades have seen considerable changes as cooking fuel consumption has gradually shifted away from biomass and toward modern energy sources such as LPG (Mensah et al., 2016). The 2021 Population and Housing Census reports that the use of LPG as a primary cooking fuel increased from 18.2% in 2010 to 36.9 % in 2021. The report indicates that rural areas (14.8%) use LPG significantly less than urban areas (51.3%) (GSS, 2021).

2.4 Factors Shaping the Promotion of LPG Use Globally

Despite health risks, the use of biofuel to meet household energy needs, particularly for cooking, is widespread in low-income countries. Household air pollution (HAP) is caused by cooking with conventional fuels like kerosene, which increases the risk of noncommunicable diseases (Naz et al., 2017). Governments and nongovernmental organizations (NGOs) all over the globe have advocated the use of modern cooking fuels due to the environmental and health effects of using traditional fuels. For example, in Indonesia, a five-year government-led campaign converted 50 million homes to the use of LPG (Thoday et al., 2018). Each home received a stove, a 3-kg LPG cylinder, and accessories from the government (Thoday et al., 2018). Furthermore, farmers in Sri Lanka are helped by the organization to set up separate biogas units to satisfy their energy requirements for lighting and cooking.

2.4.1 The Promotion of LPG in Ghana

To fulfill SDG 7, which calls for making sure that there is access to clean, efficient, and reliable sources of cooking fuel, clean cooking fuel promotion must be consciously incorporated into national policy. This includes expanding existing initiatives, boosting both private and public investment in new cooking technologies, and enhancing cross-sector cooperation. In keeping with this, the Ghanaian government instigated several Programme, including the LPG Promotion

Programme and the Rural LPG Promotion Programme, both of which were designed to boost the utilization of LPG among households.

To alleviate Ghana's overreliance on fuelwood for residential purposes, the Ghanaian government launched the LPG Promotion Program in 1990. The long-term objectives of the programme was to ensure that households transition from the use of traditional fuels to the use of LPG for domestic activities and protect the forests from degradation. The programme was targeted at urban households, public catering facilities, and small-scale food sellers. The campaign also discussed the advantages of switching to LPG. First of all, as a promotional approach, LPG cylinders were distributed to the general public for free. This was to absorb the cost involved in the uptake of LPG which is said to be a barrier to the use of LPG for cooking. Free cylinders were given to customers upon request or they were given gas-filled cylinders and just had to pay for the cost of the gas (Asante et al., 2018). To provide LPG to clients faster, the Ministry of Energy (MOE) purchased 50-cylinder pick-up trucks and distributed them to private people who were registered to sell LPG (Asante et al., 2018). The trucks operated “door-to-door” services to increase access and bring LPG closer to consumers conveniently (Ahunu, 2015).

Furthermore, the government set up a gas cylinder manufacturing company, the Ghana Cylinder Manufacturing Company (GCMC), to make LPG accessories accessible to the public at inexpensive prices (Broni-Bediako & Amorin, 2018). Another strategy was to encourage private sector investment in the nation's network of LPG refilling stations. This program resulted in the establishment of approximately 647 LPG refilling stations across the country. This helped bridge the distribution gap and encourage households to abandon the use of biofuel and switch to the use of LPG since they could now easily fill their LPG cylinder (Broni-Bediakon & Dankwa, 2013).

The promotion of LPG in Ghana led to a significant increase in the proportion of the population adopting LPG as their primary cooking fuel between 1992 and 2013. Before the inception of the LPG promotional programme, less than 5% of the population in Accra and other urban areas used LPG, and 0% in rural areas (Broni-Bediako & Amorin, 2018). LPG consumption in Accra rose from 4.8% to 22.7% in 2000, and from 0.8% to 5.2% in other metropolitan regions (Ahunu, 2015). Ghana's domestic LPG use is now above 100,000 tons per year, which is around sixteen times higher than when the LPG Promotional Program was not implemented (Ahunu,2015). Also, more than 24% of the country's population now cook with LPG as their main source of cooking fuel.

2.4.2 Rural LPG Programme in Ghana

The launching of the Ghana LPG Promotion Programme resulted in a rise in the percentage of households that used LPG. However, this increase was predominant in urban areas since the policy was targeted at urban dwellers and institutions. To reduce this urban bias, the Government of Ghana launched a Rural LPG Programme; an initiative to introduce the free LPG cylinder distribution Programme aimed at improving LPG access in rural areas (Ahunu, 2015). Under the initiative, the government provided people in low-access and low-income districts with free cylinders, cookstoves, and all related accessories. The cross-subsidization of LPG with petroleum goods was a crucial component of the campaign, to make it more accessible for households.

To get more people to use LPG in rural areas, the Unified Petroleum Price Fund (UPPF) scheme was created to give financial incentives to transporters who were willing to go to rural and remote places more than 200 km from TOR (Abdul-Wakeel karakara & Dasmani, 2019). This was to serve as a way of attracting investors to open LPG refill stations in rural areas since the distance to refill stations could serve as a breach to the use of LPG among households.

2.5 The Benefits of Using Clean Cooking Fuels

The utilization of efficient household energy for cooking is inextricably linked to other development objectives, such as those affecting environmental sustainability, gender equality, and human health (Putti et al, 2015). LPG as a modern cooking fuel has low emissions and hence meets the WHO guidelines for particulate matter (PM) which is set at $PM_{2.5}$ (Lueker et al, 2020). This makes the use of LPG among households advantageous as compared to other biomass fuels.

To start with, universal access to clean cooking solutions such as LPG would help prevent respiratory diseases that are related to being exposed to harmful pollutants (sulfur oxide, carbon monoxide, and nitrogen) emitted from the combustion of traditional fuels. The use of LPG will reduce emissions to very low levels thereby eliminating the associated ailments that come with the use of biofuel. Mottalep (2019) reports that the continued use of LPG has the potential of preventing deaths, mainly among women and children, caused by exposure to household air pollution. Imelda (2019) asserts that an Indonesian LPG promotion programme contributed to a 3.3-percentage-point decrease in newborn mortality. This research emphasizes how switching to greener energy may significantly improve one's health.

Furthermore, the use of clean cooking fuels will help reduce deforestation and lower climate-change emissions. An estimated 30 million m_3 of forestland are removed each year for the manufacture of fuelwood and charcoal, while 3.72 million m_3 of timberland are harvested and logged for export each year (Karakara & Osabuohien, 2021). Hence the use of LPG as cooking fuel will imply a drastic reduction in the falling down of trees for firewood or charcoal production. This will go a long way to mitigate the environmental impacts of the use of charcoal and firewood.

Again, a switch from biomass to modern fuel for cooking saves time spent collecting biofuel which is mostly done by women and children. This has the possibility of increasing the productivity of women, and the learning outcomes of children since the time lost in gathering firewood and burning charcoal could be used for learning, economic activities, and socialization. Additionally, obtaining biomass fuel is linked to several injuries, including falling, snake bites, and coming into contact with various disease vectors. Hence a switch to clean cooking fuel will in turn reduce the aforementioned risk associated with the gathering and use of traditional biomass.

2.6 Challenges of Adopting LPG as an Alternative Cooking Fuel by Households

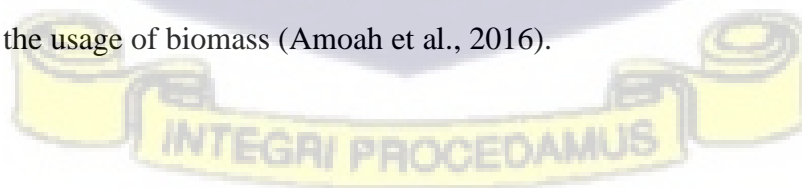
Liquified Petroleum Gas (LPG) is a clean fuel because it burns cleanly in stoves with little to no emissions. However, similar to other modern fuels adoption and sustained use, LPG faces significant barriers to widespread uptake and solid fuel replacement. Some of the barriers preventing the switch to LPG are discussed below.

First of all, a major hurdle to the adoption and continuous use of LPG by households is the upfront cost of the LPG cookstoves and accessories as well as recurring fuel prices (Gill-Wiehl et al., 2021). Some households are unable to afford the needed accessories for the uptake of LPG and others switch back to traditional biomass after adopting LPG as a result of their inability to regularly refill their cylinders. Furthermore, the expense of acquiring and maintaining LPG and its accessories prevented most potential consumers in rural areas, where such accessories may be difficult to purchase and maintain. (Broni-Bediako & Amorin, 2018). Also, data available indicates that accessibility and proximity to LPG filling stations are constraints impeding the use of LPG as a source of cooking energy (Oteh et al., 2015; Srinivasan and Carattini 2016).

Solid fuels are frequently free and easily accessible, but LPG must be obtained from supply networks outside of residential areas. Because of this, some homes might only have restricted access to LPG, which encourages infrequent use, fuel-saving techniques, and fuel stacking (Gould & Urpelainen, 2018). Inadequate refilling stations in rural areas have been identified as one of the main causes of low patronage of LPG products in these areas (Broni-Bediako & Amorin, 2018).

Another barrier that hinders the transition to modern fuel is the concern about the safety of LPG. Study results from Oteh et al., (2015) suggest widespread concern regarding the safety of using LPG for cooking. This aligns with a study carried out in Ghana by Dalaba et al., (2018) who reported that in urban respondents, safety concerns were more frequently cited as a rationale for not having LPG. According to the study's findings, the majority of families nationwide expressed worries about the safety of LPG: Urban households (80%) and rural households (85%) both thought it was risky to use LPG for cooking.

Also, the Price of LPG is considered one of the major challenges faced by households in the adaptation of LPG. Another barrier to LPG use in Ghana is the periodic increase in the price of LPG and its accessories. In 2018, the price of 18 kg of LPG was over GHs 90, a 43% increase from 2014 (Broni- Bediako & Amorin, 2018). The upsurge in the cost of refilling LPG in Ghana can be observed over the last decades. Due to the rapid increase in the price of LPG and the relatively lower pricing of alternative fuels such as firewood and charcoal, most prospective users have returned to the usage of biomass (Amoah et al., 2016).

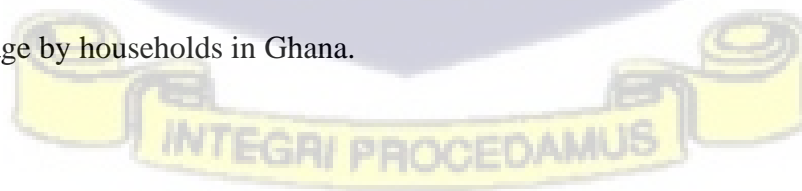


Last but not least, the full adoption of LPG may occasionally be hampered by the desire to preserve the traditional flavor of specific local dishes. The apparent suitability of LPG stoves for typical foods is a problem with acceptance. According to a study by Wiedinmyer et al., (2017), traditional dishes were almost always prepared over charcoal burners in urban households in the study area and over three-stone fires in rural households; LPG was rarely utilized.

2.7 Factors Influencing the Adaptation of LPG Among Households

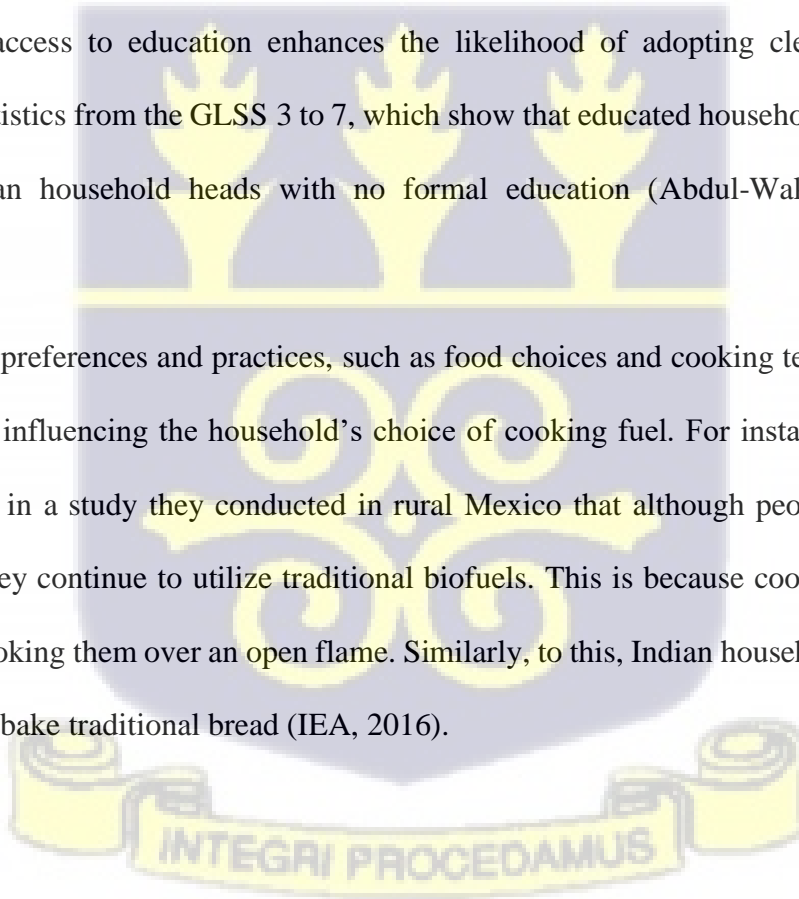
Household decisions on the type of cooking fuel they use are influenced by a complex mix of economic, social, cultural, and environmental factors (Leach, 1992; Batool et al.,2022). A review of existing literature shows that several factors can be associated with the choice of cooking fuel in a household.

First of all, income is described as a major driver of cooking fuel choice. Some studies have established a strong correlation between an increase in income and the uptake of modern fuels. For example, a study by Ouedraogo (2006) employing household data from Burkina Faso discovered that increasing income levels influenced households in the country's metropolitan regions to choose natural gas over kerosene for cooking. In Ghana Karakara, & Osabuohien (2021) reported that charcoal or LPG consumption and income levels have a positive and substantial link when using the income approach to determine household fuel adoption. Mensah & Adu (2015) used data from the fifth and sixth rounds of the Ghana Living Standards Survey to investigate the trends of cooking-fuel usage by households in Ghana.



Price, income level, the consistency of LPG supply, and other household characteristics were cited as important variables influencing the choice of cooking energy in Ghana. These findings support the energy ladder hypothesis, showing that as household wealth increases, biomass is substituted for clean fuels. Also, the use of cooking fuel is influenced by household factors such as household size, gender, age, composition, and educational attainment. Mensah & Adu (2013) used an ordered probit model with socioeconomic factors to examine household energy decisions in Ghana. They discovered that the likelihood of utilizing clean fuels as opposed to inefficient fuels is negatively impacted by household size and the age of the household head. Furthermore, a study carried out by Karakara & Osabuohien (2021), shows that education is positively related to the usage of fuel. Hence, having access to education enhances the likelihood of adopting clean fuels. This is supported by statistics from the GLSS 3 to 7, which show that educated household heads use more modern fuel than household heads with no formal education (Abdul-Wakeel Karakara, & Dasmani, 2019).

The household's preferences and practices, such as food choices and cooking techniques, are still another element influencing the household's choice of cooking fuel. For instance, Batool et al., (2022) observed in a study they conducted in rural Mexico that although people may purchase modern fuels, they continue to utilize traditional biofuels. This is because cooking tortillas with LPG requires cooking them over an open flame. Similarly, to this, Indian households opt to utilize wood burners to bake traditional bread (IEA, 2016).



2.8 Safety and Proper Handling of LPG as Cooking Fuel

Liquefied petroleum gas (LPG) is a combustible combination of hydrocarbon gases such as propane and butane. LPG is becoming the preferred energy source globally because of its relative accessibility, efficiency, and environmental friendliness (Asamoah et al., 2012). Due to the risks involved in using the gas, there are advised guidelines or protocols that one must adhere to use the gas safely. LPG should be kept in high-pressure bottles or cylinders for household use to accommodate the stored pressure in the gas. Most of these cylinders are made of low-carbon steel, with a smaller amount of aluminum and fiber material (Velmurugan et al., 2019). To maintain the temperature of the gas low, these cylinders should always be kept upright, safely fastened, and in a well-ventilated space under cover. Also, LPG cylinders must be kept out of the kitchen or away from anything that could start a fire.

Although LPG cylinders do not have a set expiration date, it is required to be tested by law after every five years. The cylinders are examined for safety before use, and a new test deadline is stamped on each one (Anon, 2022). Other safety tips in using LPG for cooking include keeping the doors and windows of your kitchen open for proper ventilation, closing the regulator knob to the off position when the cylinder is not in use, and never leaving your cooking unattended.

Over the years, disasters related to the use of LPG have occurred in Ghana. One such major disaster occurred in October 2017, when an explosion occurred in an LPG refilling station in Accra. This resulted in seven deaths and nearly 130 injuries (Asante et al., 2018). The event spurred the Ghanaian government to implement a branded cylinder recirculation model, in which cylinders are no longer owned by consumers but by LPG marketing businesses to increase cylinder inspection, maintenance, and overall safety (Puzzolo et al., 2019).

The Cylinder Recirculation Mode involves filling large refilling facilities with LPG before distributing the filled cylinders to customers at specialized retail locations known as exchange points (Asante et al, 2018). At the exchange point, the customer trades in his or her empty cylinder for one that has been filled. This programme is yet to be rolled out on a full scale due to concerns raised by various stakeholders including managers of LPG refill stations.

2.9 Theoretical Framework

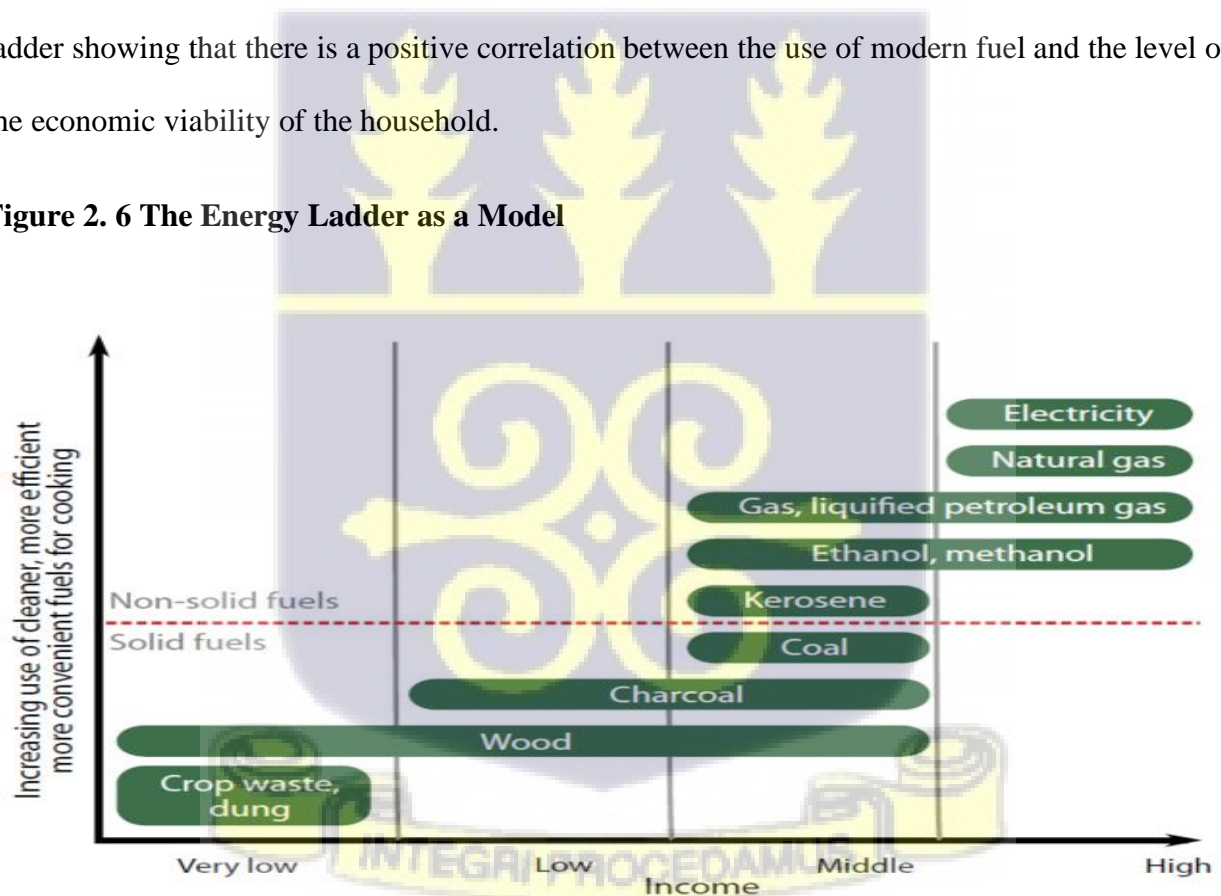
Theories have been developed in the literature to explain the factors that influence how households choose their energy sources and adopt new technologies. Prominent among the theories is the energy-ladder model and the fuel-stacking theory (Bofah et al, 2022). This study adopts the two energy transition theories as bases for the conceptual framework. This is because the application of both the energy-ladder model and the fuel-stacking theory in the conceptual framework provides a comprehensive approach to understanding household energy transitions. This integrated approach captures the sequential progression of energy sources on the energy ladder while acknowledging the simultaneous use of multiple fuels within households.

2.9.1 The Energy ladder Model

The model was developed in the 1980s and has been used by researchers to explain household fuel use switching patterns (Holdren & Smith, 2000; Treiber, 2012). The model was created using the association between income and the use of modern fuels like LPG and electricity. Thus, it represents the switch from biomass to modern fuels for household cooking in response to changes in the viability of the household's income. According to the energy ladder model, households switch from traditional fuels to modern fuels at the rate and extent permitted by variables including household income, the cost of fuel and LPG accessories, and, to a lesser extent, comparable fuel costs (Kowsari & Zerriffi, 2011).

Faisal et al., (2013), using Cross-sectional data from 8,687 homes GLSS5 revealed a positive and substantial association between charcoal or LPG consumption and income levels. The model, therefore, perceives the income levels of a household as a key determinant of the choice of fuel used by the household. According to Behera et al., (2017), three distinct progressive phases depict the linear movement or process of ascending the energy ladder. The first phase emphasizes households continued use of archaic energy sources such as animal dung, agricultural wastes, and wood, while the second emphasizes households' shift from biofuels to transition fuels such as charcoal as their income increases. The last stage involves transitioning from transition fuels to modern fuels such as LPG and electricity for cooking and heating. Figure 2.6 depicts the energy ladder showing that there is a positive correlation between the use of modern fuel and the level of the economic viability of the household.

Figure 2. 6 The Energy Ladder as a Model



Source: The Energy Ladder (Paunio, 2018)

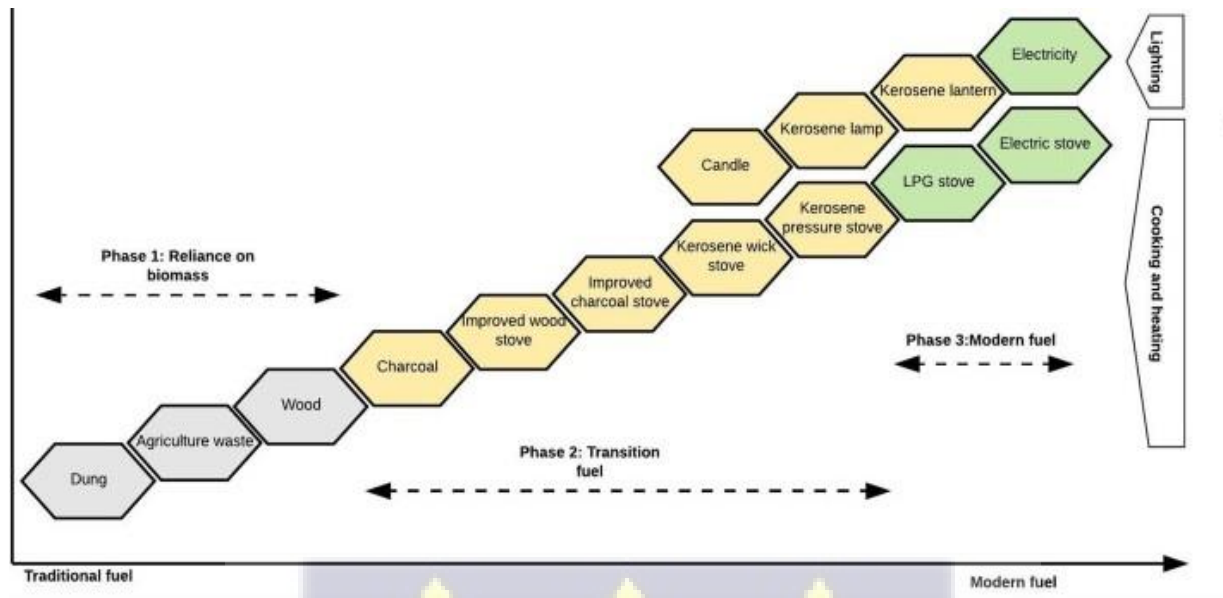
The energy ladder's key accomplishment is its capacity to highlight the strong income reliance of household energy choice, especially in urban settings. However, many researchers and academicians have questioned the energy ladder model in numerous studies (see, Waleed & Mirza, 2023) since it concentrates solely on income and ignores the impact of social and cultural aspects on fuel choice. Adamu et al, (2020) citing et al, (2000) note that the dynamics of family fuel decisions are not adequately described by the energy-ladder paradigm. They instead offered the fuel-stacking theory, which addresses multiple-fuel use patterns in which households combine fuels from both the lower and upper ends of the energy ladder.

2.9.2 Energy Stacking Model

Over the last 10 years, a growing number of scientific research on household fuel usage have revealed that transitioning between fuels is not always one-way; after adopting modern energy sources, people may switch back to traditional biofuels. As a result, fuels are imperfect substitutes. Households commonly select a combination of fuels and conversion technologies based on affordability, practicality, and other factors, with some fuels being chosen for particular tasks while others are selected for general use (Kowsari, & Zerriffi, 2011)

The Energy Stacking theory contends that households are unlikely to fully switch to modern fuels due to consumer preferences, sporadic shortages of modern fuels, their high cost, changes in the price of fuels, and the fact that modern fuels are only imperfect substitutes for traditional fuels (Bofah et al., 2022). The model allows for more accurate predictions of predicted fuelwood use and indoor air pollution in rural households Behera et al., (2017). Figure 2.7 depicts the fuel stacking model which postulates that changes in households cooking fuel are not linear in nature and hence households do not completely switch from biomass.

Figure 2.7 An Illustration of the Energy Stacking Model



Source: The energy Stacking Model (Yadav et al., 2021)

As household income levels rise, households can advance up the energy ladder and start utilizing modern fuel without giving up the fuels at the lower levels of the energy ladder, but rather by using them as supplementary fuel, as shown in figure 2.7. The practice of using multiple sources of cooking fuel by households has been observed in Ghana (Akolgo et al., 2018). Ghanaian households employ a variety of cooking fuels, cooking methods, and conversion technology (stoves) depending on fuel availability and price, and household size. According to Batool et al., (2022), households seldom achieve the ideal transition from one fuel to another, preferring instead to combine various cooking fuel options.

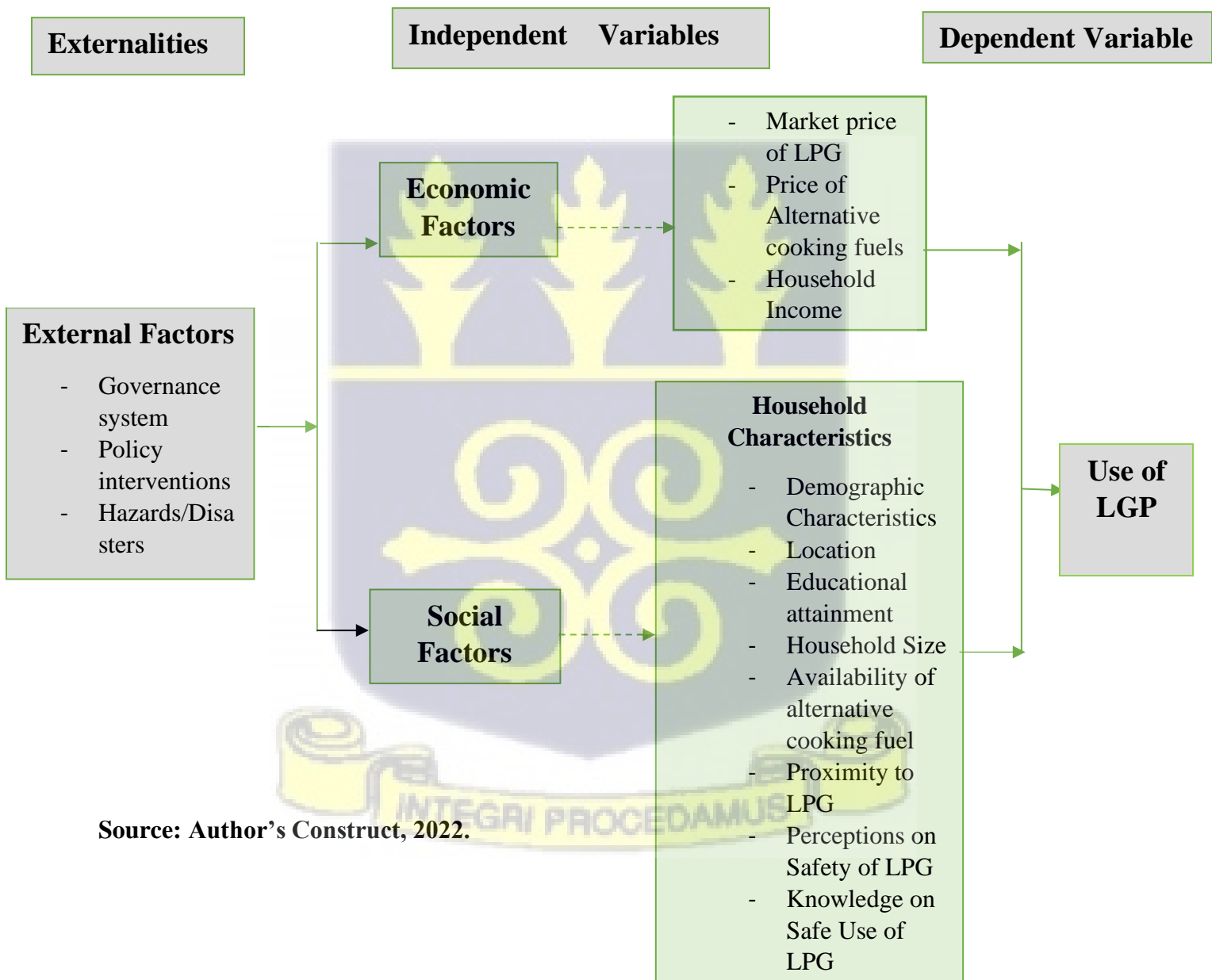
2.9.3 Conceptual Framework

The conceptual framework of this is adapted from the Energy ladder model and the fuel stacking model. This framework examines the multiplicity of factors that affect the type of cooking fuel a household would adopt and sustain its usage over some time. The dependent variable is the use of LPG as a cooking fuel among households. This can be influenced by certain external factors which are represented as externalities in the conceptual framework. An externality may be a government policy seeking to promote the use of LPG as cooking fuel. Government policies such as tax exemptions and subsidies on LPG accessories, and infrastructural development such as an expansion of the Tema Oil Refinery, all positively impact the price of LPG and consequently increase the use of LPG as a cooking fuel among households. An example of such government policy is the Rural LPG Promotion Programme which was introduced to increase the use of LPG among rural dwellers. The intermediary variable considers individual households' preferences and how such preferences affect their choice of using LPG as cooking fuel. Some of such preferences may be related to the difference in the taste of food individuals associate with different cooking fuels. Also, certain dishes are preferably prepared using traditional biomass than modern fuels. All the aforementioned can positively or negatively affect the use of LPG for cooking.

The conceptual framework also captures some explanatory variables that play a key role in determining the choice of fuel a household will choose. These are labeled as independent variables. These include sociodemographic characteristics such as the age of the household head, educational attainment of the household head, sex of the household head, employment status of the household head, and size of the household. It also includes some economic and cultural factors such as the household's income level, price of LPG and accessories, availability of LPG filling outlets, perceived dangers of using LPG, knowledge about the advantages of using LPG, and consistency

of supply of LPG. These sociodemographic and socioeconomic factors can positively or negatively impact whether a household chooses to use clean fuel (LPG) for cooking or biomass (charcoal) for cooking. The price of LPG is one major determinant of the use of LPG for cooking. Also, the prices of other cooking fuels can potentially influence the use or otherwise of LPG for cooking and heating.

Figure 2. 8 Conceptual Framework Showing the Use of LPG as a Source of Cooking Fuel



Source: Author's Construct, 2022.

Some studies have reported that the perception of how safe it is to use LPG for cooking, its ability to meet certain cooking needs, and how affordable the modern cooking fuel is, has an impact on whether or not a household will use LPG for cooking. Also, education creates awareness about the immense benefits of using LPG, and how safe and convenient it is to use LPG for cooking. This makes education positively related to the use of LPG.

2.10 Conclusion

The chapter discussed the various forms of cooking fuel adopted by households. It is estimated that 2.1 million people still lack access to clean energy for cooking. This is a cause for worry because of the related health and environmental effects associated with the use of biomass. Given curbing the impact of using biomass for cooking, governments and policy formulators have sought to promote the use of clean fuels such as LPG through subsidies, and tax exemptions among others. Furthermore, the chapter examined the trends in the use of biomass and modern fuels for cooking. The global uptake of clean cooking fuels is encouraging. This however is at a slow pace and would not be able to meet SDG goal 7 which envisions universal access to clean cooking energy for all by 2030. Lastly, this chapter elaborated on the theoretical underpinnings of the study. The Energy Ladder Model and the Fuel Stacking Model, are the bases for the study's conceptual framework. According to the two models, the choice of household cooking fuel is said to be influenced by factors including household income, socio-demographic characteristics of the household, and sociocultural factors.



CHAPTER THREE

Research Methodology and Profile of the Study Area

3.0 Introduction

The research methodology refers to the processes through which researchers approach their work of describing, explaining, and predicting phenomena (Mangal & mangal, 2013). This section thus presents the processes designed and used to generate and analyze gathered data to answer the researcher questions. The chapter is divided into two sections. The first section gives brief background information about the study area. This covers the socio-demographic characteristics and the economic activities of the Wa municipality. The second section provides information on the research design, the research methodology, the sample size, and the sampling technique used in conducting the study. The section further discusses the methods of data collection, data organization, and analysis.

3.1 Profile of Study Area

3.1.1 Location

The study was conducted in the Wa Municipality. The municipality is situated in the Upper West region's southeast. Its landmass, which is approximately 1,078 km², is located between latitudes 9° 55" north and 10° 25" north and longitudes 1° 10" west and 2° 5" west. The district has a total surface area of 579.86 square kilometers. The Wa municipality is located in the undulating Savanna high plain, which rises on average between 160 and 300 meters above sea level. Conversely, the region only experiences one rainy season, which extends from April to October and is characterized by sporadic but violent downpours. The area receives an unevenly distributed annual rainfall volume that ranges from 840mm to 1400mm. The district lies in the tropical continental climacteric zone.

Wa Municipal's agricultural output is largely focused on the cultivation of yam, which accounted for 69.8 percent of total agricultural production from 2010 to 2015. The municipality is one of the main agricultural producers in the Upper West Region and accounted for 17.9% of the regional production in 2015. The vegetation of the study area is one of the guinea savannah grassland types, comprising of short trees with minimal or absent canopies, along with shrubs of different heights and lushness. During the wet season, the ground is covered with grass. Among the frequently found trees are shea, dawadawa, kapok, and baobab. Additionally, there are exotic species such as cashew and mango that thrive in the study area (GSS, 2021). According to the 2021 population and housing census, the population of the Wa municipality stands at 200,672 with 98,493 males and 102,179 females. It has an average household size of 5.3 persons with a rural population of 57,314 and an urban population of 143,358 (GSS,2021). Because of the significant and rapid urban growth, the local administration demonstrates a notable urban population increase (2.6%) that contributes to the swift expansion of the township into peri-urban neighborhoods like Bamahu, Kpongu, Nakori, Waali-Sombo, Kumbiaha, Kperisi, Danko, Sing, and Busa, among various others (Wa Municipal Assembly Citation 2012). Farming constitutes the primary livelihood in these communities, while some residents are involved in household-based small-scale enterprises, including petty trading.

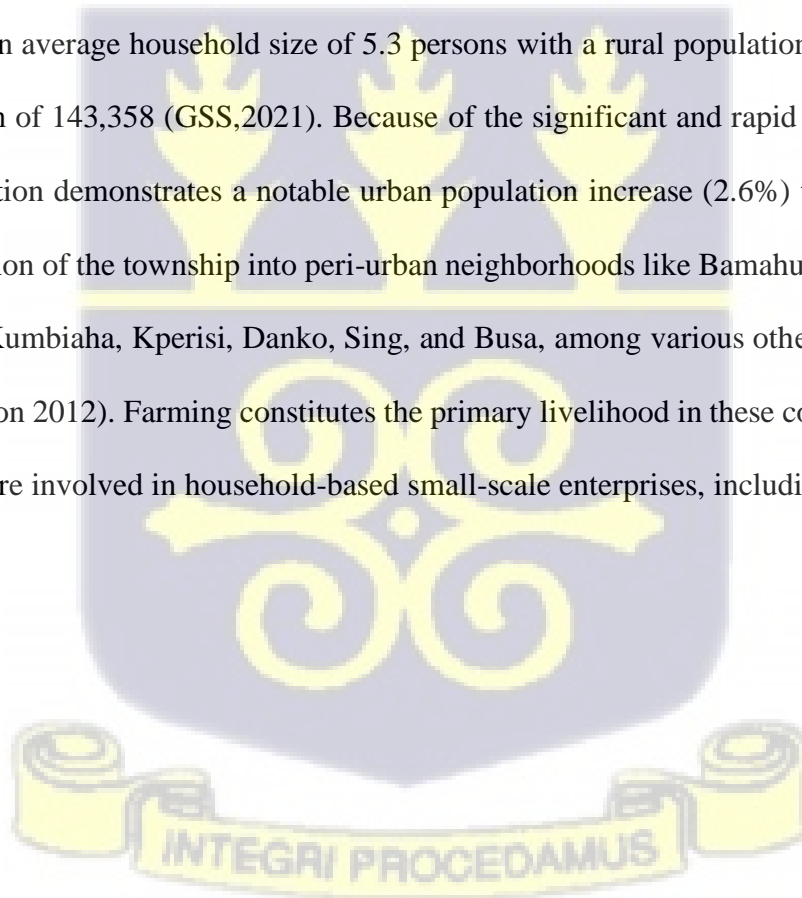
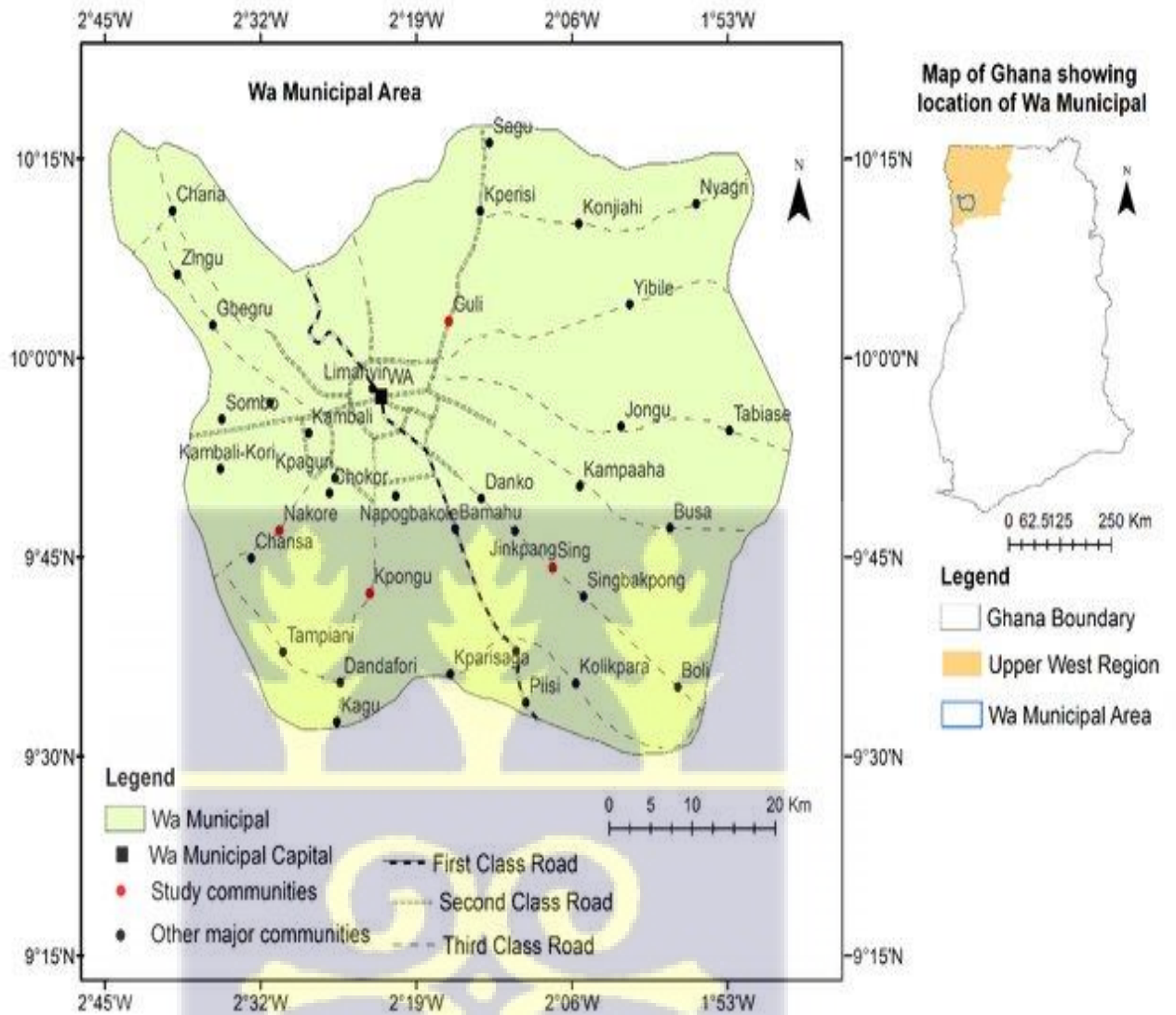


Figure 3. 1 Map of Wa Municipality



Source: Adapted from Wa Municipal Assembly, 2018.



3.2 Research Methodology

3.2.1 Research Design

The study design is defined as the general strategy that the researcher uses to get accurate, objective, and interpretive data in understanding the phenomenon under study. A mixed research method was used to conduct the study. The study used both quantitative and qualitative research techniques for data collecting and analysis. The choice of a mixed research method was informed by the research objectives and the opportunity it presents for both breadth and in-depth analysis of the study topic.

3.2.2 Quantitative Research Methods

In quantitative research, data is numerically represented and transformed to better understand the phenomena under observation. For this particular study, the quantitative approach administered a structured interview guide to various households in the study area. A household as operationalized by the study is a group of people who live together in the same dwelling or living space and share common arrangements for daily living.

Both closed and opened ended questions, together with multiple-choice questions were employed in the interview guide design to gather data that could answer the research objectives. Descriptive analysis involving the use of graphs, frequencies, charts, and crosstabulations was used to virtually present the socio-demographic characteristics of respondents and their use of LPG for cooking. Inferential conclusions were drawn from the analysis data, linking them to relevant literature. Furthermore, the relationship between the dependent variable and the independent variables was predicted using bivariate, and multivariate analysis.

The study employed quantitative research since it enables the researcher to examine and comprehend the relationship between the independent and dependent variables, as well as the extent to which the independent variables contribute to the variation in the dependent variable. Also, the quantitative data method of analysis enables the researcher to examine the opinions and attitudes of a considerable number of people in the population leading to the possibility of drawing general conclusions from the findings of the study.

3.2.3 Qualitative Research Methods

The study also used the qualitative method of research design since it is most appropriate for exploring and understanding people's perceptions and belief systems on subjects such as the adaptation and use of LPG as cooking fuel. An interview guide was developed to collect information on the belief, opinions, and perceptions about the use of LPG among households in the Wa municipality. Qualitative data was collected through in-depth interviews with key stakeholders in the distribution and promotion of the use of LPG in the municipality. These included managers of LPG refill stations, representatives from the Wa Municipal assembly, and a representative from the Ghana Petroleum Authority (NPA). Interviews were recorded using a voice recorder and transcribed for analysis. The analysis of the data was done with the aid of an ATLAS.ti software. Thematic areas were identified and discussions were made around them concerning the research objectives and relevant literature. The advantage of using a mixed research method is that the blend of quantitative and qualitative methods of research can compensate for each other's weaknesses and complement each other's strengths (Ménacère, 2016).

3.3 Sampling Technique and Sample Size Determination

3.3.1 Sampling Technique

As a result of the heterogeneity of the population of the Wa municipality, the study adopted a stratified random sampling technique to obtain the sample size for the study. The stratified random sampling technique is a sampling technique that splits a population into uniform groupings called strata. Strata are created in stratified random sampling premised on members' shared attributes or characteristics, such as income or geographical location (Levin & Kanza, 2014). The study stratified communities in the municipality based on geographical location. Hence urban, suburban and rural strata were created based on data available at the Town and Country Planning Department (TCPD) of the Wa Municipal Assembly. By categorizing communities into urban, suburban, and rural strata, the study captures the diversity and characteristics of each geographical region, allowing for a more accurate reflection of the entire population.

The study used a simple random sampling technique to select one community from each stratum. This was achieved by creating a list of all the communities under each stratum with serial numbers attached to them. A random number was generated for each stratum using the random number function in Microsoft excel. The number generated was matched to the related community on the list and the community subsequently selected for the study. Using random numbers ensures an unbiased and impartial selection process. The communities selected were Wa-Kpaguri-Upland Hotel (Urban), Wa-Ahmadiya (Suburban), and Mojon (Rural). The total number of households in the three selected communities formed the sample population from which the sample size was determined. The simple random sampling technique was used at this stage because it was observed that all communities within each stratum were homogeneous in nature. Thus, they shared the same qualities and characteristics.

After determining the sample size, a proportionate allocation process was used to determine the number of households to be enumerated in each of the three communities. This was done considering the uneven population distribution among these chosen communities. With this methodology, the population in the study areas was fairly represented. Furthermore, a systematic random sampling technique was used to select households within the study area for enumeration. The population size of each selected community was divided by the sample size to get the systematic sampling interval. The systematic interval for all three communities was seven. This meant that every 7th household was selected for an interview until the sample size was obtained.

The sampling approach employed in this qualitative study focused on purposive selection, specifically targeting key stakeholders within the context of LPG utilization in the Wa Municipality. A purposive sampling technique involves deliberately choosing individuals who possess relevant knowledge, expertise, or experience related to the research topic (Etikan et al., 2016). In this case, the research aimed to gather insights into the use of LPG in the Wa Municipality, with a particular emphasis on the perspectives of individuals directly involved in LPG distribution and regulation. As a result, four LPG filling station managers and the regional director of the Ghana Petroleum Authority were intentionally selected to participate in the study. The choice of these participants was guided by the need to capture diverse viewpoints and gather comprehensive data that could inform a deeper understanding of LPG utilization in the municipality. The LPG filling station managers were selected due to their direct involvement in the retail and distribution of LPG, allowing the research to explore operational practices, challenges, and customer behaviors. Including the regional director of the Ghana Petroleum Authority added a regulatory and oversight dimension, enabling the study to examine the broader context of LPG usage, safety measures, and policy considerations.

3.3.2 Sampling Size Calculation

The projected populations in all three selected communities were obtained from the Wa Municipal Medium Term Development Plan document and aggregated to obtain a total population of 1698. The projected population for the communities was used in calculating the sample size due to the unavailability of disaggregated data from the 2021 population and housing census. The sample size was determined using the Cochran sampling formula (Singh & Masuku, 2014)

$$n = \frac{Z^2 * P (1-P)}{e^2} \div 1 + \left(\frac{Z^2 * P (1-P)}{e^2 N} \right)$$

Where: n= sample size, N = Population size, Z = the Z- score, p = Significant criteria (P-value)

e = Margin of error

Given that: $N = 1698$, $z = 1.96$, $e = 0.06$ and $p = 0.5$

The calculation of the sample size yielded 231 respondents. However, a sample response of 220 was received due to different factors including nonresponses to interview guide and enumerators unable to return to the field due to time and financial constraints. Table 3.1 shows the communities selected and the proportion of the communities enumerated.

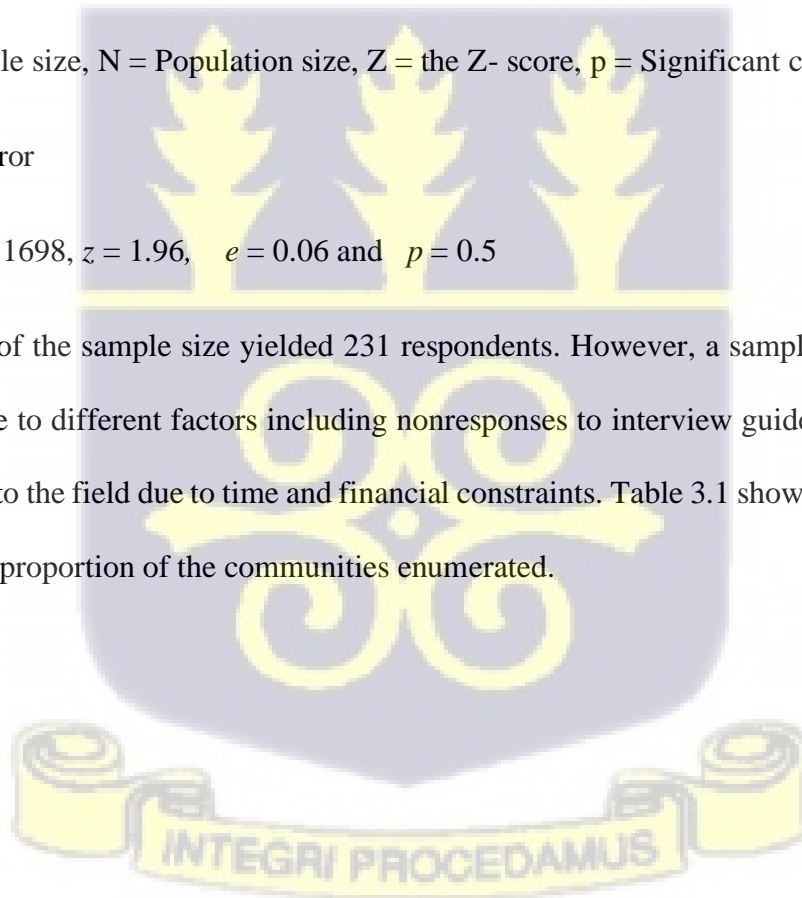


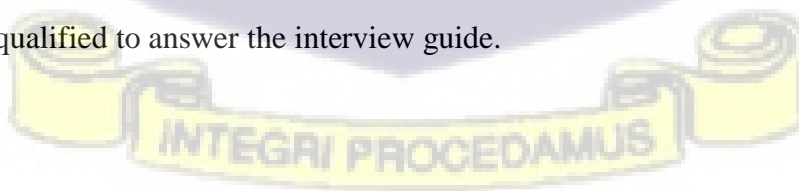
Table 3. 1 Communities Selected and the Proportion of each Community Enumerated

Residential Classification	Community Selected	Total Projected Population (2021)	Sample Size for Each Community
Urban	Wa-Kpaguri-Upland Hotel	864	117
Suburban	Wa-Ahmadiya	602	83
Rural	Mojon	232	31
Total	3	1698	231

Source: Author’s Construct, 2022.

3.4 Target Population

According to Etikan et al., (2016), the targeted population can be thought of as the entire component chosen by the researcher to be examined for the study. Since the study is more particular about the use of LPG among households, the unit of analysis was households in the Wa municipality enclave. The household head was to respond to the interview guide because of the significant role they play in the household and the influence they have in determining the type of cooking fuel used in the household. However, in the absence of the household head, other household members, particularly women, who engaged in the cooking arrangement of the household were qualified to answer the interview guide.



3.5 Sources of Data

The study used both primary and secondary data. The study obtained its primary data through the administration of interview guide to respondents and the conduction of key informant interviews using an interview guide. Secondary data for the study consisted of information obtained from relevant books, journal articles, the internet, and official documents from the Wa municipality. These served as baseline information that enabled the study to be carried out. It also assisted the study in reviewing the literature on the use of LPG as domestic cooking fuel.

3.6 Data Collection Instrument

For quantitative data, a structured survey consisting of both closed and open-ended questions was used to collect primary data for analysis. The majority of questions were either closed-ended binary or multiple choices, with some attuned to the Likert scale to elicit information regarding the use of LPG as domestic cooking fuel (See appendix 1). The survey was administered using a computer-assisted personal interviewer. The survey was structured into five (5) sections. The first section collected data on the sociodemographic characteristics of the respondents, the second section collected data on the factors influencing the use of LPG, and the third section collected data on the level of knowledge of the use of LPG among households in the municipality. The fourth section was based on the challenges associated with the use of LPG and the last section collected data on the characteristics of households that did not use LPG.

Qualitative data was collected through in-depth interviews with key stakeholders in the distribution and promotion of the use of LPG in the municipality. These included managers of LPG refill stations, assembly representatives of the study area, and officials of the Ghana Petroleum Authority in the municipality. Interviews were recorded after seeking permission and transcribed for analysis.

A three-day intensive training session was organized for five data collectors to ensure that they were abreast with the study's key terminologies and could record the responses correctly using the computer-assisted interviewer (Kobo Collect). The interview guide was pre-tested on selected households within the study area. This was to help identify and clarify all possible ambiguities and misunderstandings as well as minimize lapses in the administration of the interview guide.

3.7 Measurement and Definitions of Variables

Table 3. 2 Definition of Variables Used in the Study

Variable	Definition	Expected Outcome
Dependent Variable		
Use of LPG	The use of LPG as a cooking fuel represents the household's use of LPG as cooking fuel. It is a binary response code in dummy variables were 1 = Yes and 0 = No	(+/-)
Independent Variable		
Market Price of LPG	This measured the extent to which the price of LPG influences the use of LPG among households. The response is coded using a continuous measurement scale where 1= very costly, 2= costly, 4= Cheap, and 5= very cheap	Positive (+)

<p>Household Wealth Group</p>	<p>The Wealth Group of households was computed using the Principal Component Analysis matrix. This was done based on 10 household assets. Households that indicated that they had one of the listed assets were assigned a score of 1 and those who did not possess any of the assets listed were assigned a score of zero. The binning tool on SPSS was then used to split the households into three wealth groups; 1=poor wealth group, 2= middle wealth group, and 3=rich wealth group. The higher the accumulated score the wealthier the household (see Appendix VI).</p>	<p>Positive (+)</p>
<p>Educational attainment of the Household head</p>	<p>Educational attainment is coded as a categorical variable and represents the educational attainment of the head of the household. Here, 0= no formal education, 1= primary education, 2= secondary education, 3= tertiary education.</p>	<p>Positive (+)</p>
<p>Sex of household head</p>	<p>This was measured as a categorical variable and coded as a dummy variable where 1=Male and 2= Females.</p>	<p>Negative (-)</p>
<p>Household Size</p>	<p>The size of the household is a variable that represents the number of persons residing within the household. This study categorized the variable were 1=1-3 persons 2= 4-6 Persons, 3= 7-10 Persons 4=More than 10 persons</p>	<p>Positive/Negative +/-</p>
<p>Location of Household</p>	<p>This variable deals with whether the household resides in an Urban, Suburban, or rural setting. It was coded as 1= Urban, 2= Suburban and 3= Rural</p>	<p>Positive +</p>

<p>Proximity to LPG Refill station</p>	<p>This is a categorical variable that deals with the distance of the household from the nearest LPG refill station where 1= Less than 1 hour 2= 1-2 Hours 3= 3-4 Hours 4= More than 4 Hours</p>	<p>Positive/Negative +/-</p>
<p>Type of housing Unit/ Occupancy Status of Housing Unit</p>	<p>This measures the extent to which the type of housing and the occupancy status of the household influences the adaptation of LPG. This was recorded as a categorical variable with 1= Compound House, 2= Flat / Apartment, and 3= Uncompleted building. The variable occupancy status was recorded as 1= Own dwelling unit, 2= Rented dwelling unit and 3= Rent free dwelling unit</p>	<p>Positive/Negative +/-</p>

Source: Author’s Construct, August 2022

3.8 Data Analysis and Presentation

Data analysis entails reducing raw data to a manageable size, creating summaries, and applying statistical inferences. Data collected from the field were analyzed using descriptive statistics. The Stata software (Version 17.0) was used to process and analyze the data obtained from the field. The study used four levels of analysis to assess the use and knowledge levels of LPG among households in the Wa municipality. Thus, the study used univariate, bivariate, multivariate, and thematic methods of data analysis to answer the research objectives.

3.8.1 Univariate Analysis

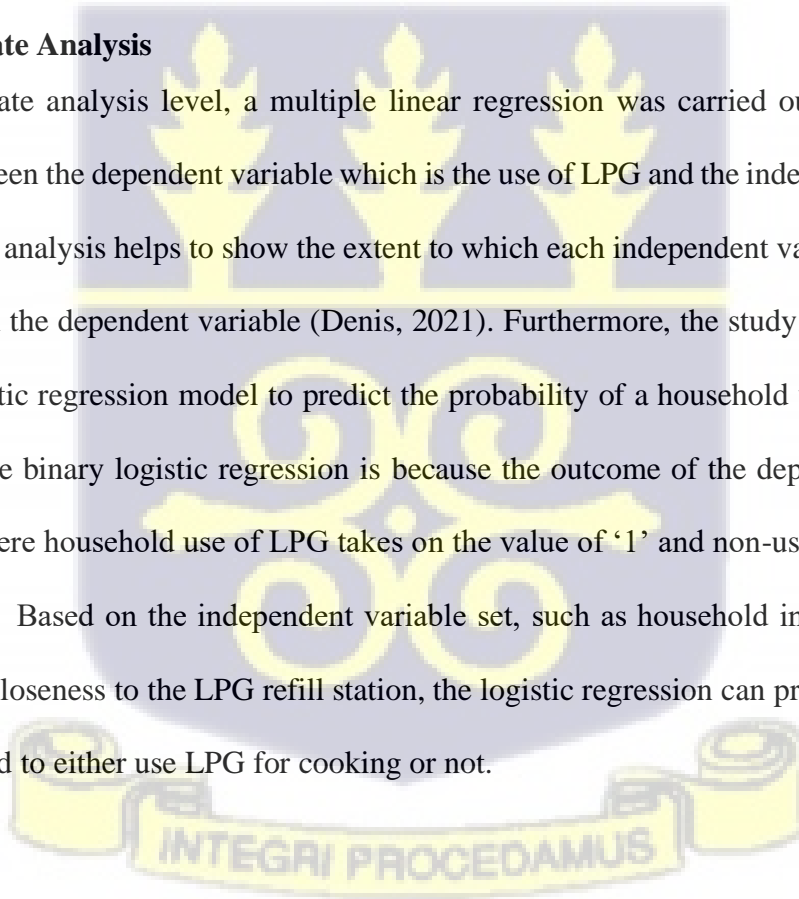
The univariate level of analysis refers to the analysis that is considered using a single variable of interest to the study (Denis, 2021). The univariate level of analysis was computed using frequencies and tables. These frequencies were used to present an analysis of the statistical computations from the data set. Variables such as the socio-demographic characteristics of the household head were presented using frequencies.

3.8.2 Bivariate Analysis

The study used cross-tabulation and a chi-square test of significance to perform bivariate analysis to investigate the effects of some independent variables on the dependent. The chi-square statistic is used to test the relationships between categorical variables. It assesses whether the observed counts are significantly different from the expected count (Denis, 2021). Thus, the study performed a cross-tabulation analysis to assess the relationship between the socio-demographic characteristics of the household head and the use of LPG. A chi-square test was also used in the study to examine the relationship between each of the independent variables and the dependent variable.

3.8.3 Multivariate Analysis

At the multivariate analysis level, a multiple linear regression was carried out to establish the association between the dependent variable which is the use of LPG and the independent variables. The multivariate analysis helps to show the extent to which each independent variable has a linear relationship with the dependent variable (Denis, 2021). Furthermore, the study employed the use of a binary logistic regression model to predict the probability of a household using LPG or not. The choice of the binary logistic regression is because the outcome of the dependent variable is dichotomous where household use of LPG takes on the value of '1' and non-use of LPG takes on the value of '0'. Based on the independent variable set, such as household income, location of household, and closeness to the LPG refill station, the logistic regression can predict how likely it is for a household to either use LPG for cooking or not.



3.8.4 Thematic Data Analysis

The study employed thematic data analysis in analyzing the qualitative gathered through key informant interviews conducted with key stockholders in the regulation and distribution of LPG in the study area. The interviews were transcribed and repeated patterns were identified and grouped into codes and further developed into themes. Discussions were made around the themes emanating from the data analysis relating them to relevant literature and the quantitative data. Thematic analysis was chosen because it is a suitable and efficient tool to employ when seeking to understand a set of experiences and ideas across a data set (Kiger & Varpio, 2020).

3.9 Ethical Consideration

The study holds ethics as a crucial part of conducting research. Hence a consent form (see appendix I) was designed comprising the purpose of the study, confidentiality, and anonymity of the respondent. The consent was read to the respondent before the interview guide is administered. The respondents were assured that the research was for educational purposes only and that any information given to us would not be disclosed to a third party. Therefore, all respondents participated freely without any compulsion. Also, introductory letters (See appendixes IV and V) from the Institute of Statistical Social and Economic Research seeking consent to conduct key informant interviews were sent to institutions in advance to facilitate the process.

3.10 Conclusion

The chapter presents the research methodology and data analysis framework for the study on LPG utilization in the Wa Municipality. Employing a mixed research approach, the study combined quantitative and qualitative methods to comprehensively investigate the use of LPG among households in the Wa municipality. Quantitative techniques involved a survey to gather data from households, which were analyzed descriptively and inferentially.

Data analysis encompassed univariate, bivariate, multivariate, and thematic approaches to explore relationships and patterns in the data. In-depth interviews with key stakeholders were conducted for qualitative insights and analyzed thematically. The target population encompassed households within the Wa municipality and key stakeholders within the LPG industry.

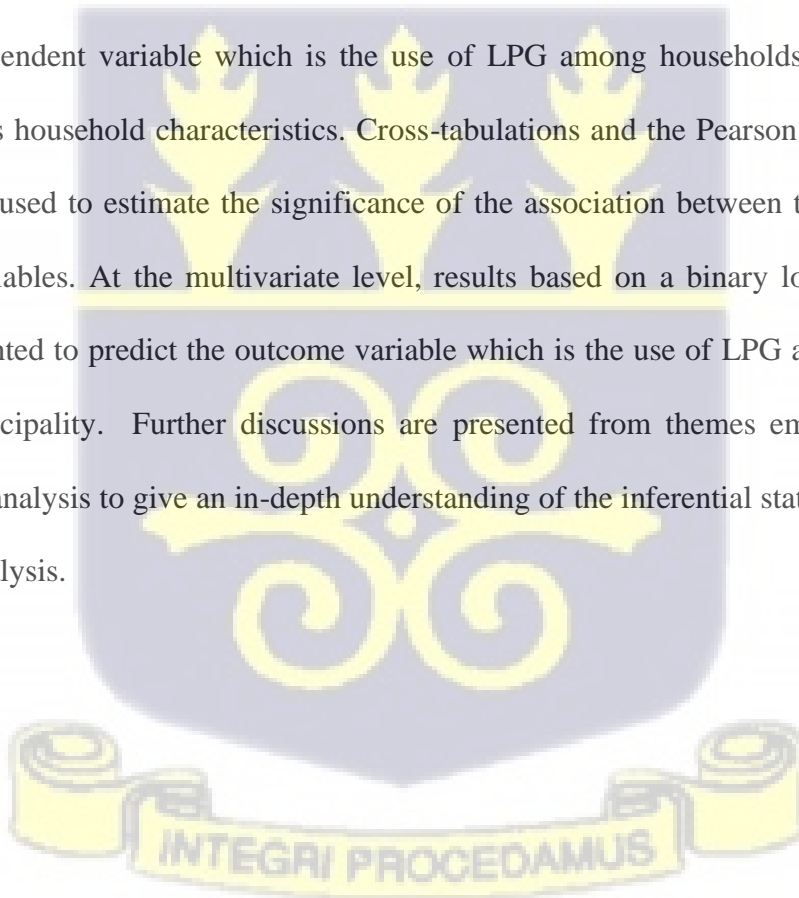


CHAPTER FOUR

ANALYSIS AND DISCUSSIONS OF FINDINGS

4.0 Introduction

Household cooking fuel choice is a multi-dimensional process defined by several social, demographic, and environmental contexts and bound by resource limitations. This chapter analyses and presents results on the use of LPG for cooking among households in the Wa municipality. The results are presented in four levels of analysis; univariate, bivariate, multivariate and thematic analysis. The first level focuses on the descriptive statistics of household background characteristics and household heads. The second section of the chapter looks at the relationship between the dependent variable which is the use of LPG among households and independent variables such as household characteristics. Cross-tabulations and the Pearson chi-square test of significance are used to estimate the significance of the association between the dependent and independent variables. At the multivariate level, results based on a binary logistics regression model are presented to predict the outcome variable which is the use of LPG among households in the Wa municipality. Further discussions are presented from themes emanating from the qualitative data analysis to give an in-depth understanding of the inferential statistics presented at each level of analysis.



4.1 Background Characteristics of Household Heads

The study through a designed interview guide collected primary data from a total of 220 households in the study area and conducted key informant interviews with relevant stakeholders including officials from the Wa municipal assembly, Managers of four LPG refill stations, and officials from the National Petroleum Authority-Wa. Table 4.1 shows the distribution of heads of households by selected background characteristics.

First of all, an observation of the data on the age of household heads indicates an almost even distribution with the largest proportion of household heads (29.1%) being between the ages of 26 and 35. A lower proportion of household heads (7.7%) were less than 26 years while household heads who were more than 55 years accounted for 19.5% of the total distribution. With regards to the sex composition of the household heads, the majority of household heads (66.4%) were males which aligns with data from the Ghana Living Standards Survey 7 on household headship in Ghana (GLSS 7, 2017). Furthermore, data on the marital status of household heads shows that most household heads (79.1%) were currently married while 20.5% of household heads were not married. With regard to the educational attainment of household heads, the distribution indicates that more than 60% of household heads had some form of formal education, with a higher proportion (42.3%) of them attaining tertiary education. A lower proportion of household heads (10%) had completed Junior High school while 34.5% of them had no formal education. Also, data analysis on the size of households shows that the majority (54.5%) of them had a membership size of between 4-6 persons while a low percentage (4.5%) of households had more than 10 persons. This aligns with statistics from the GLSS 7 which estimates the average household size in the Upper West region to be 4.8 members (GLSS,2017).

Furthermore, after computing the wealth groups of households using household assets, the household wealth group distribution indicates that close to half (45%) of the households surveyed were classified under the middle wealth group while a little above 20% of households (22%) were categorized under the rich wealth group. Again, the results illustrate that more than 50% of households resided in flats/apartments with a slightly lower proportion (44.1%) living in compound houses. It can be observed that a negligible number of households (3.6%) resided in uncompleted building structures.

The distribution of tenancy agreements showed that more than half of households (56.8%) resided in their own dwelling units while a lower proportion (9.1%) of them resided in a rent-free housing unit. Households who lived in rented dwelling units formed 32.3% of the distribution. Furthermore, the distribution presented data on household locations with the aim of understanding the dynamics in the use of cooking fuels by household location. The study classified households into urban, suburban and rural based on data from the Town and Country Planning Department (TCPD) of the Wa Municipal Assembly annual budget report 2021. The distribution shows that a higher percentage of households (42%) were located in urban areas while a slightly lower percentage (40%) were located in suburban areas. A little below 20% of households sampled were located in rural sitting. Regarding the cooking space used by households, a higher proportion of them (42.7%) used the veranda/porch as their main cooking space while a slightly lower percentage (36.4%) of households had a separate room for the exclusive use of the household. A low percentage (2.7%) of households had their separate cooking space shared with other households. The data further indicates that 14.5% of households cooked in the open space. This implies that more than 70% of households cook in an enclosed area which has health implications, especially for households that use biomass (charcoal and firewood) for cooking.

Furthermore, the distribution indicates that over 95% of households were connected to the national grid as their main source of electricity with not more than 5% using solar or flashlights as their main source of electricity. This conforms with the country’s national statistics which indicate that more than 80% of households in Ghana are connected to the national grid (Kemausuor & Ackom, 2017). It can be deduced from the data on household electricity use, that there is slow adoption of renewable sources of energy such as solar among studied households in the Wa municipality. Table 4.1 below shows a statistical summary of the background characteristics of household heads.

Table 4. 1 Percent Distribution of Background Characteristics of Household Head

Respondents Characteristic	Number	Percent
Age		
18-25 years	17	7.7
26-35 years	64	29.1
36 - 45 years	54	24.5
46 - 55 years	42	19.1
56+years	43	19.5
Sex		
Male	146	66.4
Female	74	33.6
Marital Status		
Currently not married	46	20.5
Currently Married	174	79.1
Educational Attainment		
No formal education	76	34.5
Junior High School	22	10.0
Senior High School (S.H.S.)/ (O’level)	29	13.2
Tertiary	93	42.3
Household Size		
1-3 members	53	24.1
4-6 members	120	54.5
7-10 members	37	16.8
More than 10 members	10	4.5

Respondents Characteristic	Number	Percent
Household Wealth Group		
Poor	73	33
Middle	99	45
Rich	48	22
Type of Housing Unit		
Compound House	97	44.1
Flat/Apartment	115	52.3
Uncompleted building	8	3.6
Location of Household		
Urban	92	42
Suburban	88	40
Rural	40	18
Tenancy Agreement		
Own dwelling unit	125	56.8
Rent-free dwelling unit	20	9.1
Rented dwelling unit	71	32.3
Others	4	1.8
Type of Cooking Space		
Open Space in Compound	32	14.5
Separate room for the Exclusive Use	80	36.4
Separate room shared with others	14	6.4
Varanda/ Porch	94	22.7
Main Source of Electricity		
Electricity (Mains Grid)	213	96.8
Electricity (Solar Panel)	3	1.4
Flashlight/Torchlight	4	1.8
Total	220	100

Source: Field Data,2022

4.1.1 Background of Respondents of Key Informant Interviews

The study conducted Key Informant Interviews with key stockholders in the regulation and distribution of LPG in the Wa municipality. An interview was conducted with an official of the National Petroleum Authority (NPA) in the Wa municipality. Furthermore, two officials from the Wa Municipal Assembly took part in the study as key informants. Separate interviews were conducted with four managers of different LPG refill stations within the study area. This was aimed at gaining an in-depth understanding of the use of LPG among households and some of the issues emanating from the quantitative data analysis. Table 4.2 shows the demographic characteristics of participants of the key informant interviews.

Table 4. 2 Demographic Characteristics of Key Informant Interviewees

Age	Frequency	Percentage
20-35 Years	3	43%
35-45 years	4	57%
Sex		
Male	5	71%
Female	2	29%
Level of Education		
Senior Secondary School	3	43%
Tertiary	4	57%
TOTAL	7	100

A total of seven key informant interviewees were purposeful selected to take part in the study. The data presented in table 4.2 shows that majority of participants in the key informant interview were between the age of 35-45 with 57% of them attaining tertiary education. With reference to sex, a great percentage of participants were males with females forming 29% of the total distribution.

4.2 Main Cooking Fuel Among Households in the Wa Municipality

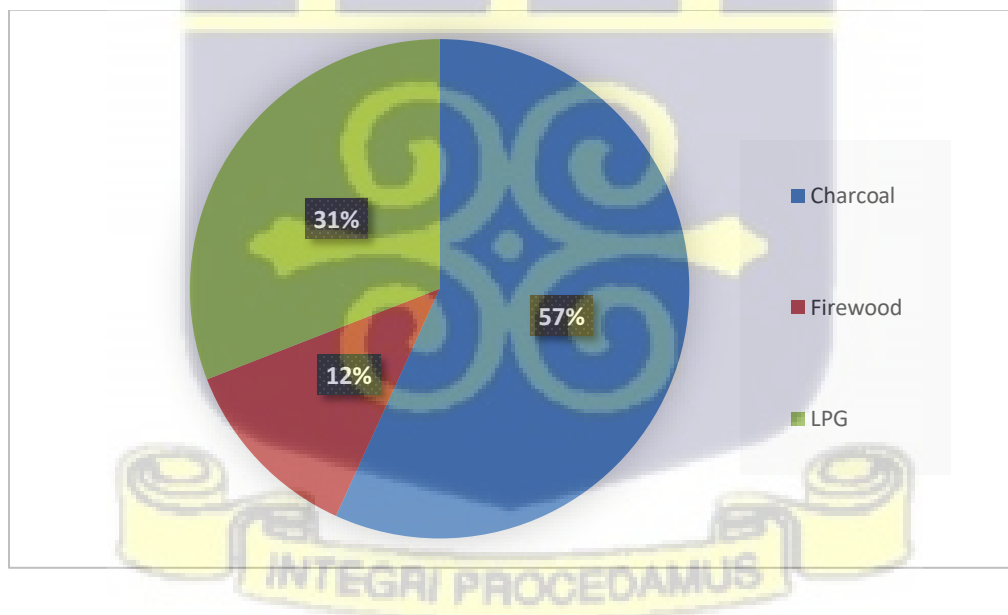
An observation of the data analysis presented in figure 4.1 indicates that a majority of the studied households (69%) within the Wa municipality use biomass (Charcoal or firewood) as their primary cooking fuel. This aligns with national statistics on the dominant use of wood and charcoal as main cooking fuels among households in Ghana. The 2021 Population and Housing Census Report indicates that more than 70% of households in the Upper West region used either wood or charcoal as their main cooking source (GSS, 2021). An observation made in an interview with an official of the National Petroleum Authority confirmed that most households in the study area turn to the use of biomass for cooking. He observed that:

“... here (the study area) most of the natives don't really use LPG, they rely mostly on charcoal and firewood. Those who mostly use LPG are people who have traveled from other places to work here and students... last week we just moved from community to community educating people on the use of gas but we released that most of them did not use it (LPG)..” (Regional Manager NPA, 2022)

A disaggregation of the data presented in figure 4.1 shows that the use of charcoal formed the highest proportion (57%) of fuels used primarily for cooking among households. This was said to be due to the availability and comparatively low price of charcoal to LPG within the municipality. The cost of fuel continues to be a key consideration for households. Many households choose charcoal because it is less expensive than LPG or electricity. Furthermore, because of its lightweight, charcoal is easy to transport and store, unlike gas which needs to be handled with precaution due to its explosive nature. This makes charcoal readily available and a preferred choice of households.

It can further be observed that the use of LPG as a primary source of cooking fuel is encouraging with more than 30% of households indicating that they used LPG as their main source of cooking fuel. This is probably a result of the LPG promotion program of the government which aimed at ensuring that 50% of Ghanaians have access to LPG for both domestic and industrial use (Kemausuor et al.,2011). Another contributing factor is the increase in the number of LPG refill stations within the study area, making it more accessible to households. Moreover, the study found that the use of firewood as a primary cooking fuel recorded the lowest proportion among households (12%). This aligns with studies by Makonese et al., (2018) who observed that urbanization has resulted in charcoal becoming the main source of cooking fuel while firewood declines. Also, Akpalu et al., (2011) argue that charcoal is preferable to firewood for household usage because it has higher energy levels compared to firewood.

Figure 4. 1 Main Cooking Fuel Among Studied Households in the Wa Municipality



Source: Field Data,2022

The pronounced use of biomass within the study area has implications for both the environment and health. Charcoal production is recognized as a key contributor to deforestation. This is because charcoal production includes the felling and burning of trees making it an unsustainable source of fuel. Lurimuah (2011) observed that in the Upper West region, trees are usually cut at 40 cm above the ground which may impede the tree from coppicing.

Furthermore, indoor air pollution increases the risk of acute respiratory diseases by double the risk hence regular smoke exposure constitutes a serious health risk (Po & Carlsten, 2011). The combustion of charcoal produces toxic smoke, which is said to be one of the leading causes of respiratory diseases, especially among women and children (Abdul-Wakeel Karakara, & Dasmani, 2019). Women and children are the most affected by biomass smoke exposure since they take up the duty of cooking in the family. Moreover, women and children tend to spend a significant time in the collection and processing of fuelwood which leads to a loss of productive hours and exposure to potential dangers such as snake bites (Eshetu, 2014).

4.2.1 Household Location and Main Source of Cooking Fuel

Household location refers to where the household is situated in the study area. The influence of household location on the use of clean cooking fuels such as LPG has been extensively discussed in the empirical literature. Hence the study disaggregated data on the main cooking fuel of households by location to understand the influence of location on the type of cooking fuel used by households. The data analysis as presented in table 4.3 shows that the use of charcoal is pronounced in all locations with a slightly higher percentage (28%) of households in suburban areas using charcoal as their main source of cooking fuel. An observation of the data analysis further shows that out of the 31% of households who indicated that they used LPG as their main source of cooking fuel, a low percentage (2%) of them were located in rural areas. This aligns with studies

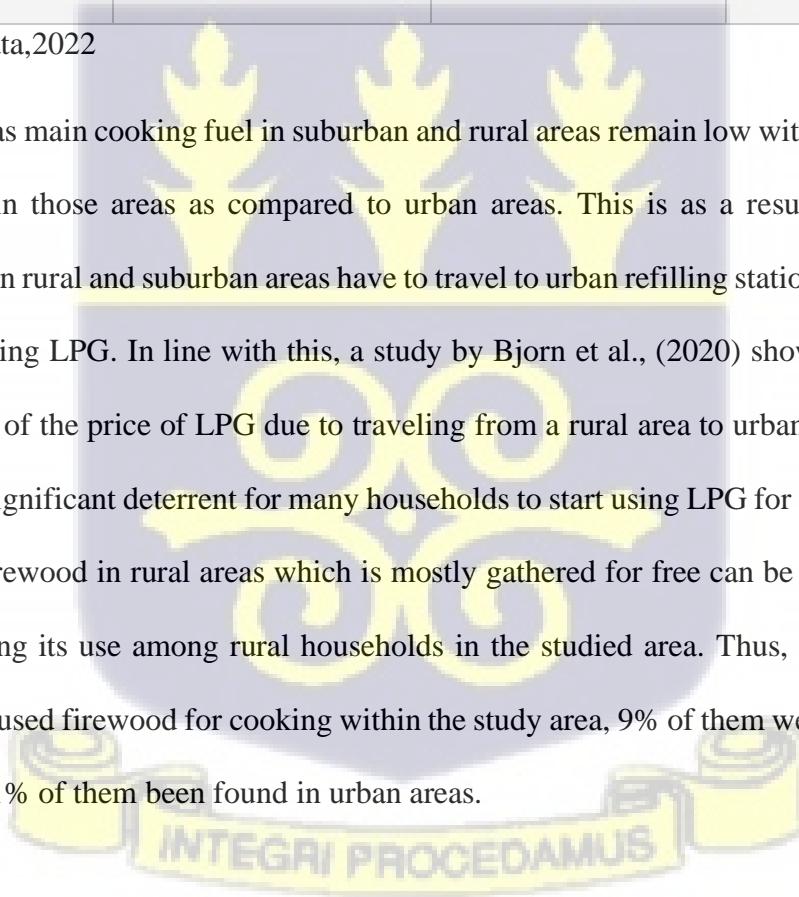
by Pope et al., (2018), who indicated that urban households were more likely to report LPG as their primary fuel compared to rural households.

Table 4. 3 Location of Household and Main Cooking Fuel

Location of Household	Main Cooking Fuel (Percentage %)		
	Charcoal	LPG	Firewood
Urban	22	19	1
Suburban	28	10	2
Rural	7	2	9
Total	57	31	12

Source: Field Data, 2022

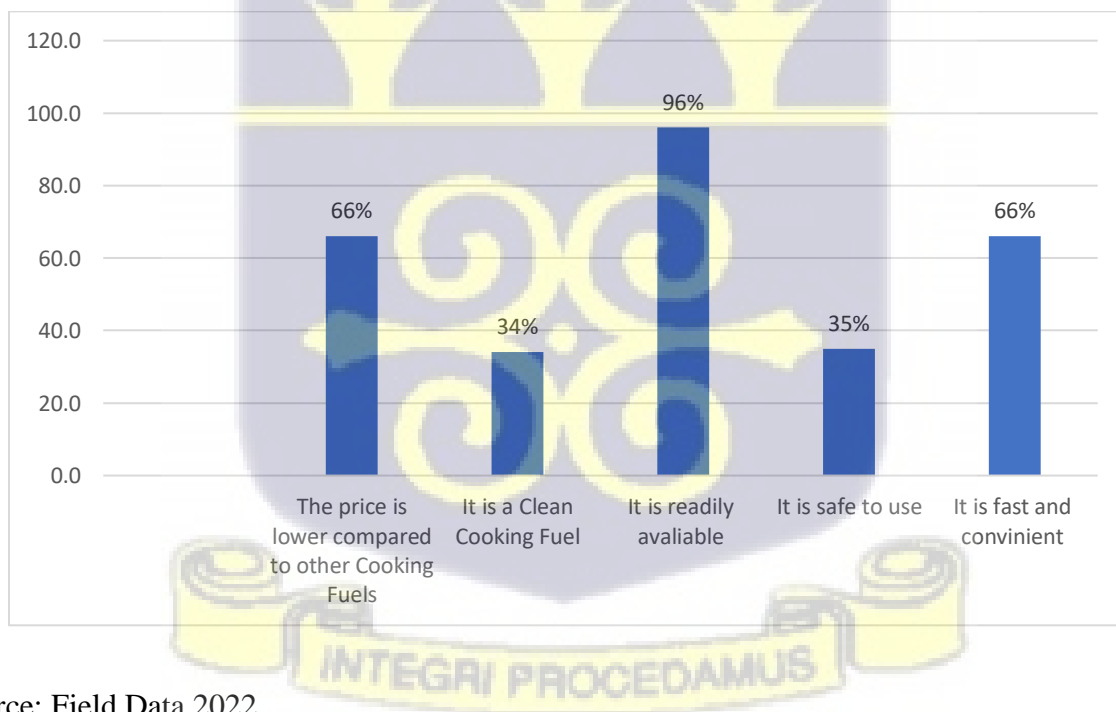
The use of LPG as main cooking fuel in suburban and rural areas remain low with a higher demand for wood fuels in those areas as compared to urban areas. This is as a result of the fact that households within rural and suburban areas have to travel to urban refilling stations thereby driving up the cost of using LPG. In line with this, a study by Bjorn et al., (2020) shows that there is an incremental cost of the price of LPG due to traveling from a rural area to urban refilling stations, and therefore a significant deterrent for many households to start using LPG for cooking. Also, the availability of firewood in rural areas which is mostly gathered for free can be said to be another factor encouraging its use among rural households in the studied area. Thus, out of the 12% of households who used firewood for cooking within the study area, 9% of them were located in rural areas with only 1% of them been found in urban areas.



4.2.2 Reasons for the Use of Traditional Biomass as Primary Cooking Fuel

Diverse reasons account for the use of biomass among households in the study area. An analysis concerning the reasons for the use of biomass as presented in figure 4.2 indicates that the majority of households (96%) use biomass as their primary cooking fuel because it is readily available. This is because charcoal is produced in many surrounding communities making the fuel available throughout the year. According to Agyman et al. (2012), the bulk of charcoal in Ghana is produced in the Upper West Region, making the fuel relatively inexpensive and readily available. Households prefer to use a source of cooking fuel that they can easily access and afford. This makes the use of biofuel more pronounced among households since it can be bought with relative ease as compared to LPG.

Figure 4. 2 Reasons for the Adoption of Biomass as a Main Cooking Fuel



Source: Field Data,2022

An equal percentage of households (66%) indicated that they use traditional biomass because the price is lower compared to other cooking fuels such as LPG and because it was fast and convenient to use. This infers that price plays a major role in determining the type of fuel a household uses in the study area. Firewood and charcoal in the study area are relatively cheaper compared to LPG and hence an increase in the price of LPG is most likely to lead to an increase in the use of biomass. In an interview with an LPG refill station manager, it came up that people in the study area use more charcoal because of the increasing price of LPG. The LPG refill station manager during the interview observed that:

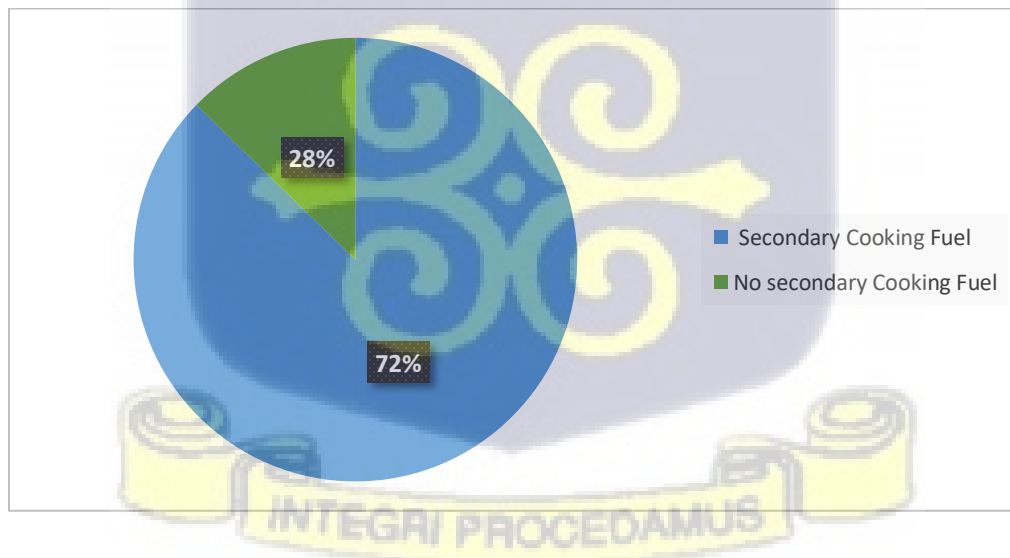
“... for charcoal, the price is lower compared to gas, you can easily buy charcoal at a low price so people here buy more of it than gas which is expensive. Even those who use gas are beginning to use charcoal all because of the continuous increase in the price...”. (LPG Refill Station Manager, October 2022).

Thus, as Pallegedara & Mottaleb, (2018) observed, an increase in the price of LPG leads to an increase in the use of cheaper and dirty fuels such as firewood and charcoal. Hence a key component of promoting the use of LPG would be to reduce the price of fuel through subsidies since this has the potential of increasing usage among households. A low proportion of households (34%) indicated that they adopted biomass as their primary cooking fuel because it is a clean source of cooking fuel. This infers that close to half of households in the study area are not aware that traditional fuels are pollutant fuels due to the smoke they emit and hence cannot be classified as a source of clean cooking fuel. This reemphasizes the need to create awareness by designing educational programmes that would enlighten people on the health and environmental dangers associated with the use of traditional fuels such as charcoal and firewood.

4.3 Fuel Stacking Among Studied Households in the Wa Municipality

According to the Fuel Stacking hypothesis, using several fuels is required for a variety of reasons and modern fuels are just a partial, not a perfect, replacement for traditional fuels (Muller & Yan, 2018). The result as presented in figure 4.3 shows that the phenomenon of using multiple sources of fuel for cooking is prevalent among households in the studied communities. A high proportion of households (72%) apart from their main cooking fuel, used a secondary source of cooking fuel. This aligns with a study conducted by Dongzagla & Adams (2022) observed that 72% of households in Wa who rely on LPG for cooking also use charcoal. On the other hand, a significantly low percentage (28%) of households used only one source of cooking fuel, thus they had no secondary cooking fuel. This observation aligns with Beltramo et al., (2015), who reported that the price and availability of fuels differ and hence households shift between different fuels over time rather than transitioning completely from dirty fuels to clean fuels.

Figure 4. 3 Use of Multiple Cooking Fuels Among Studied Households



Source: Field Data, October 2022

Also, the findings of the study align with Muazu & Ogujiuba (2020) who stated that the energy-ladder theory does not sufficiently elucidate the dynamics of households' fuel choices. Most households in the study area cook with both clean and dirty fuels simultaneously rather than transiting completely from dirty fuel to clean fuel as postulated by the energy-ladder theory. Furthermore, the findings of the study imply that the determinant of the use of cooking fuels is multifaceted and hence economic factors such as household income cannot sufficiently explain the dynamics involved in the use of fuels among households in the studied areas.

4.3.1 Reasons for Fuel Stacking Among Households

Multiple factors account for the desire to use multiple fuels simultaneously by households in the Wa municipality. An analysis of the data on the factors influencing the use of multiple fuels shows that a majority of households (76%) use multiple cooking fuels because they wanted to save time through simultaneous cooking. This implies that the cooking needs of some households in the study area cannot be met by a single source of cooking fuel, hence the use of multiple sources of cooking fuels. Further analysis of the data shows that a high proportion of households (56%) used a secondary source of cooking fuel to mitigate the risk of shortage of their primary cooking fuel. This aligns with a study conducted by Mensah & Adu, (2015), who found that households in Ghana maintain a combination of LPG and charcoal for cooking, with charcoal being used during periods of LPG shortage. This point was supported by an official of the Wa Municipal Assembly who in an interview observed that:

“...the unavailability of gas is also a reason why people use other cooking fuels such as charcoal. You know that gas is not always available in this area but as for charcoal, you can just get it from close by markets.” (Municipal Planning Officer, October 2022)

A study conducted by Alhassan (2018) reports that unreliable supplies of certain cooking fuels require households to rely on different sources of energy. For instance, during the rainy season, it becomes difficult to harvest firewood leading to a switch to charcoal (Smith & Schreckenber, 2017). Furthermore, Karimu & Adu (2018), in a study conducted in Ghana found that reliability is a key determinant of household fuels since most households have daily needs for cooking and heating. This means that to promote the sustained use of LPG, there would be a need to develop a reliable LPG network system that ensures the availability of LPG. Thus, to resolve the incidence of LPG shortage in the Wa municipality, there is a need to expand the distribution and retailing networks. Currently, only six LPG refill stations serve the Wa municipality which may not be able to ensure the availability of LPG currently or in the future.

Also, 45% of households who use multiple sources of cooking fuel indicated that they preferred to cook certain dishes with particular cooking fuels. For example, certain foods were said to take a long time to cook, and hence it was preferable to use charcoal. A study conducted by Gill- Wiehl & Kammen, (2021) discovered, that many households are stacked with firewood and won't transition to other fuels because of how simple it is to prepare a staple food in the area using a wood burner. This point is supported by an observation made by an LPG Refill station attendant who said:

“... People also believe that some dishes cannot be prepared using gas. Something like Bambara beans takes a long time to cook hence it's better to use charcoal. You can cook with charcoal and heat the food with gas.” (LPG Refill Station Manager, October 2022)

Again, the data shows that a low percentage of households (5%) attributed their decision to use multiple cooking fuels to their interest in maintaining the taste of certain dishes. This implies that the perception that cooking with LPG can change the taste of food is not pronounced among the studied households. This aligns with a study conducted by Gould and Urpelainen (2018), who reported that households remark on differences in food tastes when transitioning from wood-burning stoves to LPG. In contrast, studies by Hollada et., (2017) indicate that households frequently comment on differences in food taste when transiting from biomass to LPG.

Figure 4. 4 Reasons Attributed to the Use of Multiple Cooking Fuels



Source: Field Data, 2022



One reason attributed to the use of multiple fuels among households was the quest of households to use cooking fuels over a prolonged period. This came up in an interview with a refill station manager who observed that:

“...It (using multiple cooking fuels) is to ensure that the gas lasts longer. The gas lasts longer when you support it with charcoal. I used to fill my gas cylinder but when the price jumped to GHS195.00 I decided to buy charcoal which is GHS 75.00 a bag from a village. If I merge the two it will take me two to three months. So, I will be buying half of the cylinder from now on.”

(LPG Refill Station Manager, October 2022)

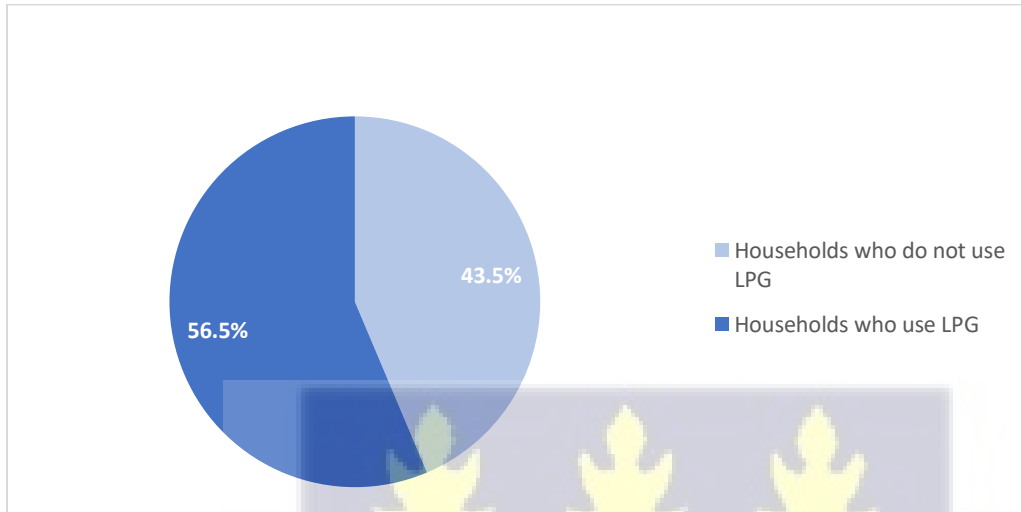
The study concludes that as reported in a study by Ogwumike et al., (2014), apart from the cost of using LPG having a significant impact on households' decisions, there are many different reasons why people utilize multiple fuels that are not solely based on economic considerations as postulated by the energy ladder theory where household income is the key determinant of household cooking fuel.

4.4 Use of LPG Among Studied Households in the Wa Municipality

The study seeks to assess the use of Liquefied Petroleum Gas (LPG) as a source of cooking fuel among households in the Wa municipality. An analysis of the data shows that 56.5% of households used LPG for cooking while 43.5% of households either used only charcoal or firewood for cooking. This aligns with statistics on cooking fuels in Ghana which indicates that in the past three decades, there has been a decrease in the use of conventional biomass. According to Ghana Statistical Service (GSS) data from 2019, household use of wood decreased from 69% in 1990 to 46.48% in 2016/17 (GSS,2019). This decrease could be the result of policy initiatives such as the

government's recent LPG promotion program and an increase in the number of LPG refill stations in the municipality.

Figure 4. 5 Use of LPG as Cooking Fuel Among Studied Households



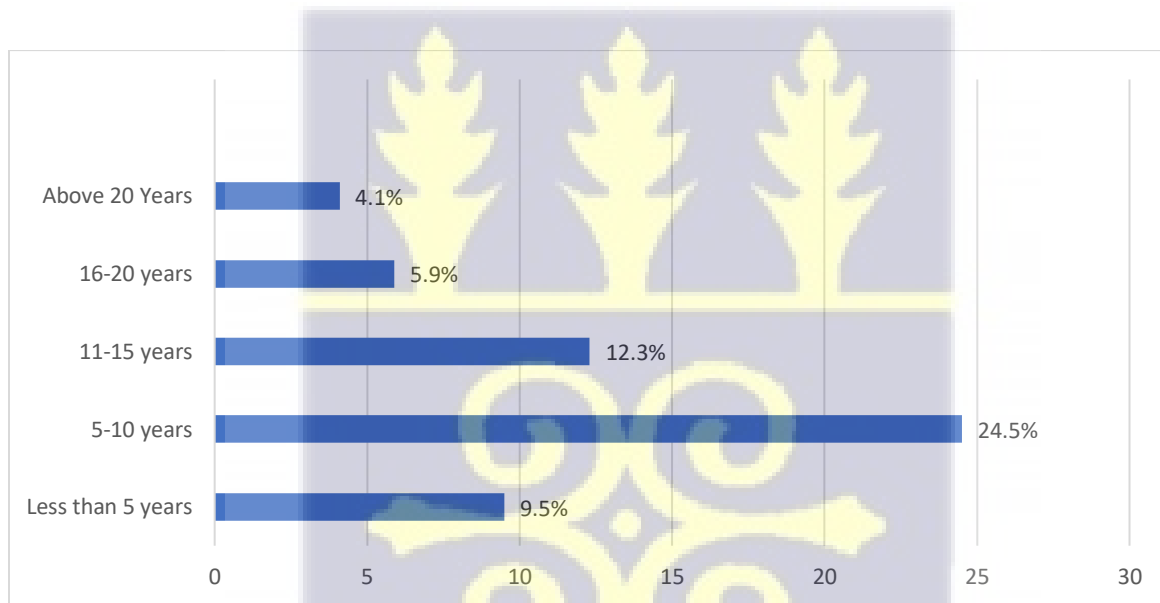
Source: Field Data, 2022

It can be deduced from the data analysis that, although a good percentage of households use LPG for cooking, only 31% of them adopted it as their main cooking fuel. Hence a majority of households who adopt LPG, use it as a secondary cooking fuel. Furthermore, the data analysis illustrates that a majority of households in the Wa municipality do not practice a linear transition between cooking fuels as postulated by the energy ladder model. This is in line with the findings of a study conducted by Gould and Urpelainen, (2018) in India who reported that fewer than 60% of LPG consumers consider it their primary cooking method, and even within this group, households regularly utilize other fuels to prepare various dishes. Rather than completely abandoning traditional fuels after switching to LPG, households in the study area who use LPG prefer to continue using biomass as cooking fuel, a phenomenon known as fuel stacking.

4.4.1 Number of Years of Using LPG Among Studied Households

Based on the number of years of using LPG in the study area, five categories were established. An observation of the data presented in figure 4.6 shows that less than 5% of households have used LPG for more than 20 years while the highest percentage of LPG users (24.5%) have been using the fuel for cooking for a range of five to ten years. From the trend observed in figure 4.5, It can be inferred that the adoption of LPG increases as the year range decreases. This aligns with studies by Mensah & Adu, (2015), using panel data on the use of LPG in Ghana observed a marginal increase in household use of LPG as a source of cooking fuel.

Figure 4. 6 Years of usage of LPG Among Studied Households



Source: Field Data, October 2022



Also, the study observed that close to 50% of LPG users adopted the fuel within the last decade which implies that an increasing number of households are adopting LPG as a source of cooking.

Furthermore, an interview with an official of the National Petroleum Authority revealed that:

“...the level of use of LPG has increased among households but most natives still use biomass.

Now we are moving forward but at a slow pace. The patronage of LPG is high. It has increased over the years....” (Regional Manager NPA, 2022)

Therefore, it can be inferred that the level of use of LPG is on the rise, with an increasing number of households using the fuel for cooking with each passing year. However, LPG is mostly used as a secondary source of cooking fuel with most households combining its usage with other traditional fuels. The slow pace at which the use of LPG is increasing in the study area indicates that such effort needs to be put in place if the provision of access to clean and efficient cooking fuel like LPG is to be achieved.

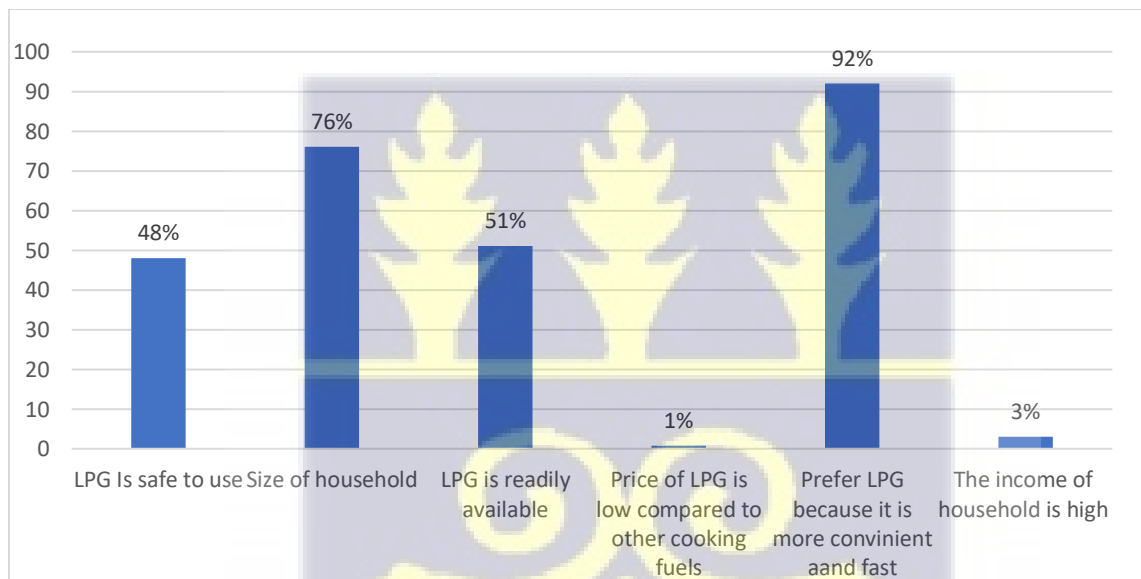
4.4.2 Reasons and Frequency of the Use of LPG as Cooking Fuel

Households who adopted LPG as a source of cooking fuel indicated that a major factor that influenced their decision to use LPG for cooking was because it is a fast and convenient way of cooking. This reason was attributed to, a significantly high percentage of households (92%). Further analysis of the data shows that the size of the household was another factor influencing the adoption of LPG among households. Thus, a high proportion (76%) of households who use LPG indicated that the small size of their household played a role in their decision to adopt LPG for cooking. This point was supported in an interview with officials of the Wa municipality:

“...If the family is large you need to use charcoal because you will need to cook for a large number of people which the gas cannot do but if it is a small number of people you can resort to the use of gas” (Municipal Planning Officer, October 2022).

This aligns with studies conducted by Brooks et al., (2016) who reported that large households were more likely to use traditional biomass taking into consideration other factors such as household income.

Figure 4. 7 Reasons for the use of LPG as Cooking Fuel Among Studied Households

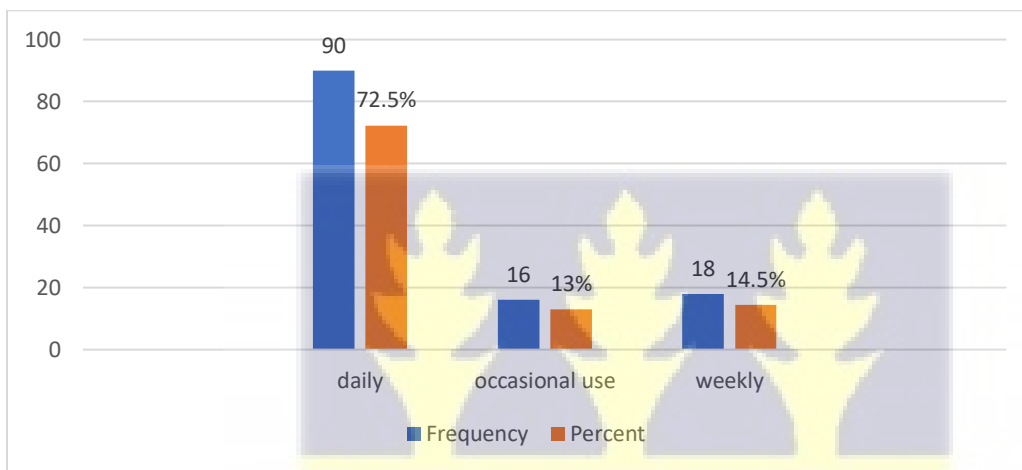


Source: Field Data, 2022

Also, it can be observed that less than 50% of households indicated that they adopted LPG for cooking because it was safe. This implies that some households who use LPG still have certain safety concerns about the use of fuel for cooking. Other factors such as the high income of the household and the low price of LPG were among the least factors influencing the adoption and use of LPG among households. A significantly low percentage of households (1%) indicated that they adopted LPG because it has a comparatively lower price than other fuels. This infers that the price

of LPG is perceived as high even among households who adopted LPG for cooking. Furthermore, the study sought to find out how frequently LPG was used among households that adopted the fuel for cooking. The analysis presented in figure 4.8 indicates that out of the 124 households that use LPG for cooking, a significant proportion of them (72.5%) used LPG daily with only 14.5% and 13% using it weakly and occasionally respectively.

Figure 4. 8 Usage frequency of LPG Among Studied Households



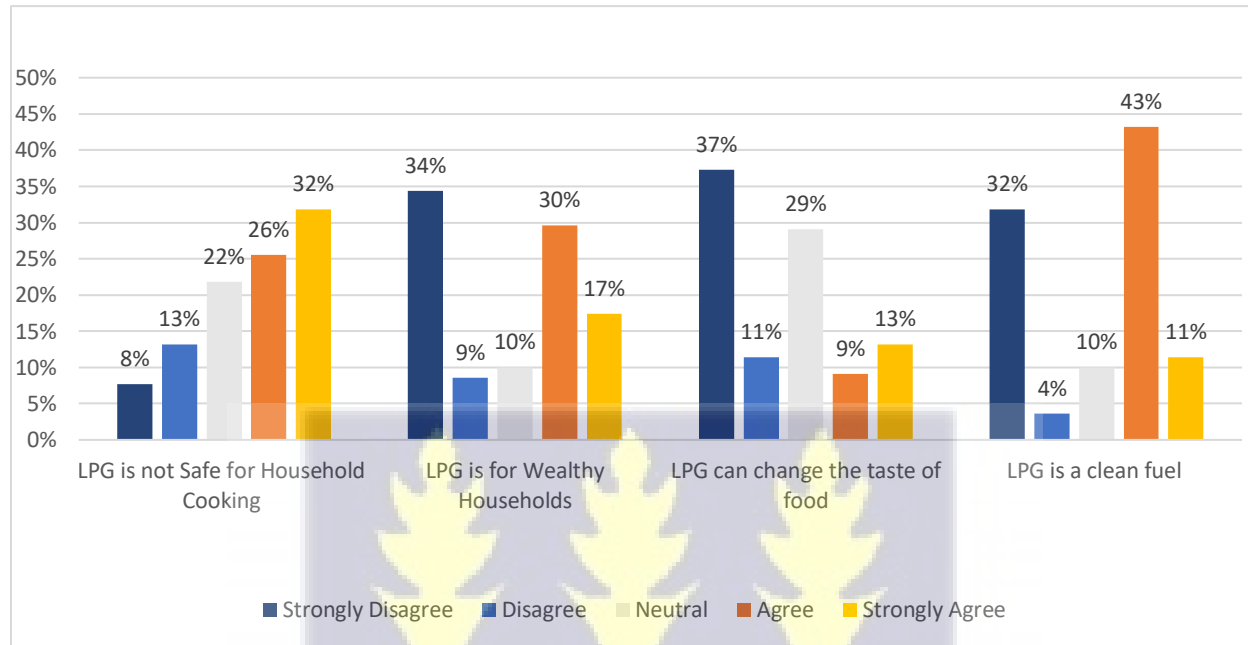
Source: Field Data, 2022

4.5 Level of Knowledge of Households on the use of LPG as a source of cooking fuel

The study sought to measure the perception of LPG users on the use of LPG as a source of cooking fuel. This was done using a 5-pointer Likert scale. The data analysis shown in figure 4.9 indicates that a majority of households do not perceive LPG to be a safe source of cooking fuel. Close to 60% of households indicated that they either agreed or strongly agreed that LPG is not a safe source of cooking fuel while a significantly low percentage of households (21%) indicated that they disagreed or strongly disagreed with the proposition that LPG is not a safe source of cooking.

This aligns with research conducted by Dalaba et al., (2018) who reported that LPG is perceived as dangerous among households in Ghana.

Figure 4.9 Perception of Households on the Use of LPG for Cooking



Source: Field Data, 2022

With regards to the perception of whether using LPG to cook could change the taste of the food, a significant percentage (37%) of households strongly disagreed that using LPG to cook could alter the taste of the food as compared to using other cooking fuels such as charcoal. Close to 30% of households indicated that they had no idea whether cooking with LPG could change the taste of food. This can be attributed to the fact that some households had never used LPG and hence could not make an informed decision on whether using the fuel to cook could change the taste of food. Regarding the perception of LPG being a fuel for wealthy households, a slightly higher percentage of households (47%) strongly agreed or agreed that the use of LPG was more predominant among

wealthy households. A slightly lower percentage of households (43%) either disagreed or strongly disagreed that LPG is adopted mostly by wealthy households.

It can be inferred from the data analysis that most households are of the view that LPG is for wealthy households. In support of this view, an interview with officials of the Wa municipality said that: “... Yes, it is true, LPG is for the rich. If you want to fill gas you have to sweat. I am working but I feel it’s hard to fill my gas cylinder.... So I think LPG is for the rich” (Municipal Planning Officer, October 2022)

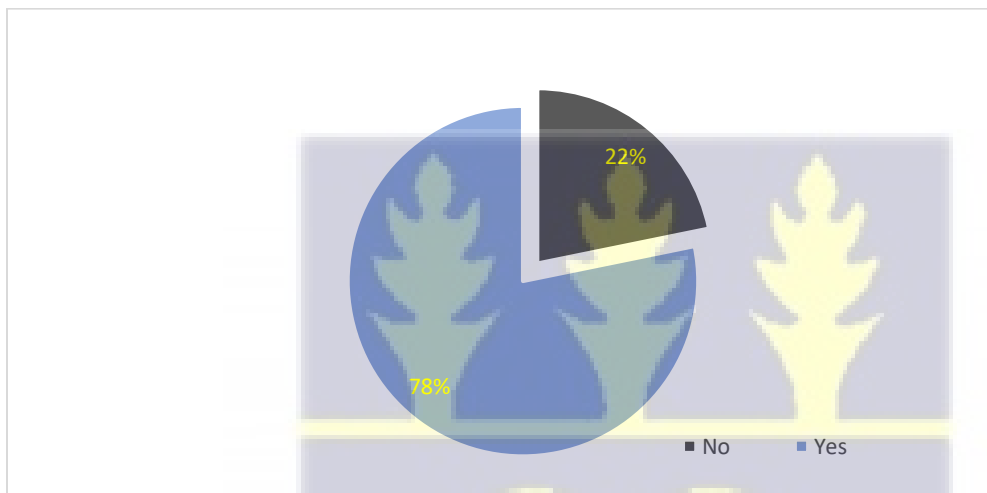
The perception of LPG being for the rich has the potential of reducing its use among households since households who do not consider themselves rich would not make efforts to adopt and use LPG for cooking. Also, the perception of LPG for the rich is due to the cost related to its usage, hence there is the need to subsidize both the cost of uptake and refilling LPG. When it comes to the perception of households on whether LPG is a clean source of cooking fuel, more than half of households (54.5%) interviewed indicated that they either agreed or strongly agreed that LPG is a clean source of cooking fuel. A comparably low percentage of households (32%) indicated that they strongly disagreed with the perception that LPG is a clean source of cooking fuel. It can be inferred from the data analysis that a good number of people are still unaware that biomass such as charcoal is a pollutant fuel and is associated with some environmental and health implications.



4.5.1 Knowledge of Safety Protocols Among Studied Households

An observation of the data shows that a high percentage of households had some form of knowledge about the recommended standards or safety protocols that must be followed to ensure the safe use of LPG. From the data presented in figure 4.9 22% of households indicated that they did not know how to safely use LPG as a source of cooking fuel while over 70% of respondents indicated that they had some knowledge regarding the safety protocols guiding the use of LPG.

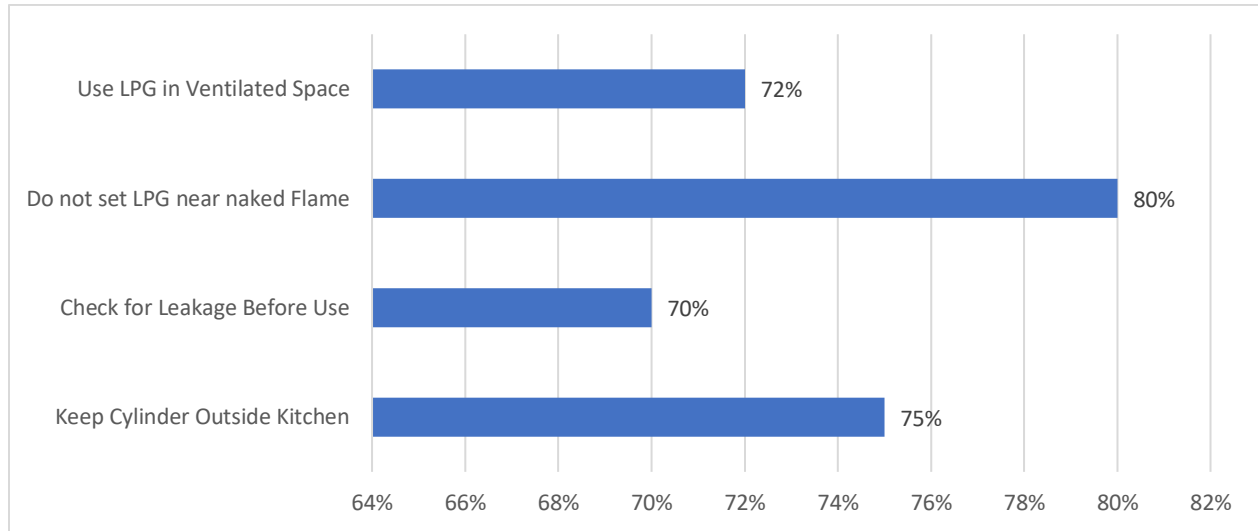
Figure 4. 10 Knowledge of Safety Protocols Among Studied Households



Source: Field Data,2022

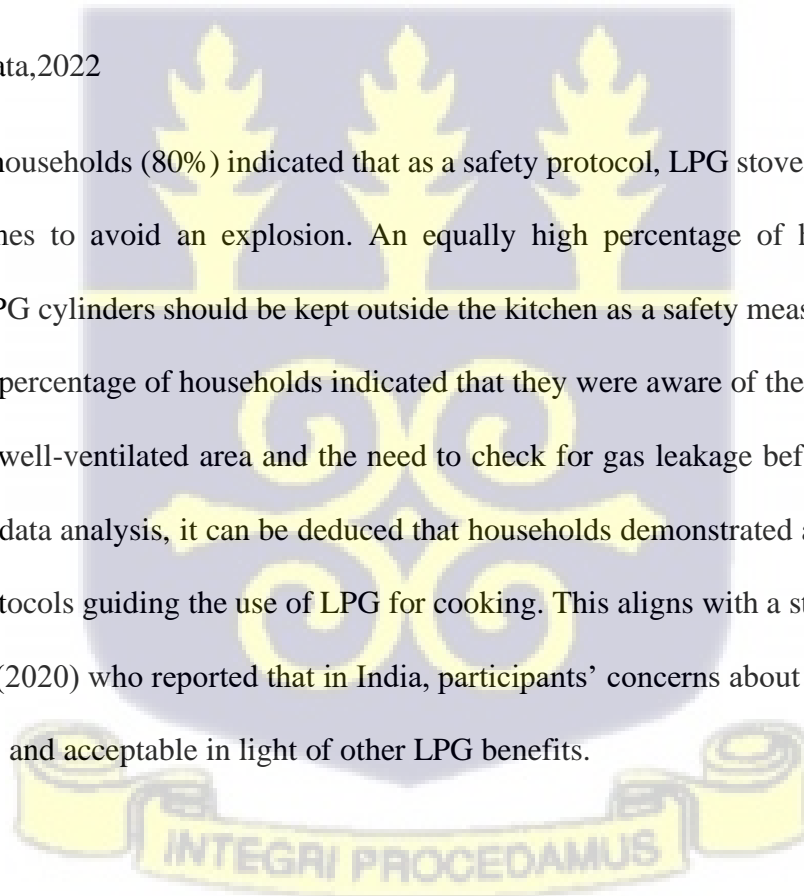
Respondents who indicated that they had some knowledge of the safety protocols guiding the use of LPG were asked to indicate the various safety protocols they were familiar with. An analysis of the data shows that a high proportion of households demonstrated a good level of knowledge concerning the safety standards of using LPG.

Figure 4. 11 Knowledge of Safety Protocols Among Households



Source: Field Data,2022

Majority of the households (80%) indicated that as a safety protocol, LPG stoves should not be set near naked flames to avoid an explosion. An equally high percentage of households (72%) indicated that LPG cylinders should be kept outside the kitchen as a safety measure. Furthermore, an almost equal percentage of households indicated that they were aware of the safety protocol of using LPG in a well-ventilated area and the need to check for gas leakage before turning on the stove. From the data analysis, it can be deduced that households demonstrated a good knowledge of the safety protocols guiding the use of LPG for cooking. This aligns with a study conducted by Williams et al., (2020) who reported that in India, participants' concerns about the safety of LPG were as minimal and acceptable in light of other LPG benefits.



4.5.2 Knowledge of Proper Handling of LPG Cylinder Among LPG Users

LPG is an inflammable gas which implies that users of LPG must observe some safety standards when using it especially for cooking in the household. Thus, proper knowledge of handling LPG cylinders and other accessories is vital to use LPG safely. Therefore, the study sought to assess the knowledge level of LPG users on the safety protocols and safe handling of LPG cylinders. This was done by examining some of the safety measures outlined by the National Petroleum Authority. These included, how the LPG cylinder is transported after refill, where it is stored within the household, and knowledge of the household regarding the retesting date for their LPG cylinder.

4.5.2.1 Position of Cylinder for Transportation

The standard practice is to store LPG cylinders vertically and securely with chains or straps when transporting them after refilling (Amorin & Dabo, 2022). This is important because transporting cylinders horizontally can cause an explosion due to high-pressure build-up. LPG users in the studied area were asked to indicate how they transported their gas cylinders after refilling. From the data analysis presented in table 4.4 a greater percentage of households (85%) in the studied area did not transport LPG cylinders by the safety standards. Majority of households positioned their gas cylinder horizontally, which has the potential of causing an explosion.

Table 4. 4 Placement of Cylinder After Refill

How Households Place LPG cylinder After Refill	Frequency	Percent (%)
Vertical Position	19	15
Horizontal Position	105	85
Total	124	100.0

Source: Field Data, 2022

Only 15% of LPG users transported their cylinders safely by placing them vertically. Since most people in the study area use motorbikes to transport their LPG cylinders, it becomes difficult to place the cylinder vertically. The practice of not properly transporting LPG cylinders after refilling is dangerous and calls for more education to enlighten users on how to safely transport LPG after refilling.

4.5.2.2 Storage of LPG Cylinders

The use of LPG inside the kitchen could lead to an explosion due to the heat generated from ongoing cooking activities. It is, therefore, advisable to place LPG cylinders outside the kitchen to avoid such an occurrence.

Table 4. 5 Place of Storage of LPG Cylinder

Place of Storage	Frequency	Percentage %
Inside Kitchen	37	29
Outside Kitchen	88	71
Total	124	100

Source: Field Data, 2022

Households who use LPG were asked to indicate where they stored their cylinders. The data presented on storage at home in table 4.5 shows that a majority of households store their LPG cylinders outside the kitchen, which is a very safe practice. On the other hand, there are close to 30% of households still store their cylinders inside the cooking area, therefore exposing them to the danger of explosion. This is as a result of the fact that some households do not fully understand the potential hazards associated with storing LPG cylinders in close proximity to cooking flames. Furthermore, in some households, the living spaces are compact, leaving little room for alternative storage locations.

4.5.2.3 Mandatory Test Date

Although LPG cylinders do not have a set expiration date, it is required by law to be tested after every five years. LPG cylinders come with mandatory dates for retesting to ensure that cylinders are still in good shape for use. However, it is reported that most LPG cylinders are not sent for retesting when imported into the country. Consequently, many of these cylinders remain in circulation despite nearing or even surpassing their mandatory retest dates (Amorin & Dabo, 2022).

Table 4. 6 Knowledge of Mandatory Testing Data

Knowledge of Mandatory Testing Data	Frequency	Percentage %
Yes	18	15
No	106	85
Total	124	100

Source: Field Data,2022

LPG users in the study area were asked to indicate whether or not they had some knowledge about the date for retesting their cylinders. The data analysis presented in table 4.6 shows that a majority of households (85%) in the study area did not know the mandatory date for retesting their cylinders. This infers that many households in the study area do not test the safety status of their cylinders after buying them which is dangerous and against the safety standards of using LPG for cooking. Therefore, to prevent any potential explosion of gas cylinders, there is a need to disseminate information regarding the need to properly check for the mandatory retesting data of their cylinder.

4.6 Conditions Under Which Studied Household Would Adopt LPG

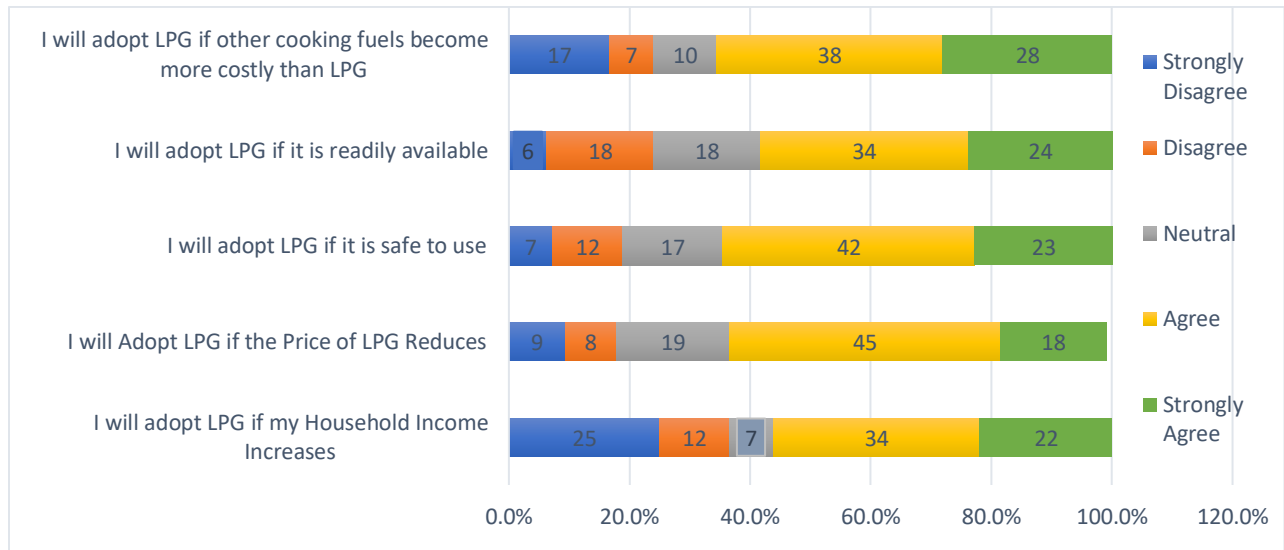
Households who did not use LPG as cooking fuel were asked to indicate the conditions under which they would adopt and use LPG. An analysis of the data as presented in figure 4.12 shows that more than 50% of households agreed or strongly agreed that they will adopt LPG if their household income increased. This aligns with the energy ladder theory which holds that an increase in household income will positively influence the adoption of cleaner fuels. Households who agreed to adopt LPG if their household income increases were more than those who either strongly disagree or disagree. Only 7.3% of households indicated that they had no idea of the effect the increase in their household income would have on their willingness to adopt LPG.

Furthermore, a higher percentage of households (62%) indicated that they would adopt LPG as a source of cooking fuel if the current price of LPG is reduced while less than 20% of households either strongly disagreed or disagreed that a reduction in the price of LPG would lead to their adoption LPG for cooking. This implies that the high cost associated with the use of LPG deters some households from adopting it as a source of cooking fuel. This point was supported in an interview with an official of the National Petroleum Authority, it came up that:

“... The cost of gas is a big problem and people will move back to charcoal. If the government wants to promote the use of LPG then we must subsidize it.” (Regional Manager NPA, 2022)



Figure 4. 12 Conditions Under Which Studied Households Would Adopt LPG



Source: Field Data, 2022

When it comes to the cost of other cooking fuels, 65.6% of households either strongly agreed or agreed that they will adopt LPG if the price of other cooking fuels (charcoal and firewood) becomes more costly than that of LPG, a lower percentage of households (15%) indicated that they would not adopt LPG even if it becomes cheaper than other cooking fuels. With regards to safety, a high proportion of households (42%) indicated that they will adopt LPG if they are convinced that LPG is a safe source of cooking fuel. This implies that safety concerns are a deterrent to the use of LPG. The uncertainty surrounding the safety of LPG is another obstacle preventing the switch to modern fuel.



There is widespread apprehension about the safety of utilizing LPG for cooking. According to a study done in Ghana by Dalaba et al. (2018), safety concerns were more frequently given as a reason why respondents in urban areas did not use LPG. The study can therefore conclude that the decision to change from the use of traditional fuels to the use of modern cooking sources such as LPG in the study area is not solely dependent on economic factors but is also influenced by factors such as the availability of the fuel and perception of the safety of the fuel.

4.7 Factors Associated with the use of LPG in Studied Households

This section examines the relationship between some selected socio-demographic characteristics of households such as educational attainment, wealth group, distance to the nearest LPG refill station, and the use of LPG in the studied households using Cross-tabulations and the chi-square test of significance. Pearson Chi-square test statistics were computed for each independent variable and the dependent variable with reference to a 95% confidence interval or an alpha value of 0.05 significance. Therefore, a chi-square test statistical value below 0.05 shows a significant relationship between the two variables. A significant association between the dependent and independent variables means that a change in one corresponds to a considerable rise or decrease in the other. Each of the association tests is discussed below.

4.7.1 Household Wealth and the Use of LPG in the Studied households

The study hypothesized that low-income households are less likely to adopt LPG as a cooking fuel source compared to households classified under the rich wealth group. This is supported by the energy ladder hypothesis, which states that as household income rises, they prefer to switch to cleaner cooking fuels like LPG. Hence, households with high wealth status are more likely to use LPG for cooking since they have enough funds to cover the expense of utilizing LPG.

Table 4. 7 Household Wealth Groups and the Use of LPG in the Studied Area

Wealth Group	Use of LPG as Cooking Fuel by Household		Total
	No	Yes	
Poor	40	33	73
Middle	47	52	99
Rich	9	39	48
Total	96	124	220

Source: Field Data,2022

 $\chi^2 = 16.375$ df=2 p-value = 0.00

An analysis of the data indicated that at a 95% confidence level, there is a significant ($P < 0.000$) association between household wealth status and the use of LPG among households in the studied areas. This aligns with a study conducted in Cameroun by Pope et al., (2018) which shows that LPG consumption was also significantly correlated with owning assets and income level. The results imply that households under the rich wealth category are more likely to use LPG compared to those classified under the poor wealth group. This is consistent with the findings of Faisal et al., (2013) who explored the links between energy use and income levels among Ghanaian households and discovered a positive relationship between charcoal or LPG and income levels. It is observed that 81% of the households belonging to the rich wealth group used LPG for cooking. This implies that a significantly low percentage of households (19%) under this category did not use LPG. For households classified under the poor wealth group, it can be observed that more than 50% of them did not adopt LPG as a cooking fuel. This is due to the cost associated with using LPG. Households under this category adopted other sources of fuels that are comparatively cheap and can be bought in small portions.

The result also shows that among the 124 households who adopted LPG as a source of cooking fuel, a low percentage (27%) of them belong to the poor wealth group with the majority of households who adopted LPG belonging either to the middle wealth group (42%) or the rich wealth group (31%). This aligns with the energy ladder theory which postulates that high household income is positively related to the use of cleaner fuel.

4.7.2 Educational Attainment and Use of LPG Among Studied Households

The study hypothesized that the high educational attainment of the household head will result in the use of LPG as cooking fuel. This was based on the premise that well-educated household heads were likely to be gainfully employed and had enough resources to cover the cost of using LPG. Also, household heads with higher educational attainment are expected to know the benefits of using LPG and hence would adopt LPG for cooking. Results from table 4.8 show that educational attainment is significantly ($p < 0.000$) associated with the use of LPG. It can be observed that out of the 56.4% of the 220 households that indicated that they use LPG, more than 45% of them had household heads who attained some level of formal education. Furthermore, the results indicate that a higher proportion of households (32.3%) that use LPG in the Wa municipality had household heads who had obtained tertiary education. Also, an observation of the data shows that as the educational attainment of the household head increased from Junior High School to Senior High School, there is an increase in the percentage of households that use LPG.

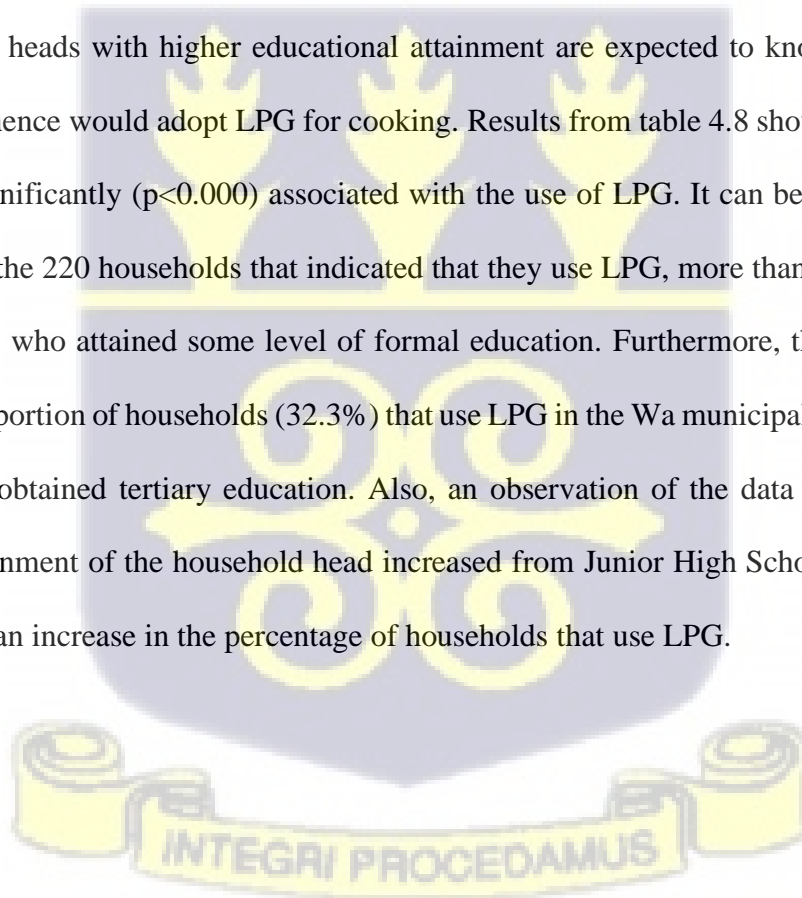


Table 4. 8 Educational Attainment and Use of LPG in Studied Area

Educational Attainment	Use of LPG as Cooking Fuel Percentage (%)	Number of Households
No formal education	10.5%	76
Junior High School	5.0%	22
Senior High School (S.H.S.)/ (O'level)	8.6%	29
Tertiary	32.3%	93
Total	56.4%	220

Source: Field Data,2022

 $\chi^2 = 37.436$ df=2 p-value = 0.000

The data analysis shows that out of the 56.4% of the total households that use LPG, 45.9% of them had household heads with some level of formal education. This is similar to studies conducted by Mensah & Adu (2014); Nlom & Karimov (2014) and Karakara, (2018) who reported that education is positively related to clean fuel usage and, hence, access to education increases the probability of using clean fuels.

4.7.3 Perception of Safety and the Use of LPG Among Studied Households

Table 4.9 shows the perception of household heads and the use of LPG as cooking fuel. The chi-square test statistics show that there is a significant association between the perception of LPG as a safe cooking fuel and its adoption by households. The chi-square p-value is < 0.000, indicating a strong relationship between the perception of household heads on the safety of LPG and the use of LPG for cooking. This is in line with a study by Puzzolo et al, (2016) who reported that a lack of knowledge of safe LPG use and fear of LPG explosions were a deterrent to the adoption of the fuel.

Table 4. 9 Perception of Safety and Use of LPG in Studied Area

LPG is safe for Cooking	Use of LPG as Cooking Fuel Percentage (%)	Number
Yes	51%	122
No	5.4	12
Total	56.4%	124

Source: Field Data,2022 $\chi^2 = 30.898$ df=2 p-value = 0.000

The results presented above demonstrate that majority of households (51%) who adopted LPG for cooking perceive LPG to be a safe cooking fuel. This implies that how safe a source of cooking fuel is perceived to be, plays a major role in influencing its adoption. Therefore, education to address the safety concerns of people has the potential of increasing its usage. A significantly low percentage of households (5.4%) who perceived LPG as a dangerous source of cooking fuel adopted it for cooking. The same observation is made by Brownson et al., (2020), who reported that respondents who perceived LPG as harmful had an 88% lower likelihood of using LPG than those who did not perceive LPG as unsafe.

4.7.4 Distance to LPG Refill Station and Use of LPG in the Wa Municipality

Households were asked to indicate in minutes the travel time by foot to the nearest LPG refill station. The asymptotic chi-square test of independence value (P-value = 0.000) reveals a significant relationship between households' distance from an LPG refill station and LPG use. This is consistent with the findings of a similar study conducted by Adjei-Mantey et al., (2021), who found that the distance to the nearest LPG refill station was statistically significant, implying that LPG usage decreases with distance. The study observed that as the distance to the nearest LPG refill station increases, there is an increase in the number of households that do not use LPG as

cooking fuel. From the data analysis, 1.8% of households less than 1 hour from an LPG refill station did not use LPG as cooking fuel. This trend continues with more than 20% of households located between 3-4 hours' walk away from an LPG refill station not using LPG as a source of cooking fuel.

Table 4. 10 Show the distance to the nearest LPG station and the Use of LPG

Distance to nearest LPG refill station	Use of LPG as Cooking Fuel		Total
	No	Yes	
Less than 1 hour	4	28	32
1-2 Hours	20	33	53
3-4 Hours	46	50	96
Above 4 Hours	26	13	39
Total	96	124	220

Source: Field Data,2022

$\chi^2 = 22.489$ df=3 p-value = 0.000

Out of the total number of households using LPG, only 5.9% of households located more than 4 hours walk away from an LPG refill station adopted LPG as cooking fuel. The result highlights the importance of providing LPG distribution services to make the refilling of cylinders more convenient and has the potential of increasing adoption.



4.7.5 Household Location and Use of LPG Among Households

Table 4.11 presents data analysis on the association between location of households in the studied area and their use of LPG for cooking. The chi-square test of significance with a P-Value of < 0.103 shows that there is no significant association between the location of a household and their use of LPG in the studied area. However, a close observation of the data shows that a higher percentage of households (27%) located in urban areas used LPG as a source of cooking fuel while a slightly lower percentage of households (24%) used LPG in suburban households. Furthermore, a lower percentage (5.4%) of households located in rural area used LPG. This is in line with a study conducted by Delaba et al., 2018, which reported a substantial discrepancy between rural and urban LPG uptake: with fewer than 10% of rural households using LPG, compared to nearly 50% of urban households.

Table 4. 11 Household location and use of LPG

Location of Household	Use of LPG Cooking Fuel	
	Frequency	Percentage (%)
Urban	60	27
Suburban	52	24
Rural	12	5.4
Total	124	56.4%

Source: Field Data, 2022

$$\chi^2 = 4.540 \text{ df}=2 \text{ p-value} = 0.103$$

Different factors can be attributed to the differences observed in the rural- urban dynamics of using LPG. One of such factors is the additional cost incurred by households located in rural and suburban areas as they travel long distances to fill their cylinders. As observed by Broni-Bediako & Amarin (2018) in their study, inadequate refilling stations in rural areas have been the primary reason of rural inhabitants' poor patronage of LPG.

Along with the traveling cost of filling LPG cylinders, other variables that might impact LPG usage in rural areas include the cost and availability of alternative cooking fuels. For example, wood fuels are mostly cheaper in rural areas and firewood in particular is mostly gathered for free, making it a preferable choice among rural households. Furthermore, a study conducted by Karimu et al., (2016), show that urban households with better socioeconomic and demographic characteristics are more likely to utilize LPG as their primary cooking fuel than rural households. Hence these rural-urban disparity must prompt governments and other relevant stakeholders to formulate programs that are sensitive to these disparities.

4.8 Multivariate Level of Analysis

A binary logistics regression analysis was run at the multivariate level of analyses. The results predict the use of LPG which is the dependent variable taking into consideration independent variables ranging such socio-economic characteristics of respondents, household characteristics, and knowledge of safety regarding the use of LPG. A goodness of fit model was run to assess how well the observed data is aligned with the expected data. The output of the Hosmer and Lemeshow goodness-of-fit test was at 0.537 level of significance which shows that the model estimates fit the data at an acceptable level. From the model, while independent variables such as wealth group of household, sex, and education of household head, knowledge of safety protocols guiding the use of LPG were significant predictors, other variables such as the size of household, marital status of household head, and type of cooking space were found not to be significant predictors of the outcome variable.

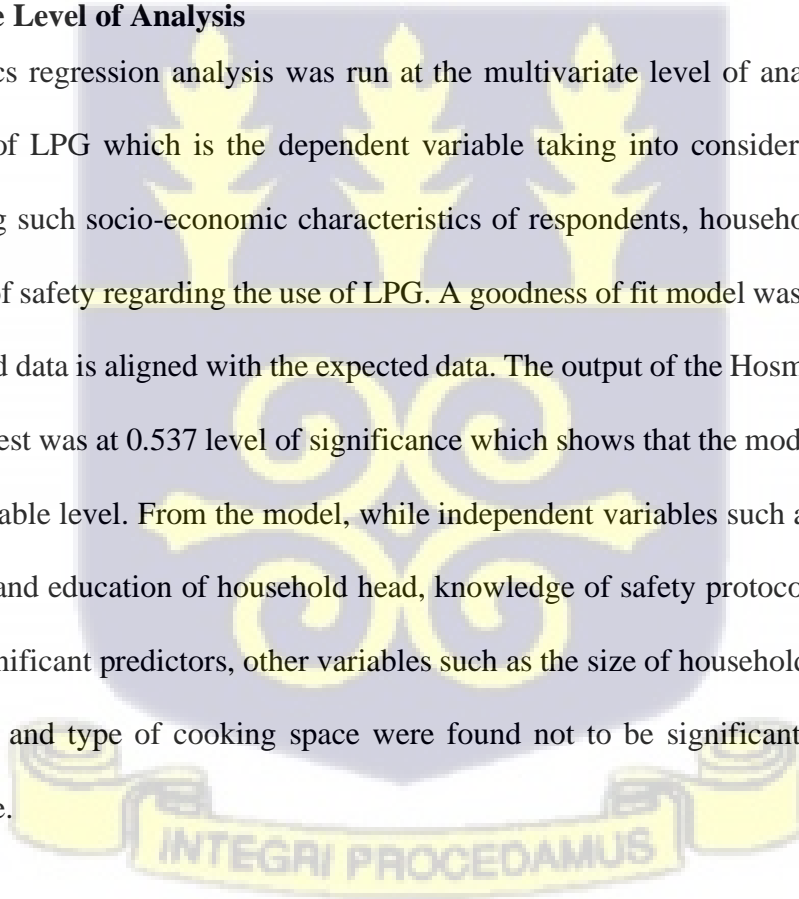


Table 4. 12 Show the Binary Logistics Regression Estimates

Explanatory Variables	df.	Sig.	EXP(B)
Household Size New	3	.408	
1-3 members	1	.519	2.023
4-6 members	1	.414	2.394
7-10 members	1	.963	.945
More than 10 members (RC)		1	
Age	4	.193	
18-25 years	1	.040	8.519
26-35 years	1	.327	2.125
36 - 45 years	1	.731	1.264
46 - 55 years	1	.684	.753
56+years (RC)		1	
Wealth Group	2	.051	
Poor wealth Group	1	.015	.121
Middle Wealth Group	1	.061	.250
Rich (RC)		1	
Sex of Household	1	*	*
Sex of household head		.087	.449
Female (RC)	1		
Highest Level of Education	3	.002	
Junior High School	1	.271	.426
No formal education	1	.000	.114
Senior High School/ O'level	1	.190	.431
Tertiary (RC)			

Explanatory Variables	df.	Sig.	EXP(B)
Marital Status	1	.746	.820
<i>Currently Married (RC)</i>	1		
Tenancy Agreement	3	.713	
Own dwelling Unit	1	.545	.607
Rent-free dwelling unit	1	.456	.331
Rented Dwelling Unit	1	.498	.722
<i>Others (RC)</i>	1		
Type of Housing Unit	2	.630	
Compound House	1	.338	.276
Flat/ Apartment	1	.380	.304
Uncompleted Structures (RC)	1		
Is LPG Safe for Cooking	1	.116	.407
<i>Yes (RC)</i>	1		
Do you know any safety tips regarding the use of LPG	1	.003	.141
<i>Yes (RC)</i>	1		

Source: Field Data, 2022

RC: Reference Category

At the multivariate level of analysis, the results from the binary logistics regression model showed that household size is not a significant predictor of the household's usage of LPG at $p=0.408$. Though not significant, results indicate that households with membership sizes between 1 to 10 are all more likely to use LPG as compared to households with more than 10 members. Furthermore, the age of the household head is a significant predictor of the household's usage of LPG. Household heads within the age group 18 to 25 years with a p-value of 0.04 is a significant predictor of the household's usage of LPG.

From the data analysis, household heads within the age group 18 to 25 are 7.5 times more likely to use LPG compared to those within the age group 56 years and above. This aligns with studies conducted by Mensah & Adu (2015), who found that in Ghana older household heads were less likely to transition to modern fuels than younger heads of households. Furthermore, household heads within the age group 26 to 35 years are 2.1 times more likely to use LPG as compared to those in the reference category (56+) whereas those within the age group 36 to 45 years are 0.26 times more likely to use LPG compared to those in the reference category.

The model further shows that the wealth group of the household is a significant determinant of whether the household will use LPG or not. Results from the model indicate that households within the poor and middle-wealth groups are all less likely to use LPG compared to households within the rich wealth group. Households within the poor wealth group are 0.12 times less likely to use LPG as compared to households within the rich wealth group.

An observation of the model shows that the sex of the household head is not a significant predictor of LPG usage. Results from the model indicate that male household heads are 0.45 times less likely to use LPG compared to female household heads. Also, household heads who are not married were found to be 0.82 times less likely to use LPG compared to those who are married, though the test association showed that marital status is not a significant predictor of a household's usage of LPG at an alpha value of 0.05. The educational status of the household head is a highly significant predictor of the household's usage of LPG with a p-value of 0.02. Results from the model show that household heads with no formal education, junior high school, and secondary education are all less likely to use LPG compared to those with a tertiary level of education.

The model predicts that household heads with no formal education are 0.1 times less likely to use LPG compared to those who attained tertiary education. Similar studies by Mensah & Adu 2014, show that higher educational attainment lowers the likelihood of households utilizing biomass. Furthermore, the model shows that there is a highly significant relationship between knowledge of the safety protocols guiding the use of LPG and its adoption as a source of cooking fuel. At a p-value of 0.003, the model predicts that households who did not know the safety standards guiding the use of LPG were 0.14 times less likely to use LPG as compared to households with knowledge of the safety protocols.

An observation of the model shows that the perception of whether LPG is a safe cooking fuel or not is not significantly related to its adoption and use when combined with other variables. However, the model predicts that households who perceived LPG as a dangerous source of cooking fuel are 0.14 times less likely to use LPG as compared to households who perceived LPG as a safe source of cooking fuel. Though not statistically significant, households living in compound/flats and apartments housing units are all more likely to use LPG compared to households living in uncompleted structures.

4.9 Challenges of Adopting LPG as an Alternative Cooking Fuel Among Households

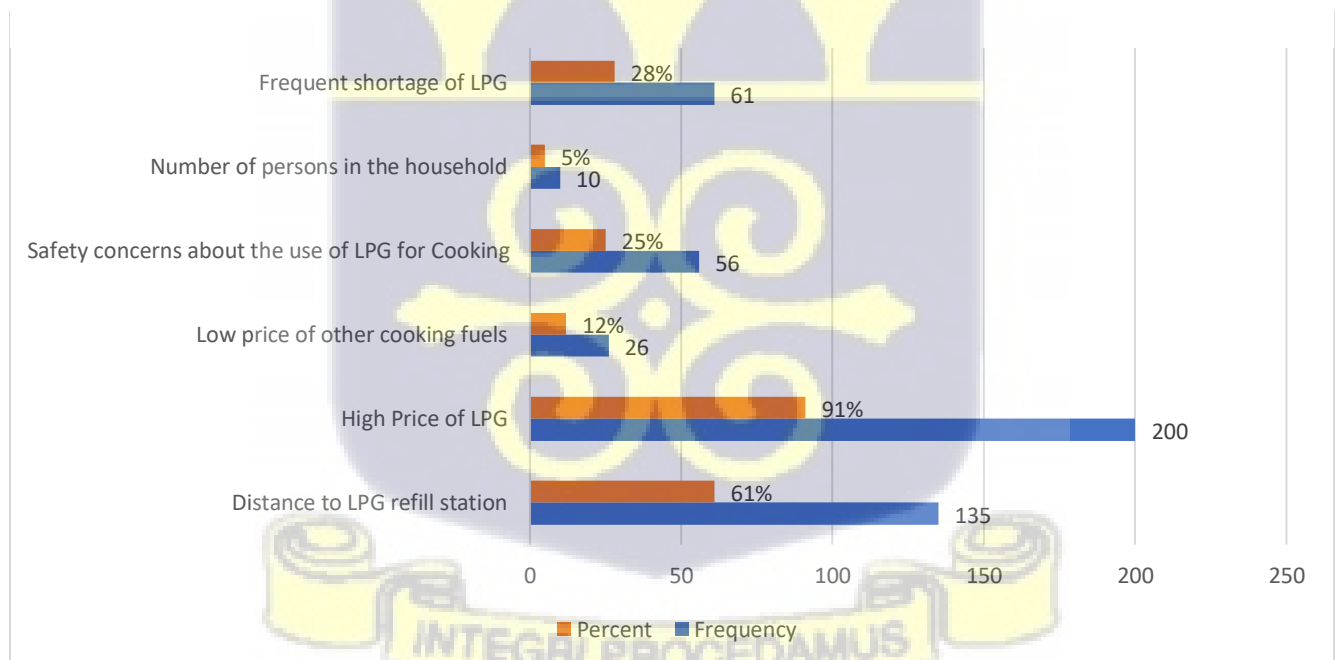
In response to the challenges faced by households in the Wa municipality regarding the use of LPG as a source of cooking fuel, more than 90% of respondents indicated that the high cost involved in using LPG is a major challenge to its adoption and use among households in the municipality. The cost of uptake and refilling the LPG cylinder, all form part of the cost component associated with using LPG. The price of LPG over the years has increased which tends to reduce patronage.

In support of the view above, an interview with a refill station manager revealed that:

“Gas is very expensive. The price was low but now it is very high and only a few people can afford it now. Even some people have stopped using gas because of the high price. The people still buying now buy in small quantities and no longer fill their cylinders.” (LPG Refill Station Manager, 2022)

This aligns with studies by (Puzzolo et al., 2016 and Beltramo et al., 2014) which indicate that cost is a significant factor preventing the sustained use of LPG among households in the studied area. Some households are not able to afford the needed accessories for the uptake of LPG and others switch back to traditional biomass after adopting LPG as a result of their inability to regularly refill their cylinders due to the cost.

Figure 4. 13 Shows the Challenges of Adopting LPG Among Households in the Studied Area



Source: Field Data, 2022

Another challenge associated with the adoption of LPG as indicated in the data analysis is the distance to LPG refill stations. Most households live very far away from LPG refill stations which are good in terms of safety but also imply that households have to travel a far distance with their LPG cylinders for refilling which comes at an extra cost. In support of the aforementioned challenge, an interview with officials of the Wa municipality implied that:

“The distance and the means of transportation are a challenge to the use of gas in the municipality. Because where you are staying and where the gas station is can be very far...”

(Municipal Planning Officer, October 2022)

One of the primary reasons for the low usage of LPG products in rural areas has been attributed to the lack of adequate refilling stations in these areas. For instance, the Wa municipality, which has more than 900,000 residents, only has six LPG refill stations that serve the entire municipality. Similar studies by Adjei-Mantey et al., 2021 in Ghana show that the distance of households from an LPG refill station reduces the use of LPG as a source of cooking fuel.

Furthermore, the incidence of shortage of LPG in the Wa municipality was identified as one of the major challenges to its adoption for cooking. Gould and Urpelainen, (2018) in their study found that while biomass is widely available, acquiring LPG requires supply networks which may limit its accessibility and contribute to infrequent usage. Hence it is not surprising that the periodic shortage of LPG deters some households from using it as a source of cooking fuel. Households in the study area are interested in using cooking fuels that are in constant supply and readily available. This further implies that households who use LPG may have to adopt other sources of cooking fuel to mitigate the possibility of a shortage of gas. While solid fuels are frequently free and widely available, acquiring LPG requires supply networks that are not under the control of households (Puzzolo et al., 2016; Bruce et al., 2017).

As a result, some households may have limited access to LPG, which contributes to infrequent use, fuel conservation, and fuel stacking. Hence to increase the use of LPG in the study area, there is the need to upgrade the LPG supply chain which would guarantee that the product is constantly accessible to consumers. Another identified challenge when it comes to the adoption of LPG in the Wa municipality is the fact that some households have some safety concerns regarding the use of LPG as a source of cooking fuel. Close to 30% of households were of the view that the safety concerns about the use of LPG for cooking is a major barrier to its adoption and use in the municipality.

This point was emphasized in an interview with a refill station manager who said:

“... Some of them fear using gas to cook because of the fear of it exploding. Also, the fear that one of your children would turn it on leading to a fire outbreak.... Some of them are also just afraid of the name gas.” (LPG Refill Station Manager, 2022)

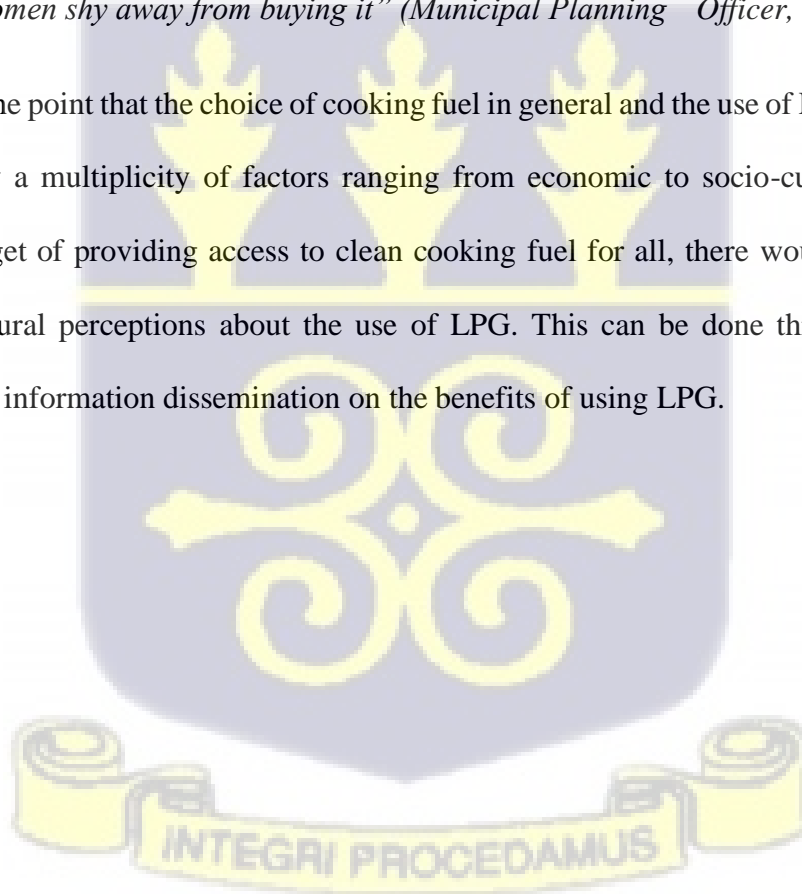
This aligns with a study conducted by (Hollada et al., 2017) who reported that many households express fear of the explosion of LPG cylinders and tanks in their households. Furthermore, Dalaba et al, (2018) in a study in Ghana reported that safety concerns were more commonly mentioned as a reason for not having LPG among urban respondents. The data analysis further shows that a low percentage of households (12%) perceive the low price of other cooking fuels as a major challenge to the adoption of LPG in the Wa municipality. The price of firewood and charcoal are relatively cheaper than LPG in the municipality and hence households are more likely to adopt them as their source of cooking fuel.

Some cultural behaviors were identified as a challenge to the adoption and use of LPG in the Wa municipality during a key informant interview with officials of the Wa municipality. The respondent indicated that some traditional norms and cultural perceptions regarding the use of LPG deter people from adopting the fuel.

The respondent observed that:

“Within the outskirts of the municipality, we still have some traditional beliefs that make it difficult to use gas. For example, women usually cook in the house and when a woman gets money and wants to buy gas, the men will classify them as boastful and arrogant. So that also makes the women shy away from buying it” (Municipal Planning Officer, October 2022)

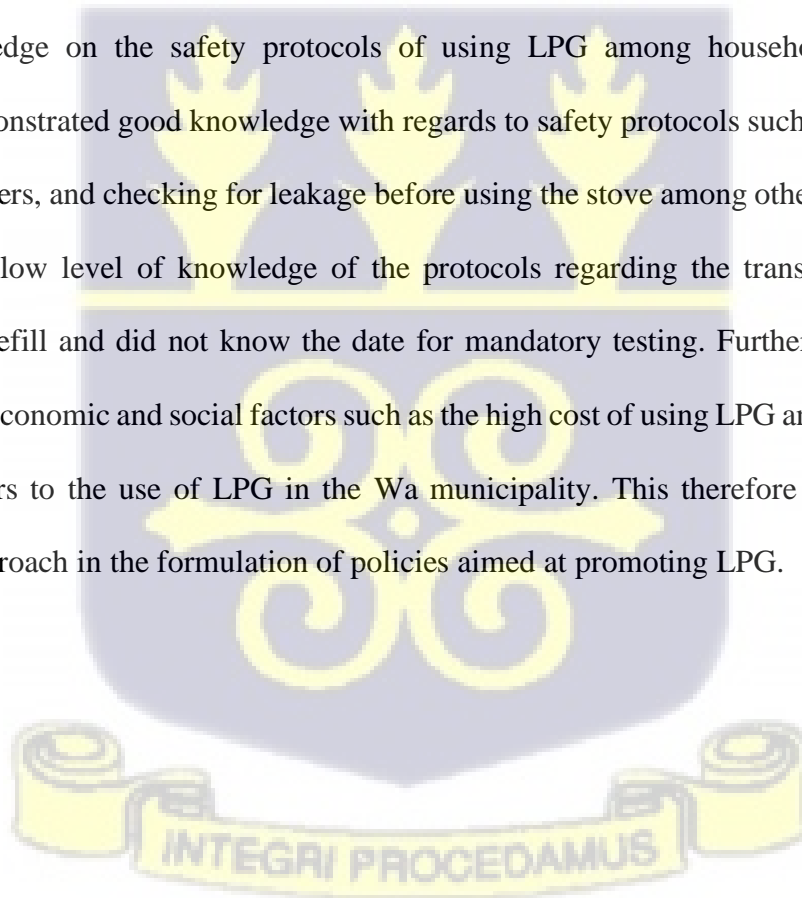
This buttresses the point that the choice of cooking fuel in general and the use of LPG, in particular, is influenced by a multiplicity of factors ranging from economic to socio-cultural factors. To achieve that target of providing access to clean cooking fuel for all, there would be the need to dispel such cultural perceptions about the use of LPG. This can be done through community engagement and information dissemination on the benefits of using LPG.



4.10 Conclusion

The study observed a marginal increase in the use of LPG in the study area over the last decades. The majority of households who used LPG within the study area adopted it as their secondary source of cooking fuel. Although the increasing use of LPG in the study area is plausible, it is not sufficient enough to meet the SDG 7 target of providing access to efficient clean cooking fuel to all households and also the ability to reduce the environmental and health impacts of using biofuels such as charcoal and firewood.

The study further found that households in the study area did not transition completely from the use of dirty fuel to clean fuels but rather used both simultaneously for cooking. Also, data on the level of knowledge on the safety protocols of using LPG among households indicate that households demonstrated good knowledge with regards to safety protocols such as not setting fire near LPG cylinders, and checking for leakage before using the stove among others. However, they demonstrated a low level of knowledge of the protocols regarding the transportation of LPG cylinders after refill and did not know the date for mandatory testing. Furthermore, the studies found that both economic and social factors such as the high cost of using LPG and sporadic supply of gas as barriers to the use of LPG in the Wa municipality. This therefore calls for a multi-dimensional approach in the formulation of policies aimed at promoting LPG.



CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.0 Introduction

This chapter provides a summary of the study's key findings and draws conclusions from them. The chapter also includes policy and research recommendations aimed at increasing the use of LPG as a source of cooking fuel among households in the study area.

5.1 Summary of Findings

The study sought to determine the level of use of LPG as a source of cooking fuel in the Wa municipality and to assess the knowledge level of households concerning the use of LPG as a source of cooking fuel. Also, another objective of the study was to assess the challenges of using LPG as an alternative cooking fuel among households in the Wa municipality.

5.1.1 Level of LPG Usage and Biomass Dependency

The result from the study indicates that a majority of the households in the studied area used biomass as their main source of cooking fuel with 51% of them using charcoal. This has implications for the environment and health since the production of charcoal is acknowledged as one of the key drivers of deforestation and its combustion a major contributor to ambient air pollution. The study observed an increasing trend in the number of households that used LPG as their source of cooking fuel in the studied area, with 31% of them using it as their main cooking fuel. It could be deduced from the study that close to half of households who use LPG as a source of cooking fuel adopted the fuel within the last ten years.

This can be interrelated to the LPG promotion programme by the government which sought to provide LPG access to 50% of Ghana's population by 2020 and the increasing number of LPG refill stations in the municipality which increased from 4 Refill stations in 2011 to 11 as of 2022. Also, evidence from the study reveals that a significant proportion of households who used LPG as a source of cooking fuel used it because it was perceived to be fast and convenient, safe to use, and readily available.

5.1.2 Fuel Stacking Phenomenon Among Households in the Study Area

Furthermore, the study found that the phenomenon of fuel stacking is pronounced in the Wa municipality. Households who use clean cooking fuels (LPG) do not completely abandon the use of biomass for cooking but rather cook simultaneously with both fuels. Some reasons given for the practice of fuel stacking included the desire to save time through simultaneous cooking, to mitigate the risk of shortage of cooking fuel, and the fact that some households prefer to cook certain dishes using particular cooking fuels.

5.1.3 Safety and Use of LPG Among Households in the Study Area

The study observed that close to 30% of households indicated that they did not have any form of knowledge about the safety protocol guiding the use of LPG. In line with the perception of safety and usage of LPG, the study found that households who perceived LPG as safe were more likely to use it as a source of cooking fuel than those who did not. This, therefore, buttresses the call to continuously educate people on the safety standards regarding the use of LPG. This has the potential of increasing the use of LPG among households. Moreover, households who did not use LPG were asked to indicate the conditions under which they were willing to adopt and use LPG as a source of cooking fuel. The data analysis showed that a high proportion of households indicated that they were willing to use LPG if the price of LPG was reduced or if they perceive

LPG to be a safe source of cooking fuel. Also, conditions such as an increase in household income and the availability of LPG had a positive influence on the willingness of households to use LPG as a source of cooking fuel.

5.1.4 Factors Influencing LPG Adoption Among Households in the Study Area

Furthermore, at the bivariate level of analysis, a chi-square independent test was used to assess some chosen household background characteristics. The study's findings indicate that factors like the household head's level of education, the household's socioeconomic status, its proximity to an LPG refill station, and its familiarity with safety procedures were significantly associated with LPG use among households in the study area. Other independent variables such as age and marital status of the household head, family size, type of housing unit and cooking space, tenancy arrangement, and were found not to be significantly associated with the outcome variable at a 95% confidence level.

At the multivariate level, the study performed a binary logistic regression model analysis to predict the use of LPG among households taking into consideration the various independent variables. From the model, independent variables such as wealth group of households, education of household head, and knowledge of safety protocols guiding the use of LPG were significant predictors of the use of LPG among households. For example, the educational status of the household head was found to be a highly significant predictor of the household's usage of LPG. The model predicted that household heads with no formal education were less likely to use LPG compared to those who attained tertiary education. The study further showed that the wealth group of the household was a significant determinant of whether the household will use LPG or not.

Results from the model indicate that households within the poor and middle-wealth groups were all less likely to use LPG compared to households within the rich wealth group. Concerning the age of the household head and use of LPG, the model predicted that household heads within the age group 18 to 25 were 7.5 times more likely to use LPG compared to those within the age group of more than 55. Thus, age was a significant predictor of the use of LPG among households in the studied communities.

5.1.5 Challenges Hindering LPG Adoption Among House in the Study Area

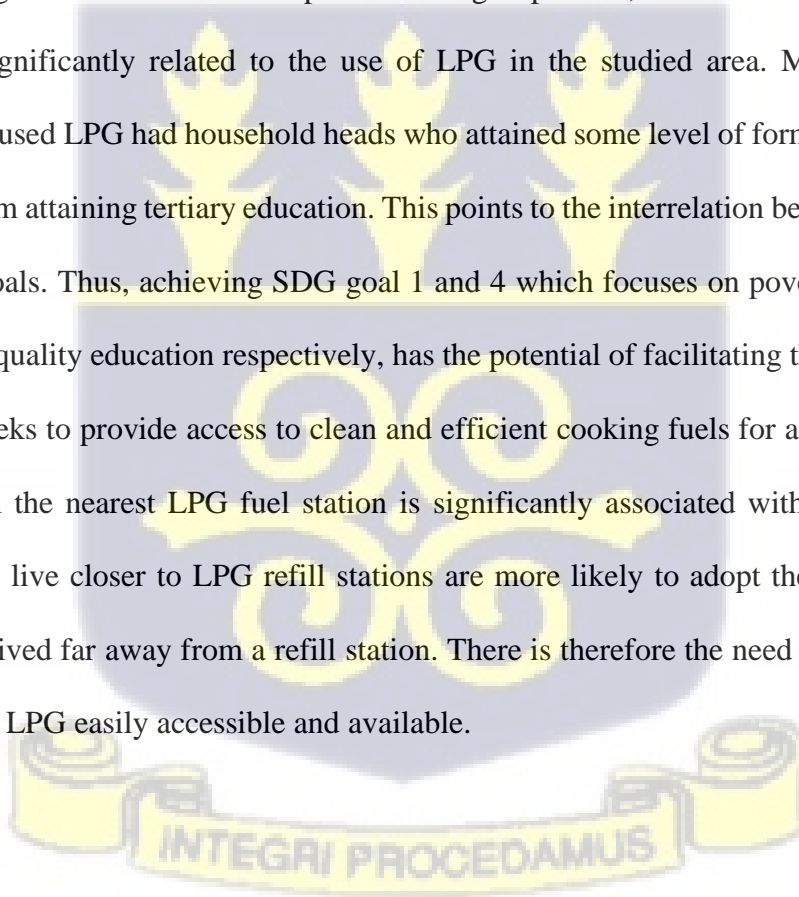
Lastly, the study looked at the challenges facing the adoption and use of LPG as a source of cooking fuel among households in the Wa municipality. The study identified the high cost associated with using LPG, the distance of LPG refill stations from households, and the frequent shortage of LPG as among the major bearers hindering the adoption and use of LPG as a source of cooking fuel in the studied area.

5.2 Conclusion

Evidence from the study shows that although a majority of households use biomass as their main source of cooking fuel, an increasing number of households are beginning to use LPG as a source of cooking fuel in the Wa municipality. It was observed that households that use LPG adopted it as a secondary source of cooking fuel. Also, the phenomenon of fuel stacking is noticeable among households in the Wa municipality. Households that used LPG as a source of cooking fuel did not abandon the use of charcoal and firewood. Thus, households preferred to use both clean and dirty fuels simultaneously contrary to the Energy Ladder model which postulate a complete transition from dirty to clean fuels by households as income increases. Regarding the perception of households on the use of LPG as a source of cooking fuel, a significant number of households

perceived LPG as a dangerous source of cooking fuel. Furthermore, while a majority of households did not perceive that using LPG to cook could change the taste of food, the fuel was perceived to be for wealthy households. This was attributed to both the cost of uptake and the continuous cost of refill. This calls for initiatives such as subsidizing the price of LPG to encourage its usage among households. This has the potential of increasing usage and preventing households from reverting to the use of biomass.

Again, the study found an association between household wealth status and the use of LPG as a source of cooking fuel. Households classified under the rich wealth group were more likely to use LPG for cooking than those under the poor wealth group. Also, the educational attainment of households is significantly related to the use of LPG in the studied area. More than 70% of households who used LPG had household heads who attained some level of formal education with a majority of them attaining tertiary education. This points to the interrelation between Sustainable Development Goals. Thus, achieving SDG goal 1 and 4 which focuses on poverty reduction and the provision of quality education respectively, has the potential of facilitating the achievement of SDG 7 which seeks to provide access to clean and efficient cooking fuels for all. The distance of households from the nearest LPG fuel station is significantly associated with the use of LPG. Households who live closer to LPG refill stations are more likely to adopt the fuel for cooking than those who lived far away from a refill station. There is therefore the need to initiate policies that would make LPG easily accessible and available.



Furthermore, the challenges facing the use of LPG as a source of cooking fuel were multifaceted. Economic factors such as low household income and the high cost associated with the use of LPG posed a challenge to its adoption and use among households. Socio-cultural factors such as safety concerns about the use of LPG and some traditional norms which associate the use of LPG with arrogance are also major barriers to the use of LPG among households in the Wa municipality.

5.3 Recommendations

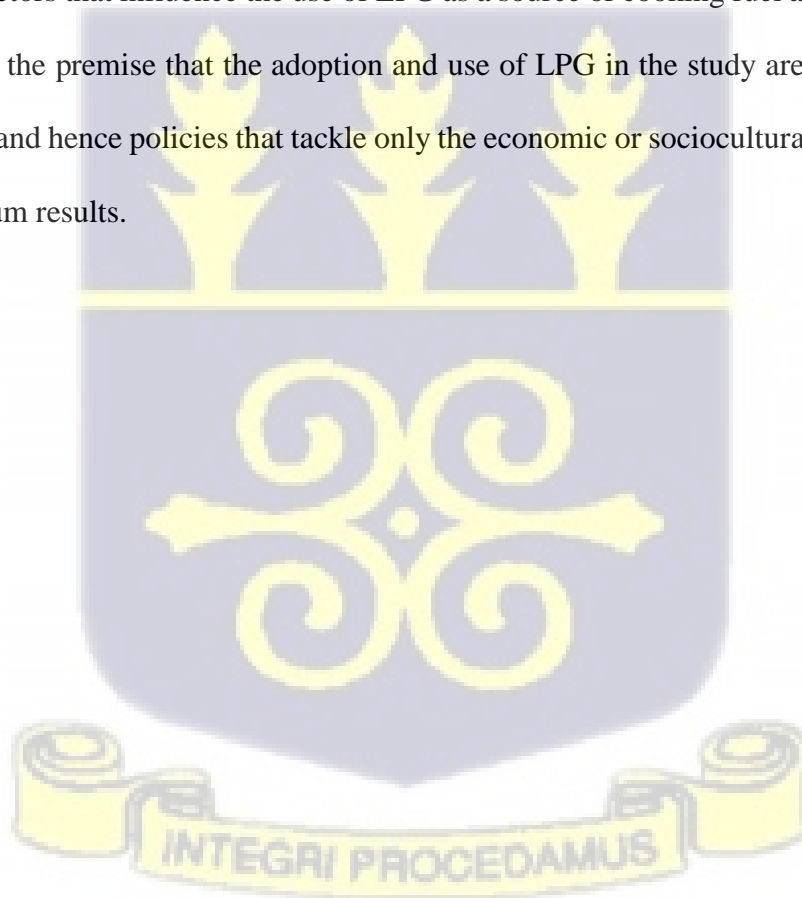
The study's findings provide information on the level of LPG use and the significant predictors of LPG use among households in the Wa municipality. These findings have insinuations for policy and academic research. It is from the aforementioned context that the following recommendations are proposed.

To start with, the study recommends that various stakeholders such as the NPA, and the Municipal Assembly should design educational programmes tailored towards addressing the safety concerns raised by households about using LPG as a source of cooking fuel. Effective and efficient training on some of the safety standards guiding the use of LPG should be offered to the general public. This has the potential of increasing the level of adaptation and use of LPG among households.

Furthermore, the cost involved in using LPG is a major challenge to its adoption and sustained use among households in the Wa municipality. The government in partnership with the private sector should consider establishing regional LPG manufacturing industries that would produce LPG accessories such as cylinders, tubes, and gas stoves to reduce the uptake cost of adopting LPG. In line with reducing the cost of using LPG, the government should consider subsidizing the price of LPG to make it more affordable. This will help the country contribute its quota towards achieving Sustainable Development Goal 7.

Moreover, the study also calls on the government to dialogue with various stakeholders in view of speeding up the process leading to the implementation of the Cylinder Recirculation Model (CRM). This has the potential of solving the challenge of traveling long distances to refill LPG cylinders which the study found to be a deterrent to the use of LPG for cooking in some households. Also, the model has the potential of curbing explosions, ensuring rigorous monitoring mechanisms, as well as generating more green job opportunities in the LPG retail market.

Lastly, the study recommends that the government in designing LPG promotional programmes such as the National LPG Promotion Policy should take into consideration both economic and socio-cultural factors that influence the use of LPG as a source of cooking fuel among households. This is based on the premise that the adoption and use of LPG in the study area is influenced by multiple factors and hence policies that tackle only the economic or sociocultural aspect would not produce maximum results.



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APPENDIX I

CONSENT FORM

Dear participant, I am a graduate student from the Institute of Statistical, Social, and Economic Research (ISSER), at the University of Ghana. I am carrying out a study to assess the level of use and challenges of using LPG for cooking among households in the Wa municipality. This research would assist various stakeholders in the area of clean energy to design interventions that will help promote the use of LPG for cooking among households. It will also add to the body of existing literature on the use of clean energy for cooking in the Wa municipality.

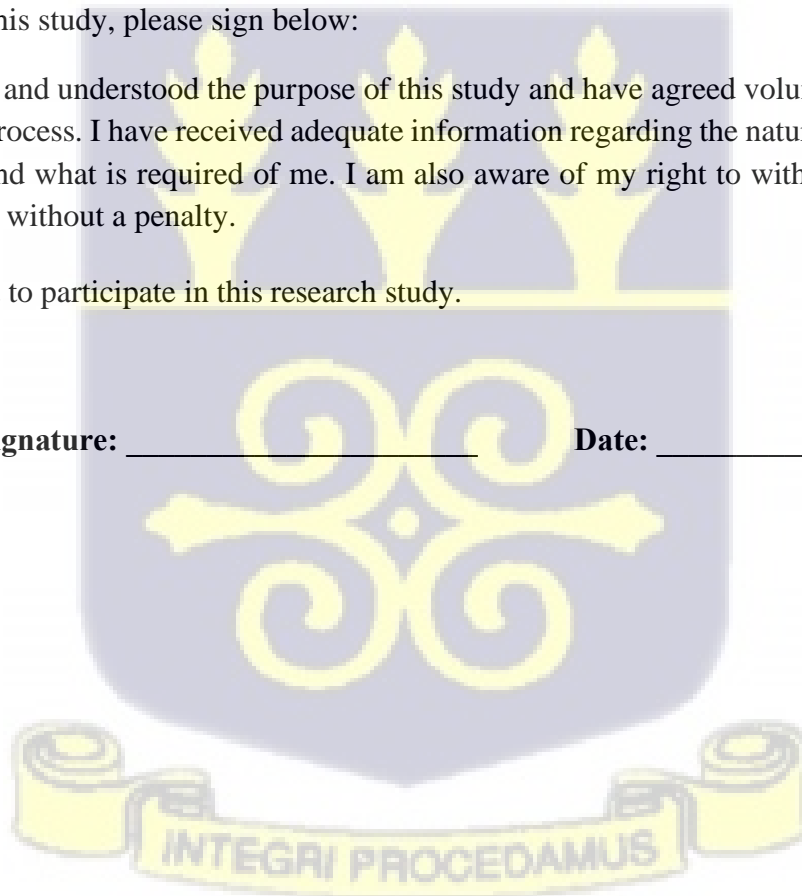
There are no incentives for participants in this study and participation is on voluntary bases. This interview guide has been structured into five (5) sections and completing this interview guide will take a maximum of 15 minutes however, you have the right to choose to opt out at any point in time without a penalty. This study is strictly for academic purposes and so all information provided will be confidential so feel free to complete the interview guide as truthfully as possible.

To take part in this study, please sign below:

Yes, I have read and understood the purpose of this study and have agreed voluntarily to part take in the research process. I have received adequate information regarding the nature of the study and clearly understand what is required of me. I am also aware of my right to withdraw at any point during my study without a penalty.

I hereby consent to participate in this research study.

Participant's Signature: _____ **Date:** _____



APPENDIX II
INTERVIEW GUIDE DESIGN

GENERAL INFORMATION

1. Date of Entry.....
2. Interview Number.....
3. Location of Household

NOTE: PLEASE TICK OR SPECIFY WHERE APPLICABLE.

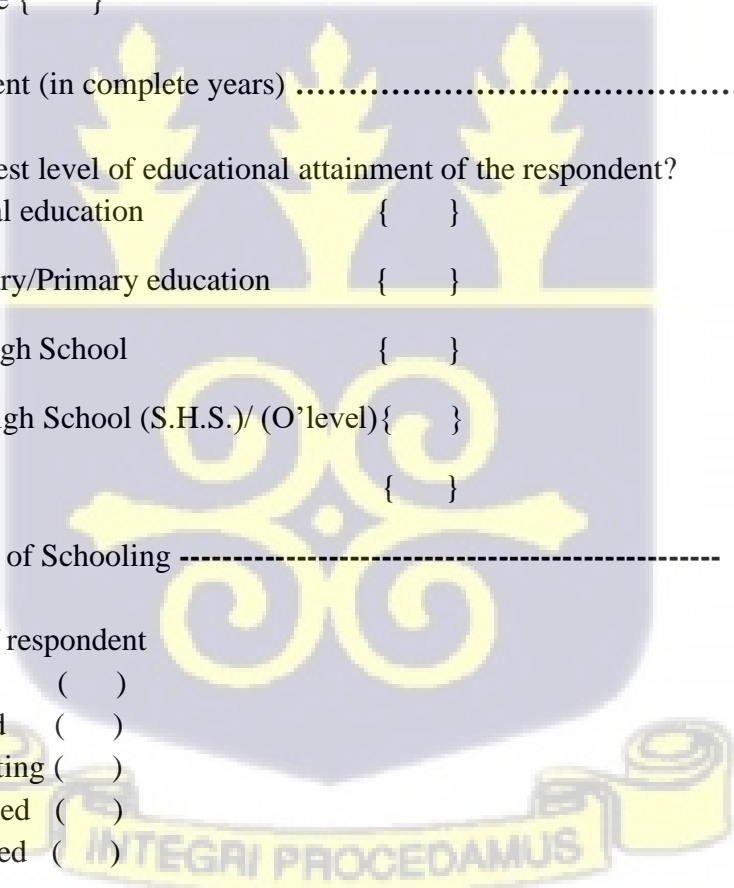
SECTION A: Socio-Demographic Information

1. Sex of Respondent
 1. Male { }
 2. Female { }

 3. Age of Respondent (in complete years)

 4. What is the highest level of educational attainment of the respondent?
 1. No formal education { }
 2. Elementary/Primary education { }
 3. Junior High School { }
 4. Senior High School (S.H.S.)/ (O'level){ }
 5. Tertiary { }

 5. Number of years of Schooling -----

 6. Marital Status of respondent
 1. Single ()
 2. Married ()
 3. Cohabiting ()
 4. Divorced ()
 5. Widowed ()
- 
- The logo of the University of Ghana is a large, semi-transparent watermark in the background. It features a shield with three golden flames at the top, a central golden emblem, and a banner at the bottom with the Latin motto "INTEGRI PROCEDAMUS".

7. What is the status of the respondent in the household?
 1. Household Head { }
 2. Spouse { }
 3. Son { }
 4. Daughter { }
 5. Others (Specify)
8. If the respondent is the not household head
 - 8a. What is the sex of the household head? 1. Male 2. Female
 - 8b. What is the age of the household head? (In years)
 - 8c. What is the level of educational attainment of the household head?
.....
9. How many people reside in the household?
10. What is the household's occupancy status of the dwelling unit?
 1. Own dwelling unit
 2. Rent-free dwelling unit
 3. Rented dwelling unit
 4. Perching with other household(s)
 5. Squatting
11. What type of housing unit does the household occupy?
 1. Flat/Apartment
 2. Compound House
 3. Huts
 4. Uncompleted building
 5. Wooden structure/ Kiosk
 6. Others.....
12. What type of cooking space does the household use?
 1. Separate room for the exclusive use of household
 2. Separate room shared with another household (s)
 3. Varanda/ Porch
 4. Open Space in Compound
 5. Enclosure without a roof
 6. Structure with a roof but without the wall
 7. Others (Specify)

13. What is the main source of lighting for your dwelling?

1. Electricity (Mains Grid)
2. Electricity (Private Generators)
3. Electricity (Solar Panel)
4. Kerosene Lamp
5. Flashlight/Torchlight
6. Others (Specify).....

HOUSEHOLD ASSETS

12. Does the household have the following assets? Indicate Zero (0) for No and one (1) for Yes

Asset	No (0)	Yes (1)
1. Television		
2. Radio		
3. Car		
4. Moto bike		
5. Bicycle		
6. Washing Machine		
7. Satellite Dish		
8. Computer		
9. Mobile phone		
10. Air Condition		



SECTION B: Factors Influencing the level of use of LPG

1. What is the primary source of cooking fuel for the household?

1. Firewood
2. Charcoal
3. LPG
4. Electricity
5. Bio Gas
6. Saw Dust

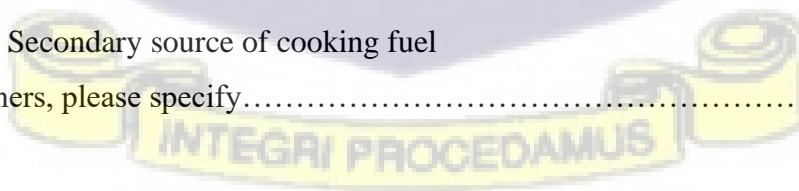
Others, please specify.....

2. What are the reasons for the adaptation of primary cooking fuel by household?

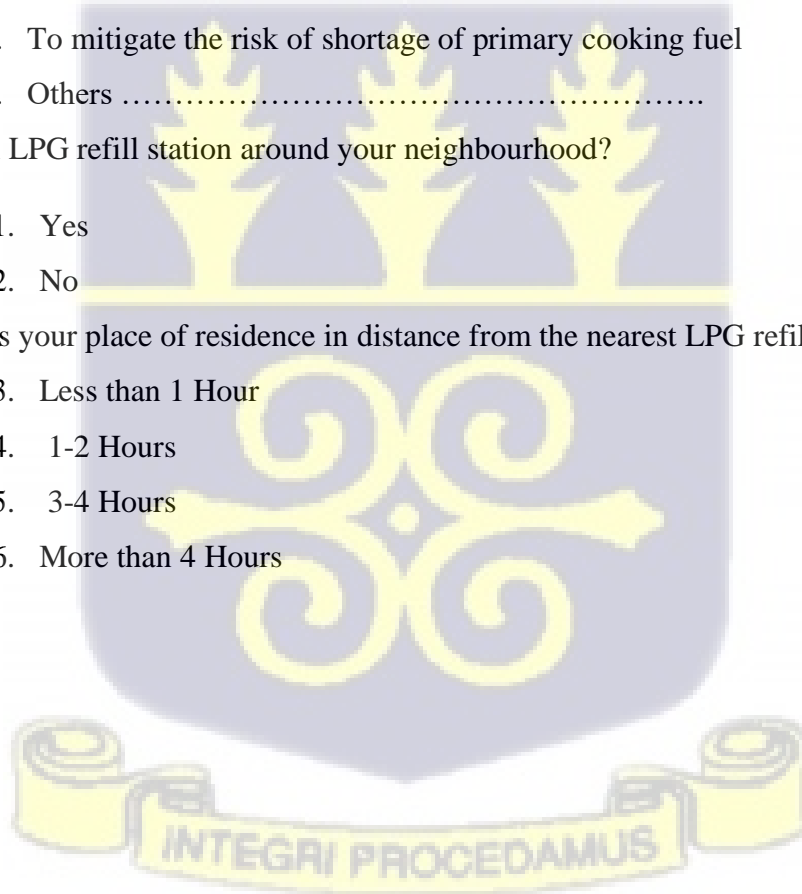
1. The price is lower compared to other sources
2. It is a clean energy source (does not produce smoke)
3. It is readily available
4. It is very safe to use
5. It is fast and convenient
6. Others (Specify)

3. What is the secondary source of cooking fuel for the household?

1. Firewood
2. Charcoal
3. LPG
4. Electricity
5. Biogas
6. Saw Dust
7. No Secondary source of cooking fuel
8. Others, please specify.....



4. What are the reasons for the adaptation of secondary cooking fuel by household?
 1. The price is lower compared to other sources
 2. It is a clean energy source (does not produce smoke)
 3. It is readily available
 4. It is very safe to use
 5. It is fast and convenient
 6. Others (Specify)
5. What are the reasons attributed to the use of multiple cooking fuels in your household?
 1. To save time through simultaneous cooking
 2. Prefer to cook certain dishes using certain cooking fuel
 3. To maintain the taste of certain dishes
 4. Cooking fuel not readily available
 5. Unstable Prices of fuel
 6. To mitigate the risk of shortage of primary cooking fuel
 7. Others
6. Is there an LPG refill station around your neighbourhood?
 1. Yes
 2. No
7. How far is your place of residence in distance from the nearest LPG refill station?
 3. Less than 1 Hour
 4. 1-2 Hours
 5. 3-4 Hours
 6. More than 4 Hours



SECTION C: Level of Knowledge of Use of LPG (To be Answered by all Households)

1. Do you know any safety tips for using LPG for cooking?
 1. Yes
 2. No
2. If yes, which of the following safety tips for using LPG do you know?
 1. Cylinder should be kept in an upright position
 2. LPG should be used in a well-ventilated area
 3. Fire should not be set near LPG cylinder
 4. Check for gas Leakage before use
 5. LPG cylinder should be kept outside of the kitchen
 6. Others.....

3. Please state your opinion on the following statement about LPG by ticking 1= strongly disagree 2= strongly agree 3= neutral 4= agree 5= strongly agree

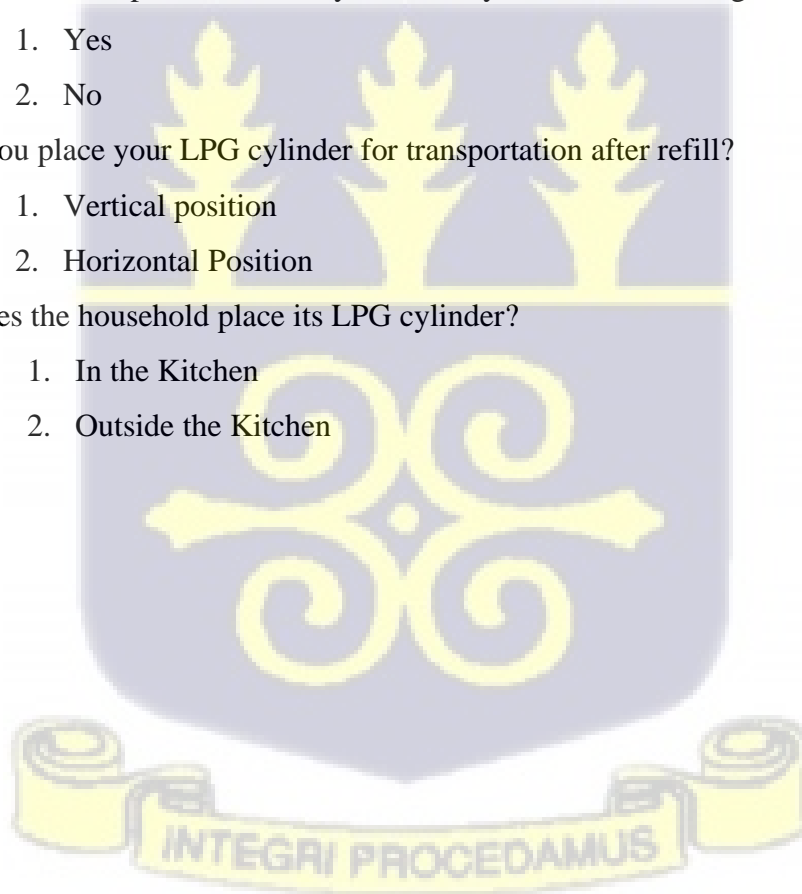
Statement	1	2	3	4	5
3C a. LPG is a clean fuel					
3C b. LPG is not Safe to use					
3C c. LPG produces smoke					
3C d. LPG is for the rich					
3C e. LPG can change the taste of food					
3C f. LPG is not good for the environment					

4. Are they any benefits of using LPG for cooking?
 1. Yes
 2. No
5. If yes, which of the following are the benefits of using LPG?
 1. It does not emit smoke
 2. It is fast and convenient
 3. It is safe for cooking
 4. It is environmentally friendly
 5. LPG is cheaper compared to other cooking fuel
 6. Others (Specify)

6. Are there any disadvantages to using LPG for cooking?
 1. Yes
 2. No
7. If yes, which of the following do you consider as the disadvantages of using LPG?
 1. LPG is dangerous to use
 2. LPG is not readily available
 3. LPG is expensive
 4. LPG cannot cook all dishes (especially traditional dishes)
 5. LPG Refill station far from household dwelling
 6. Others Specify)

.....

8. Do you know the expiration date of your LPG cylinder for Retesting?
 1. Yes
 2. No
9. How do you place your LPG cylinder for transportation after refill?
 1. Vertical position
 2. Horizontal Position
10. Where does the household place its LPG cylinder?
 1. In the Kitchen
 2. Outside the Kitchen



SECTION D: Challenges of Adopting LPG as Cooking Fuel in the Household

1. Which of the following do you consider as the challenge to the use of LPG in cooking?

(Multiple choice)

1. Distance to LPG refill station
2. Price of LPG
3. Price of other cooking fuels
4. Safety concerns
5. Number of persons in the household
6. Inadequate access to LPG
7. Others, Specify.....

2. Please indicate to what extent you agree or disagree with the following statements as the barriers to the use of LPG in the Wa municipality. Tick for 1= strongly disagree 2= strongly agree 3= neutral 4= agree 5= strongly agree

Statement	1	2	3	4	5
2Da. High cost of LPG					
2Db. Low price of other cooking fuel					
2Dc. LPG safety concerns about the use of LPG					
2Dd. LPG refill stations are far away from households					
2De. Food tastes different when cooked with LPG					
2Df. Find it difficult to operate LPG Stove					
2Dg. Some local dishes cannot be prepared using LPG					



SECTION E: To be Answered by Households Who Use LPG

11. How many years has the household been using LPG for cooking?

12. Which of the following factors influenced the household’s decision of adopting LPG for cooking? (Multiple options)

1. LPG is safe to use
2. Prefer LPG because it is more convenient compared to other fuels
3. LPG is readily available
4. Price of LPG is low compared to other fuels
5. Size of household
6. Income of the household is high
7. Most of our neighbours use LPG for cooking
8. Others, please specify.....

13. How often does the household use LPG for cooking?

1. Daily
2. Weekly
3. Monthly
4. Occasionally

14. In your opinion, is LPG a safe cooking fuel?

1. Yes
2. No

15. If yes, on a scale of 1-5, how safe would you say LPG is as a cooking fuel?

Very safe	Safe	Moderately safe	Unsafe	Very unsafe
1	2	3	4	5

SECTION F: To be Answered by Households Who Don't Use LPG

1. Have you heard about using LPG as a cooking Fuel?

1. Yes
2. No

2. If yes, which of the following is your main source of information about using LPG as cooking fuel?

1. Government Institutions
2. Media- radio, TV
3. Social Media
4. LPG distributors
5. Social Associations (Family, Friends)
6. others

3. Which of the following is/are the reason (s) for not using LPG

1. Low-income level of household
2. LPG is costly
3. Other cooking fuels are cheaper than LPG
4. LPG is not readily available
5. The LPG refill station is far away from the household dwelling
6. LPG is not safe to use
7. Others, please specify.....

4. In your opinion, is LPG a safe cooking fuel?

1. Yes
2. No



5. If no, which of the following makes LPG not a safe fuel for cooking?

1. LPG can explode During cooking
2. LPG can lead to death and injury when it explodes
3. LPG can easily burn food
4. The gas can leak polluting the air
5. Others

6. Do you plan of adopting LPG as cooking fuel in the future?

1. Yes
2. No

7. Please state your opinion on the following statement as to whether you will adopt LPG. Use

1= strongly disagree 2= strongly agree 3= neutral 4= agree 5= strongly agree

Statement	1	2	3	4	5
7Fa. I will adopt LPG if my household income increase					
7Fb. I will adopt LPG if the price of LPG is low					
7Fc. I will adopt LPG if it is readily available					
7Fd. I will adopt LPG if it is safe to use					
7Fe. I will adopt LPG if other cooking fuels become more costly than LPG					
7Ff. I will adopt LPG if I am educated on the advantages of using LPG as cooking fuel					

THANK YOU FOR PARTICIPATING IN THIS SURVEY

APPENDIX III

UNSTRUCTURED INTERVIEW GUIDE FOR LPG REFILL STATION

Key Informant Interview (KII) To be administered to the Manger of an LPG refill station

SECTION A: Demographic Characteristics

1. Sex.....
2. Age.....
3. Level of Education.....
4. Job Title.....

SECTION B: Questions on the Use of LPG

1. How has the patronage of LPG been over the years?
2. What can you tell me about the level of use of LPG among households in the Wa municipality?
3. Can you share with me some of the factors affecting the use of LPG in the Wa Municipality?
4. In what ways can these challenges mentioned in question 3 be resolved?
5. What can be done to promote the use of LPG in the municipality?
6. Does your outlet sensitize households about the need to use LPG for cooking? If yes, How do you go about it and what platforms do you use?
7. What safety concerns have you observed about the use of LPG among households?
8. What are your thoughts on the cylinder recirculation model proposed by the government?
9. Any further recommendations for policy and research formulation?

Thank you very much for speaking with me

**UNSTRUCTURED INTERVIEW GUIDE FOR OFFICIALS OF THE NATIONAL
PETROLEUM AUTHORITY AND THE WA MUNICIPAL ASSEMBLY**

Key Informant Interview (KII) To be administered to Officials of the National Petroleum Authority and the Wa Municipal Assembly

SECTION A: Demographic Characteristics

1. Sex.....
2. Age.....
3. Level of Education.....
5. Position.....

SECTION B: Questions on the Use of LPG

1. What is the work of your office about the use of clean energy for cooking?
2. How many refill stations do we have in the municipality?
3. What is the level of use of LPG among households in the Wa municipality over the past ten years?
4. What are some of the barriers to the use of LPG among households?
5. Does your department have programmes geared towards promoting the use of LPG? If yes, what are some of these programmes?
6. What safety concerns have you observed concerning the use of LPG among households?
7. Does your department educate households on safety tips for using LPG? If yes, what medium does the department use to disseminate that information?
8. What are the challenges your department face in promoting LPG as cooking fuel?
9. Any further recommendations for policy and research formulation?

Thank you very much for speaking with me

INTEGRI PROCEDAMUS

APPENDIX IV



UNIVERSITY OF GHANA

INSTITUTE OF STATISTICAL, SOCIAL AND ECONOMIC RESEARCH



ISSER-AC 5/6

OFFICE OF THE DIRECTOR

November 15, 2022.

The Head of Central Administration
Wa Municipal Assembly P.
O. Box 16
Upper West Region, Wa.

Dear Sir/Madam,

LETTER OF INTRODUCTION - MR. NIBENANG MODESTUS (10933825)

The Institute of Statistical, Social and Economic Research (ISSER), wishes to introduce to you Mr. Nibenang Modestus, a Master of Arts in Development Studies student with ID number 10933825.

Mr. Nibenang's research topic is "Assessing the Use of LPG as an Alternative Domestic Cooking Fuel. A case study of the Wa Municipality." He will therefore need the assistance of your establishment to collect data for the research work. All data collected will be used solely for academic purposes and treated with the strictest confidentiality.

If you have any queries about this, please do not hesitate to contact the MA Coordinator on +233 268363281 or ktasante@ug.edu.gh

We hope we can count on your kind co-operation.

Yours faithfully,

A handwritten signature in blue ink, appearing to read 'Peter Quartey'.

Prof. Peter Quartey
Director



APPENDIX V



UNIVERSITY
OF GHANA



INSTITUTE OF STATISTICAL, SOCIAL AND ECONOMIC RESEARCH

ISSER-AC 5/6

OFFICE OF THE DIRECTOR

November 15, 2022.

The Head of Management
National Petroleum Authority
Upper West Region, Wa.

Dear Sir/Madam,

LETTER OF INTRODUCTION - MR. MODESTUS NIBENANG (10933825)


The Institute of Statistical, Social and Economic Research (ISSER), wishes to introduce to you Mr. Modestus Nibenang, a Master of Arts in Development Studies student with ID number 10933825.

Mr. Nibenang's research topic is "Assessing the Use of LPG as an Alternative Domestic Cooking Fuel. A case study of the Wa Municipality." He will therefore need the assistance of your establishment to collect data for the research work. All data collected will be used solely for academic purposes and treated with the strictest confidentiality.

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We hope we can count on your kind co-operation.

Yours faithfully,



Prof. Peter Quartey
Director



APPENDIX VI: Chi-Square Outputs

Level of Education and Use of LPG

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	37.496 ^a	3	.000
Likelihood Ratio	38.605	3	.000
N of Valid Cases	220		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.60.

Distance to Refill Station and Use of LPG

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	22.489 ^a	3	.000
Likelihood Ratio	24.480	3	.000
N of Valid Cases	220		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 13.96.

Knowledge of Safety and Use of LPG

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	30.898 ^a	2	.000
Likelihood Ratio	31.892	2	.000
N of Valid Cases	220		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is .44.



Location of Household and Use of LPG

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.540 ^a	2	.103
Likelihood Ratio	4.571	2	.102
N of Valid Cases	220		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.60.

Wealth Group (Binned) * Use of LPG as Cooking Fuel Crosstabulation

Count

		Use of LPG as Cooking Fuel_		Total
		no	yes	
wealth (Binned)	Poor Wealth Group	40	33	73
	Middle Wealth Group	47	52	99
	Rich Wealth Group	9	39	48
Total		96	124	220

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	16.375 ^a	2	.000
Likelihood Ratio	17.566	2	.000
N of Valid Cases	220		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 20.95.



APPENDIX VI

Procedure for Calculation of Wealth Groups

Due to the challenges in collecting and measuring income and expenditure accurately, the study used data on asset ownership and combined this information into a proxy indicator, the wealth groups. This was created using principal component analysis (PCA).

The following steps were adopted to calculate the wealth groups for the study:

STEP 1: Selection of variables

The study in creating the wealth groups selected variables to be incorporated in the interview guide. The interview guide ask what assets the households own based on a list of ten household assets (see Section A of Appendix II). The response was recorded as a binary variable Yes/No with yes coded as 1 and no coded as 0.

STEP 2: Explore Variables

The study performed a descriptive analysis of each household asset. This was done to select the assets that are capable of distinguishing relatively “wealthy” households and relatively “poor” ones based on the rule of thumb. The rule of thumb says that if a variable/asset is owned by more than 95% or less than 5% of the sample, it should be excluded from the analysis.

STEP 3: Perform Principal Component Analysis

The study performed the principal component analysis using the factor analysis procedure in SPSS. The higher the score of the index, the wealthier the household. The wealth group as created is a continuous variable that can be used in correlations or regression models.

STEP 4: Rank the Wealth Index

Using the “Rank Cases” option on SPSS, the study ranked the households into three wealth groups i.e., Poor wealth group, the Middle wealth group, and the rich wealth group.

