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An Analysis of Liquefied Petroleum Gas Adoption for Household Cooking in Nigeria

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Walden University
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Abstract

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MBA, Ahmadu Bello University, 2009

BSC, University of Lagos, 1990

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Policy and Administration—Management and Leadership

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Abstract

The Nigerian government established a domestic liquefied petroleum gas penetration program (DLPGPP) to support Nigerian households that still use traditional fuels, which are inefficient and hazardous for users while polluting and degrading the environment. Little is known about the relationships that exist among liquefied petroleum gas (LPG) accessibility, LPG affordability, and LPG adoption to guide DLPGPP implementation. Narrowing this gap was the purpose of this study using the general framework of consumer theory. The study's research questions addressed the effects of LPG affordability and LPG accessibility on LPG adoption for cooking in Nigeria's households. A cross-sectional, correlational survey was employed to analyze responses to a structured questionnaire received from 544 participants selected through stratified random sampling across the rural, suburban, and urban areas of the Federal Capital City. The relationships were tested using Pearson's correlational analysis, and binomial logistic regression models were fitted to test whether LPG affordability and LPG accessibility predicted LPG adoption for cooking in Nigeria's households. The results showed that a significant relationship exists among LPG affordability, LPG accessibility, and LPG adoption. Additionally, LPG affordability predicted LPG adoption, and LPG accessibility also predicted LPG adoption. This study has implications for positive social change, in that addressing LPG affordability and LPG accessibility for Nigerian households is critical to the success of the DLPGPP.

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Dedication

Alhamdulilah. I dedicate this work to my late maternal grandmother, Alhaja Simbiat Aroyewun (Nee Salami), and my late paternal grandmother, Alhaja Wulemotu Ashabi Jose (Nee Mustapha). In turn, both grandmothers took care of me when I was a child, and without them, I might not have lived to adulthood. I would also dedicate this work to my late father, Dr. Shamusideen Iyanda Lasisi, who encouraged me and did all he could to ensure that I received a good education.

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Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction to the Study

Household cooking is a large consumer of energy, accounting for nearly 80% of Nigeria's household energy (Gujba et al., 2015). Energy for domestic cooking in Nigeria primarily comes from burning traditional fuels such as wood, dung, coal, and other biomass variants that are inefficient and hazardous to the user while polluting and degrading the environment. Nigeria, as a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, developed the National Gas Policy (NGP), which, among other things, targets the promotion of liquefied petroleum gas (LPG) as a sustainable substitute for traditional fuels used for domestic cooking (Ministry of Petroleum Resources, 2017).

LPG provides higher energy efficiency than traditional fuels, and it is cleaner and more ozone-layer friendly. Moreover, it is abundant in the country. Nevertheless, the total contribution of clean fuels—LPG, electricity, natural gas, and biogas—to domestic energy in Nigeria is less than 3% (Buba et al., 2017). Nigeria is rich in natural resources and was estimated to have 198.7 trillion cubic feet (tcf) of gas with a flare rate of 8.6% or 683 million standard cubic feet per day (mmscfd) as of November 2019 (*Zero Gas Flare Still a Mirage,* 2019). The potential demand for LPG, the monetary loss incurred by gas flaring, and the unfavorable health implications of using traditional fuels for domestic cooking are critical reasons for the government intervening to replace traditional fuels with LPG in households. However, the success of any policy and legal framework on household fuel transition depends largely on how it addresses the effective determinants of fuel choice.

The NGP and its policy tools, including the Domestic LPG Penetration Program (DLPGPP), need to focus on those determinants that can foster the transition to LPG by households nationwide. A good amount of research on the attributes of consumers' choice of household fuel focuses on income and demographic issues. However, there is little research on the effects of the affordability and accessibility of LPG on consumer LPG choice, fuel transition, substitution, and LPG adoption that might help in assessing or supporting the domestic LPG adoption policy. There is limited experimental or fact-based evidence on the impact of affordability and accessibility on LPG adoption. This study fills a gap in the literature regarding the effects of the ease of access to the LPG outlet facility in determining consumers' transition to LPG from traditional fuels.

There are five chapters in this study. The first chapter introduces the study's background, significance, purpose, nature, assumptions, and limitations. Chapter 1 also presents research questions and hypotheses. Chapter 2 details the literature review. Chapter 3 describes the research methodology and its design, while the fourth chapter explains the procedure for data gathering, treatment, analysis, and the findings of the study. Chapter 5 includes interpretations of the results, the study's outcomes for social change, and recommendations for future research.

Background

Two general bodies of literature are related to this study. The first is the literature on energy transition management, including conversion programs, transformative change, and transition acceleration. The second relates to public policy and program analysis. The

study focused on Nigeria's DLPGPP. The program is a targeted intervention to accelerate Nigerian households' transition from traditional fuels to LPG for cooking.

An energy transition is a structural change in a country's energy system, and policymakers need a framework to manage complex interactions, processes, and governance of long-term structural change related to this effort. There is also a need for greater scrutiny of performance and accountability of government interventions targeting social change to encompass factors related to stakeholder and knowledge management (Missoni & Alesani, 2016), along with requisite tools and processes to plan activities and learn from programs. Anecdotal evidence suggests that households' transition from traditional fuels to modern LPG is underway and progressing slowly in urban areas of Nigeria and other developing countries. However, the slow speed of change is problematic when transformational change is required for economic growth and energy sustainability. An energy transition on a transformative scale differs from an incremental growth strategy because the former uses proven techniques that work to grow the achievement of objectives (Skoll, 2014).

Scientific research has many roles in policy formulation, one of which is to change the debate on a policy issue (Almeida & Bascolo, 2006). Numerous factors can affect policy goals, including income level, infrastructural financing, and governance. The provision of scientific evidence can help policymakers in the decision-making process (Sajadi et al., 2019). Policy analysis is important to policy formulation on energy transition, the definition of the best policy goals and paths, and policy implementation assessment. Public program analysis, which uses social research methods to

systematically investigate the effectiveness of social intervention programs in ways adapted to their political and organizational environments, is designed to inform social action to improve social conditions. Energy transitions in some countries in Asia and Latin America, such as Indonesia's LPG conversion program, provide examples of energy transition acceleration or societal transformation programs that invite comparative interpretations. In this study, I addressed the potential of the DLPGPP policy instrument to impact the transformative-scale adoption and utilization of LPG for household heating in Nigeria by assessing the effect of LPG accessibility and affordability on households' energy adoption.

In conducting this study, I reviewed articles and literature related to the analysis of government interventions concerning the fostering of the energy transition. Examples of these sources are as follows:

- Adeyemi and Adereleye (2016) analyzed the factors determining the choice of cooking energy in Nigeria. They recommended the government's promotion of higher levels of education and general economic development as effective instruments for encouraging rural households to substitute traditional fuels with modern energy fuels.
- The developers of the NGP initiated and approved for the Ministry of Petroleum Resources (2017) envisioned Nigeria as an attractive gas-based industrial nation focused on satisfying local gas demand requirements and developing a significant presence in international markets.

- Bazilian et al. (2014) examined governance of elements of energy poverty across different scales (local, regional, and global) and the effectiveness of the energy governance systems in addressing the needs of the poor. With a focus on Africa, the authors also considered the role of governments and the international community in strengthening related tools, institutions, and the regulatory environment.
- In efforts geared toward fostering the world's energy transition from environmentally degrading fuels to modern and renewable energy, the World Economic Forum (2019) established a facts-based energy transition index (ETI) as a framework to guide policymakers and enable a fact-based assessment of countries' policies, status, and programs toward the transition to sustainable energy.
- Astuti (2017) analyzed households' transition to modern energy under Indonesia's energy conversion program. Astuti investigated the impact of the policy and program on the development of access to modern energy between 2007 and 2011 in Indonesia and found that the number of households using traditional fuels had reduced and that more households had access to LPG in 2011 than in 2007.
- Quinn et al. (2018) analyzed efforts to support clean household energy for cooking around the world. The authors reviewed a variety of intervention programs in low- and middle-income settings to make publicly available the

literature on what has worked well and in what context to enable global learning

- Suleiman (2019) presented a proposal by Nigeria's Ministry of Petroleum Resources to the newly appointed Minister of State for Petroleum Resources containing the details of the DLPGPP.

Problem Statement

LPG is a mixture of varying proportions of propane and butane produced as a by-product of refining crude oil or processing natural gas. Consumers use LPG as a source of energy or fuel for driving vehicles, household heating and cooking, industrial heating, and as a propellant and refrigerant. There are several traditional cooking fuel sources, including biomass, charcoal, wood, and kerosene; LPG, however, is environmentally cleaner and ozone-layer friendly, with higher energy efficiency than competing fuels.

According to the Ministry of Petroleum Resources (2017), Nigeria currently produces approximately 4 metric tons per annum (MTPA) of LPG, mainly for export. LPG consumption per day in Nigeria was 3.4 thousand barrels (TB) in 2012—relatively low when compared with countries with similar population size, such as Russia with daily consumption of 404tb; Brazil, with consumption of 226tb per day; and Indonesia, with daily consumption of 160tb (The GlobalEconomy.com, 2018). Despite being the world's seventh-largest owner of proven gas (Ministry of Budget and National Planning, 2017), Nigeria barely consumes 15% of its over 3MTPA production of LPG. Nigeria's per capita consumption of LPG in 2015, at 2.3 kg, was significantly lower than that of similar least developed countries (LCDs; e.g., Indonesia—24 kg, Egypt—85 kg, South

Africa—8.5 kg) as well as lower than the West Africa regional average of 3.5 kg (Nigeria LNG, n.d.; Suleiman, 2019; United Nations Statistics Department, 2015).

Household cooking accounts for a large percentage of Nigeria's energy consumption (Gujba et al., 2015), translating to significant latent demand for LPG. The causes of low consumption of LPG in Nigeria found in the literature include household income, infrastructural challenges, subsidy on kerosene, the perceived higher cost of LPG, and safety issues that have led to various government interventions through policies and plans (Ige, 2009; Nigeria LNG, n.d). Government policies and actions have yet to succeed in prompting most households in Nigeria to transition from inefficient, traditional fuels to LPG for household cooking (Batchelor et al., 2019; Suleiman, 2019). The problem of underutilization of modern energy has negatively impacted the growth of Nigeria's economy and employment, increased household air pollution, deforestation, and erosion, and exacerbated other environmental hazards (Megbowon et al., 2018).

There is considerable literature on LPG production, supply, and trade and household consumption of LPG in other countries. Few studies have explored the effect of income and the price of fuel on energy consumption in Nigeria. Most scholars have agreed on the need for government intervention in bringing about energy transitions (Buba et al., 2017). There is also a growing interest in how policy initiatives support energy transitions (World Economic Forum, 2019). There is, however, limited research analyzing the effect of LPG affordability and accessibility on LPG adoption in Nigeria's households for policy formulation. Researchers and policymakers know little about how the affordability of and ease of access to LPG impact the domestic substitution of

traditional fuels with LPG in Nigeria for household cooking. Recent studies have indicated the need to track the adoption and benefits of government interventions to attain transformative-scale adoption and consumption of LPG for cooking in Nigeria's households (Abdulai et al., 2018; Gujba et al., 2015; Schunder & Bagchi-Sen, 2019; World Economic Forum, 2019). By conducting a quantitative analysis of the factors impacting household LPG adoption, I sought to assess ex ante the effectiveness of the DLPGPP in accelerating households' fuel transition to LPG, thereby supporting decision making, strengthening plans, and enhancing advocacy for domestic LPG utilization.

Purpose

A national pathway toward catalyzing transformative-scale energy transition to LPG for domestic cooking should involve understanding evidence-based attributes and key indicators that have worked in similar under developing countries and contexts. There is a need for consumer, market, and stakeholder transformation strategies whereby the different phases or stages of the energy transition may proceed concurrently or interactively and at a much faster pace (Lund, 2007) than a transition lacking governance and landscape support. Nigeria needs to determine effective energy transition factors for mobilizing quicker adoption of the LPG. Research is required to identify the factors, landscape support, and governance needed in implementing the government intervention program designed to achieve transformative scaling of LPG utilization for household cooking and develop the metrics to evaluate the LPG expansion initiative. The quantitative design of this study helped determine whether the variables—accessibility and affordability of LPG—are effective attributes for promoting a fuel switch to LPG and

deriving the marginal effects of the attributes on households' transition to LPG for cooking through a household survey. The purpose of this quantitative research was to analyze the effect of LPG accessibility and affordability on households' adoption of LPG for cooking in Nigeria. I sought to determine whether LPG accessibility and affordability are critical determinants that the DLPGPP should address to become a transformative catalyst for LPG utilization in Nigeria's households.

Research Questions

The research question is a critical element for research design and systematic study of a phenomenon. It points to what the researcher wants to understand concerning what is known and the purpose of the study (Maxwell, 2005). The research question helped clarify the study's purpose, frame the study, and induce findings through the research process. The research questions for this study, which were designed to induce answers concerning the governance and effectiveness of the DLPGPP to catalyze fuel transition to LPG and to address the issue of household energy poverty, were as follows:

1. What is the relationship between LPG affordability and LPG adoption for household cooking in Nigeria?

   H01: There is no relationship between LPG affordability and LPG adoption for household cooking in Nigeria.

   Ha1: There is a statistically significant relationship between LPG affordability and LPG adoption for household cooking in Nigeria.

2. What is the relationship between LPG accessibility and LPG adoption for household cooking in Nigeria?

H02: There is no relationship between LPG accessibility and LPG adoption for household cooking in in Nigeria.

Ha2: There is a statistically significant relationship between LPG accessibility and LPG adoption for household cooking in Nigeria.

3. Does LPG affordability predict LPG adoption for household cooking in Nigeria?

   H03: LPG affordability does not predict LPG adoption for household cooking in Nigeria.

   Ha3: LPG affordability predicts LPG adoption for household cooking in Nigeria.

4. Does LPG accessibility predict LPG adoption for household cooking in Nigeria?

   H04: LPG accessibility does not predict LPG adoption for household cooking in Nigeria.

   Ha4: LPG accessibility predicts LPG adoption for household cooking in Nigeria.

I analyzed the impact of LPG accessibility and affordability on household fuel switch from other fuels to LPG by performing binomial logistic regression on the collected data from a household survey using stratified random sampling from urban, suburban, and remote rural areas of Nigeria. I used in-person questionnaires to collect data on households' access to LPG bottling plants and the affordability of LPG in Federal Capital Territory (FCT) households. The binomial logistic regression also assessed the

relative marginal effects of each of the factors of affordability and accessibility on LPG substitution for wood, coal, kerosene, and electricity in Nigeria. In this study, I used descriptive statistics for the household choice of cooking fuels—kerosene, wood, coal, electricity, or LPG—obtained from the survey to analyze the pattern of household fuel consumption and how the variables of LPG accessibility and affordability affect the diffusion of LPG in Nigeria.

In this study, accessibility was the degree of ease in purchasing LPG in terms of the consumer's proximity to the LPG bottling plant and the ease of conveying home an LPG bottle from the retail outlet, as measured on a Likert scale. Affordability was measured as the ratio of annual household income to LPG adoption cost, including the cost of LPG stove, cylinder, and accessories and the annual household cost of LPG consumption.

Theoretical Framework

A theory is a bridge between previous experiences and lessons for understanding future behavior, formulating policies (Fouquet, 2016), and implementing programs. According to Sovacool (2012), there are four theoretical approaches to understanding energy transitions. Theoretical frameworks for energy transitions may develop from socio-technical transitions, ecological modernization, social practice, or political ecology (Sovacool, 2012). This study used the energy ladder theory (ELT) built on utility maximization's consumer economic theory. The ELT follows a rational utility-maximizer to determine energy choice by an economic rationale (Astuti, 2017; Johansson & Goldemberg, 2002). The ELT postulates that household income is the determinant of

energy choice. The implication is that household income influences affordability, and energy price influences affordability for people with less income (Hosier & Dowd, 1987; Treiber, 2013). The ELT indicates a three-stage energy switching process, with the lowest income households relying on biomass. According to the ELT, households will shift to transition fuels such as kerosene, coal, and wood as their income increases. They will ultimately move to the third phase of modern fuels such as LPG and electricity with higher income (Andadari et al., 2014). The ELT helped assess the pattern of LPG use and the impact of LPG accessibility and affordability on fuel transition to inform the DLPGPP.

Nature of the Study

In this study, I applied a quantitative method of inquiry to answer the research questions. From a research design perspective, the nature of a study involves the study's structural features, variables, and the sampling strategy that links the research questions to the collection of data. A nonexperimental survey is excellent for collecting information on attitudes and behavior in quantitative research (Burkholder et al., 2016). The correlational design of this study allowed for the measurement of variables. A nonexperimental survey is not helpful when manipulating variables or determining the direction of relationship or causality due to possible relationship with other variables that may affect the dependent factor not under consideration (bidirectionality and third variable problem); a correlational study enables the researcher to predict the relationship

and effect of the predictor variables on the dependent variable (Burkholder et al., 2016) through a simple or multiple regression, depending on the number of predictor variables.

The technique for data collection was multistage sampling. First, I used stratified random sampling to break the FCT states into rural, urban, and suburban areas; second, I performed a random sampling of households for data collection. Stratified random sampling allows a researcher to select samples based on infrastructure availability, dependent variable characteristics such as households using or not using LPG, demographics, or subgroups. According to Burkholder et al. (2016), stratified sampling is appropriate when a random sample must reflect a proper mix or ratio of subgroups of the dependent characteristics. In this study, the specific interest was the accessibility of LPG dispensing outlets, which are present along the rural-urban demographic dichotomy. Because this study analyzed a social change program that measured people's attitude and behavior toward a government intervention, the nonexperimental survey, and correlational method were appropriate to review the relationship of the variable factors—LPG affordability and accessibility—with the dependent variable, LPG adoption. Performing a regression analysis of collected data is a valid approach to predicting the marginal effect of the independent variables on fuel substitution and LPG adoption.

Definitions

Accessibility: Broadly, accessibility refers to the quality of being able to be reached and obtained easily. In this study, accessibility was the convenience of purchasing fuel. According to Jenkins et al. (2018), fuel accessibility is the opportunity for those in a geographical space to obtain fuel. A product is accessible if obtaining it is

easy by proximity to the consumer with ease of carriage. In this study, obtaining LPG occurred through cylinders. LPG only became accessible to the consumer when the dispensing point was close to walk-in or drive-in consumers, and the fuel could easily be transported home to the point of need. Researchers such as Andadari et al. (2014) measured energy accessibility as the freedom to choose an energy carrier; however, the measure of energy accessibility in this study was in terms of convenience in accessing energy and proximity to the energy source.

Affordability: This is a relative term indicating inexpensiveness. Bouzarovski and Petrova (2015) defined energy affordability as the ratio between the cost of fuel and household income—a low share of energy expenditure to disposable income. Product affordability for an individual or household implies that purchasing the product does not diminish the household income significantly. The household has enough money to buy other essentials it may need and service other debts that it may incur. The affordability of LPG implies a low ratio of the cost of buying LPG startup kits and accessories, including stoves, LPG cylinders, connectors, and sustained periodical refill of LPG when needed against the household income.

Assumptions

A key assumption that informed this research was that access to LPG in Nigerian households is predicated on a household's location (i.e., whether the household is in a city or rural area). I assumed this because cities often have infrastructure that provides access to energy products. However, metropolitan cities in Nigeria still have a high number of people using kerosene and wood fuels.

Scope and Delimitations

In this study, I analyzed LPG adoption ex-ante the DLPGPP because program implementation has yet to commence. Not like the usual evaluation of impact or assessment of outcomes of a government intervention program. The study was not an evaluation of the DLPGPP's success or failure in expanding the adoption of LPG but an analysis of factors that should be under consideration in the government intervention. Although the DLPGPP focuses on expanding LPG in the domestic market, which includes households and industries, the study reviewed the extent to which the factors of accessibility and affordability can influence households' fuel shift to LPG for cooking. Due to a large amount of missing data and unreliability of the national socioeconomic datasets on domestic energy utilization, a pretest-posttest of the DLPGPP is not possible yet. The study relied on data collected from a survey using an in-person questionnaire for residents of the FCT. They were responsible for purchasing energy fuel for cooking. A self-administered web survey may have a poor response rate due to the population's perception of surveys. Although a self-administered questionnaire is an efficient and cheap way of collecting information from participants in a study, it may not be effective with some classes of respondents due to the difficulty in getting such participants to respond by writing and mail, and because there may also be illiterate individuals among the participants who cannot read or write. The study results may be useful in keeping in or out of the agenda factors influencing LPG adoption that the intervention program should target in its implementation.

Limitations

Accessibility and affordability may not be the only factors influencing household fuel transition in Nigeria. Future research may analyze the influence of other socioeconomic and socioecological factors in the DLPGPP, such as price and deforestation, to evaluate the impact of the DLPGPP across Nigeria. Future studies may compare pre-DLPGPP and post-DLPGPP household fuel consumption patterns to assess the impact of the policy and intervention program.

Significance

For 40 years, Nigeria has implemented various plans and policies to drive incremental adoption and LPG utilization for heating and cooking in households. A transformative-scale adoption and utilization of LPG for domestic cooking would present an opportunity to reduce Nigeria's energy poverty, reduce gas flaring and air pollution, reduce deforestation, mitigate erosion, gain carbon credit, and improve the quality of life in Nigeria. LPG adoption and utilization for household heating and cooking would further diversify Nigeria's economy from its current crude oil concentration, translating to jobs, reducing unemployment, and other socioeconomic gains. This study may contribute to improving DLPGPP implementation and thereby contribute to the success of the program.

Summary

Chapter 1 introduced the key parts of this study. It captured the essence and the social impact of energy transition and the need to ensure that policy focuses on the important attributes influencing fuel adoption to achieve a transformational leap of

Nigeria's households to LPG from traditional fuels. The usual focus on the attributes of fuel price and household income, as provided by the ELT, leaves a gap in the literature because outcomes of existing studies have lacked practical solutions for direct policy intervention. An assessment of the effect of affordability and accessibility of LPG may help determine effective energy transition factors for mobilizing quicker adoption of the LPG because the provision of scientific evidence can help policymakers make good decisions (Ifegbesan, 2016; Sajadi et al., 2019).

The chapter included the study's limitations. The study did not address all of the variables that may affect fuel transition. Although there are all types of settlements in Nigeria—rural, urban, and suburban—there may be peculiarities of regions concerning the attributes under study that are not in the analysis for Nigeria's household energy transition. In the next chapter, I discussed the importance of energy transition in Nigeria's households and globally and the theoretical constructs that researchers use in analyzing energy transitions.

Chapter 2: Literature Review

Introduction

Energy is a vital element of human life. Reliable access to sustainable, affordable, and modern energy plays a fundamental role in nations' social well-being and economic development (Joshi & Bohara, 2017; Mishra, 2015). To an extent, energy is a significant scale for measuring a nation's standard of living and economic development (Joshi & Bohara, 2017; Mishra, 2015). The predominant use of energy fuels in households is for lighting, cooking, heating, and cooling. Household cooking fuels come in different categories, such as traditional, transitional, and modern (Megbowon et al., 2018). The use of traditional dirty-burning fuels such as coal, wood, and kerosene for cooking emits a high level of pollutants and carbon monoxide, which are the leading causes of house air pollution associated with adverse health effects (Ozoh et al., 2018). The reduction of environmental pollutants is critical to addressing many of today's developmental challenges, including human health, climate change, food security, and general household welfare.

The ELT describes the use of different combinations of fuels as reflecting various stages of development. Biomass and wood, for example, are at the lower end of the household fuels spectrum. Nevertheless, an estimated 72% of Nigerian households use wood and biomass as the primary fuels for cooking (Eleri et al., 2012). The continued burning of fuelwood and biomass as primary fuels for cooking in many Nigerian homes is worrisome for environmentalists and policymakers. Even though Nigeria is a global energy exporter rich in oil and gas, Nigeria's domestic energy poverty continues to be of

concern to researchers. Various studies have indicated reasons for the heavy reliance on traditional fuels for household cooking in developing countries and Nigeria. However, countries need to find a way of transitioning to modern and sustainable energy usage (Ozoh et al., 2018). Efforts to shift Nigeria's households away from using traditional, polluting, and environmentally degrading fuels and toward the use of the abundantly available LPG in Nigeria for cooking have recorded limited success (Ozoh et al., 2018).

Literature Search Strategy

ProQuest Dissertations and Theses Global and Walden Dissertations and Theses played a significant role in searching for relevant literature for this study. Google Scholar was also a useful research tool, as it enabled a drill-down of related literature from the earliest to the latest. Using "cited by" and "related articles" associated with an article of focus helped find the latest research work on the problem and topic of discussion. The research also involved significant use of the Walden University library databases for peer-reviewed journals. The databases searched included Sage Journals, Science Direct, Political Science Complete, Google Scholar, Scholar Works, and Walden open access research journals. Other resources were Nigeria's government publications, institutional libraries, archives of ministries and government agencies, and online repositories of academic works such as Research Gate and Academia. I also reviewed newspaper editorials and articles on the related topics of energy, gas, and LPG.

Keywords and terms that I used to search the literature were *energy transition, energy substitution, LPG transition, socio-technical transition, system dynamics, energy models, household cooking, residential energy, domestic energy, transition strategies,*

sustainability studies, transformational strategies, transition pathways, household fuel choice, impact evaluation, program evaluation, and *government policy intervention*. The search terms helped in locating books and scholarly peer-reviewed articles relevant to the topic of study. The literature review built on the work of scholars on the subject of household cooking fuel transition in developing countries. The review also included discussions on household interfuel substitution, determinants of household energy fuel choice, energy efficiency, and sustainable energy sources (Baiyegunhi, 2014; Danlami et al., 2017; Joshi & Bohara, 2014).

This study's focus was exploring, reviewing, and highlighting those factors that mitigate LPG diffusion in Nigeria about government policy goals and instruments. The study also focused on analyzing the government intervention policy's success for the substantial transition of Nigerian households to LPG for cooking. Active policy intervention for change in consumer behavior depends on a clearly articulated strategy. The problem is that no country or government has unlimited resources and must make trade-offs at each point in time.

For the review of literature, I examined the work of scholars on the subjects of household cooking fuel transition in developing countries, household interfuel substitution, determinants of household energy fuel choice, energy efficiency (Baiyegunhi, 2014; Danlami et al., 2017; Gould & Urpelainen, 2018; Joshi & Bohara, 2014; Trotta, 2018), sustainable energy, and Nigeria's evolving policy framework for low-carbon development (Ministry of Petroleum Resources, 2019; Oyedepo, 2014).

Buba et al. (2017) confirmed the ELT that increases in income and other socioeconomic, demographic, and socio-ecological factors influence the transition from less efficient fuels to modern and more efficient fuels for household cooking. Researchers have found that variables such as income, price, culture, household size, education level of the head of household, type of housing, ownership of housing unit, geopolitical region, marital status, capital, installation cost, operating and maintenance cost, distribution, safety, and quality (Buba et al., 2017; Denis et al., 2017; Ifegbesan & Rampedi, 2018; Ogwumike et al., 2014; Ranganath et al., 2016) influence choice of household fuel and the substitution of one fuel by another as the primary source of energy for cooking in households. Some of the listed factors are exogenous to the household. Factors outside the domain of household control, such as national or local energy policies, regulations, and the physical environment, including the geopolitical context, urbanization, and development of the fuel market, play a significant role in adopting modern fuel (Danlami et al., 2017). The extent of variable influence and the statistically significant influence of income and other socioeconomic variables are discussed widely in the literature.

Identifying research gaps is fundamental to the literature review process (Muller-Bloch & Kranz, 2015). The purpose of this research was to fill a gap in the literature regarding LPG transition and government intervention preferences for prospective users of LPG in Nigeria. Various studies have addressed the determinants of household fuel choice. Although socioeconomic factors have frequently been studied, little research has been conducted on the influence of fuel accessibility, operationalized as ease of procurement, and affordability, which includes the capital cost of fuel switch, on

household fuel transition in Nigeria. There was also the need to assess attribute importance by considering individual preference for suitable policy measures to decipher factors leading households to accept or reject LPG adoption. I reviewed the literature on processes, patterns, and pathways in energy transition (Coelho et al., 2018; Edomah, 2017; Elzen et al., 2004; Geels & Schot, 2010; Hussein, 2015), energy poverty in Sub-Saharan Africa, and the determinants of household fuel choice in the context of cooking (Emordi, 2015; Malakar, 2018; Walker, 2014). Danlami et al. (2017) found that deployment of resources and the combination of policies and technologies can improve energy access and security. Riahi et al. (2012) also identified pathways to the evolution of energy systems. Consequently, the literature review examined government interventions toward a framework for the rapid transition of household cooking fuel from traditional fuels to LPG in India, Nepal, and Bolivia and the effectiveness of policy measures in transforming energy systems.

Theoretical Foundation of Energy Transitions

Numerous studies have been conducted in recent years on energy transitions; however, most of these studies have occurred in developed countries (Osunmuyiwa et al., 2018). Therefore, this study reviewed and used models and theoretical frameworks to analyze household fuel choice for cooking in Nigeria to determine fuel choice, plan energy fuel diffusion process, and energy transition. The theoretical models included (a) the consumer theory—energy ladder and fuel stacking transition model and (b) the transition management approaches—multilevel perspective (MLP) of socio-technical transitions and system dynamics approach to transition management.

Consumer Theory

The authors of the consumer utility theory postulated that consumers derive utility from the attributes embedded in a commodity and not the commodity itself (Baiyegunhi, 2014; Lancaster, 1966; Rosen, 1974). I used the utility and preference approaches to consumer economic theory to delineate fuel attribute importance to consumers, model household fuel energy choice and each attribute's effect on LPG consumption, and thereby disaggregate individual preferences for policy intervention. The mathematical construct for modeling the choice and preference of consumers is utility. This study included discussions of evidence from the literature that household fuel decisions are made based on socioeconomic and agro-ecological factors beyond the narratives of the energy ladder (Amoah, 2019; Astuti, 2017; Baiyegunhi & Hassan, 2014; Bisu et al., 2016; Denis et al. 2017; Muller & Yan, 2018). Consumers reach a preference and choose from among the full set of fuel alternatives and multidimensional properties the fuel that maximizes utility (Hensher et al., 2005; Lancaster, 1966; Ratchford, 1975; Rosen, 1974). The maximum utility approach to consumer economic theory presented in the utility matrix model enables the analysis of brand substitution and alternative fuels. The modeling demand for underlying product characteristics is similar to using multiattribute scaling and attitude models in explaining the brand preference for consumers and attributes of government intervention (Ratchford, 1975).

Empirical Model of Consumer Choice

The consumer economic model provides a useful framework for empirical demand analysis from survey data. The model is valid in circumstances where the

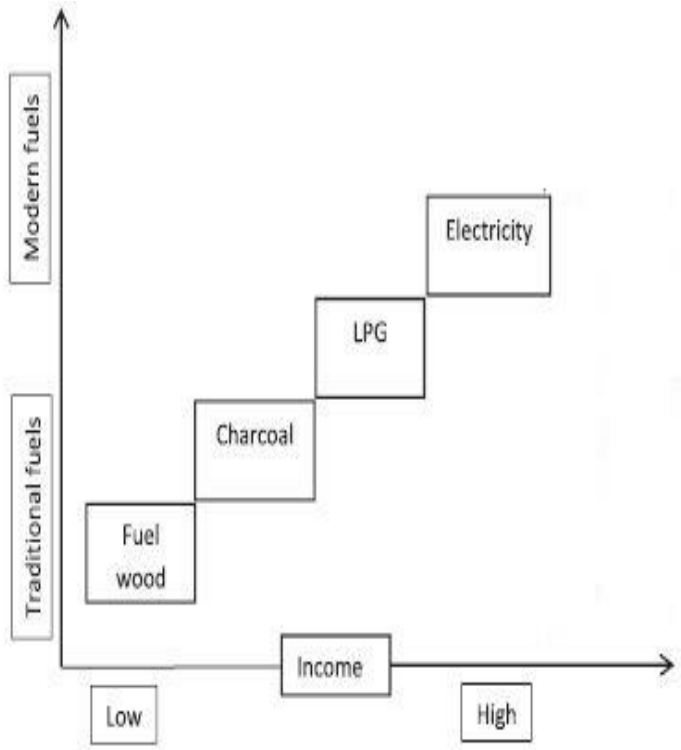
individual customer is rational and therefore maximizes a perception of utility function $U(Z_i)$ established by a functional relationship with an objective characteristic or attribute Z. For example, in a choice set of all fuel alternatives *j* (wood, kerosene, LPG, and electricity) for a household *i*; the household *i* is said to have a utility given by $U_{ij} = Q(Z_j, S_i) + \varepsilon(Z_j S_i)$ for a given quantity of fuel *j*, where S_i is the socioeconomic and agro-ecological factors affecting the household, and ε (epsilon) is the function constant (Baiyegunhi & Hassan, 2014).

The Energy Ladder Model

The energy ladder model connects access to household energy with economic development. The theory stresses household income as the main pointer to household fuel adoption through a linear hierarchical model that combines household fuel types with rising economic status. In extending consumer economic theory to energy, Horst and Hovorka (2008) and Hosier and Dowd (1987) ordered households' use of cooking fuels from low quality, low technology, and high emission to top quality, higher technology, and low emission with increasing household income, as described in Figure 1. Therefore, as household income increases, a consumer ascends the energy ladder and transitions from low-quality, solid fuels to higher quality, nonsolid fuels.

Figure 1

The Energy Ladder Model—Illustration of Fuel Shift

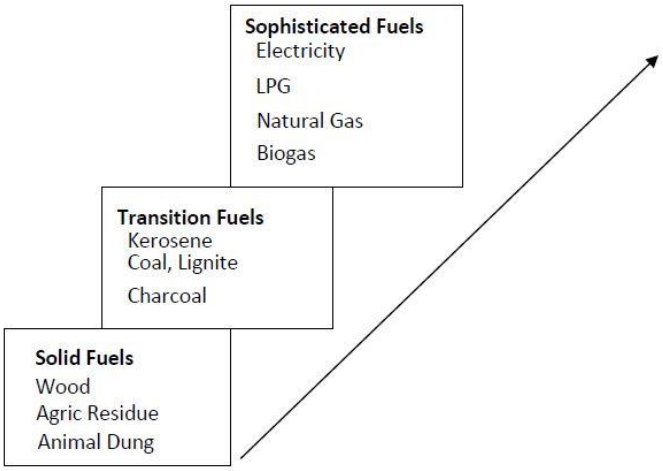


Therefore, fuel switching is an important process in the energy ladder transition model, in which case one fuel completely displaces another as households gain socioeconomic status (Astuti, 2017). The movement of fuel choice may be characterized as occurring in three distinct phases (see Figure 2), whereby households move from the use of (a) biomass fuels such as dung, coal, and wood to (b) transition fuels such as coal, charcoal, and kerosene, and then to (c) modern fuels such as LPG, electricity, and renewable energy fuels (Andadari et al., 2014). There are variants of the process with three, four, five, or six phases. Hosier and Dowd (1987) presented a five-step ladder by

differentiating gathered fuel from purchased fuel; Reddy (1995) expressed a six-rung ladder of dung/waste, wood, charcoal, kerosene, LPG, and electricity.

Figure 2

The Energy Ladder Model Illustrating Fuel Transition



Note. From "Socio-Economic Determinants of Households Fuel Consumption in Nigeria," by A. Buba, M. Abdu, I. Adamu, and Y. I. Usman., 2017, *International Journal of Research—Granthaalayah*, *5*(10), p. 353. Copyright 2017 by Abdulahi Buba. Reprinted with permission.

In testing the ELT's validity regarding household fuel consumption in Nigeria, Buba et al. (2017) used data from the 2013 Demographic Health Survey for Nigeria to test whether economic status affected fuel choice. The researchers found modern fuel use to be higher in the rich geopolitical areas of the country. The finding that financial status strongly influences a household's fuel choice is consonant with the energy ladder.

Researchers have recently queried and contradicted the energy ladder model. Astuti (2017) used the energy ladder model to assess modern fuel use pattern in Indonesia before and after the implementation of government policy designed to promote the transition of domestic energy fuel from kerosene to LPG. Astuti found that low-income

households consumed LPG after the program and that the intervention policy circumvented the energy ladder.

The energy ladder model has been criticized as deficient by some researchers. Megbowon et al. (2018) argued that the studies proposing the energy ladder and fuel stacking were methodologically flawed. Factors influencing the choice of cooking fuel are not uniform across different households. Denis et al. (2017) faulted the energy ladder model and its switching process. They argued that most households' fuel choice and consumption decisions are impacted by factors beyond economic factors, such as noneconomic, psychological, cultural, qualitative, and quantitative factors. Andadari et al. (2014) found that the level of education, household size, household income, and an LPG program positively influenced a massive shift from kerosene to LPG in Indonesia. A community survey of the pattern of household sources of energy conducted by Desalu et al. (2012) in South-West Nigeria found that the use of energy in urban areas was associated with education and utility ease of access to the dispensing depot for the energy fuel. Researchers have agreed that household income positively influences the choice of energy but have also argued that households do not discard traditional fuels completely but combine the use of traditional fuels with other energy sources (Astuti, 2017; Desalu et al., 2014; Megbowon et al., 2018). Some researchers have aligned with alternative models such as the fuel stacking model (Bisu et al., 2016; Masera et al., 2000). This model posits that households will increase the number of energy sources they use as household socioeconomic status improves, without completely forgoing the use of fuels lower on the energy ladder.

I acknowledge the validity of the energy ladder model, considering other socioeconomic and socioecological variables, and used the energy ladder as extended to include the socioeconomic factors of LPG accessibility and affordability. The study used the energy ladder model to test the effect and the effect size of LPG affordability and accessibility on fuel choice and fuel substitution to LPG in Nigeria by translating the energy ladder model into a logit model.

Fuel Stacking Transition Model

The fuel stacking model concept emerged as a result of observations that households in developing countries do not switch completely into modern fuels but consume multiple fuel types during energy transitions (Masera et al., 2000; Heltberg, 2005; IEA, 2006). Researchers have argued that fuel stacking describes better the fuel-switching behavior of households in the developing countries of Africa as opposed to the energy ladder model (Coelho et al., 2018; Megbowon et al., 2018). According to Han et al. (2018), fuel stacking in households results from irregular and variable income, fuel supply problems, fluctuation of fuel prices, and complex interaction of economic, social, and cultural factors that compels households to choose various fuels for different household activities and food types (Astuti, 2017; Sole, 2015). Multiple energy fuels are employed in complex ways in an energy transition time, depending on the purpose. In a study aimed at strengthening evidence-based policies for government incentives for fuel switching, Andadari et al. (2014) found that Indonesia's LPG program contradicted the energy ladder theory and led to an increased stacking of fuels. The researchers found that a combination of incentives, household attributes, and constraints guide the household

choice of any of the six sources of energy carriers – electricity, LPG, kerosene, charcoal, wood, and waste.

Despite the understanding of the complex nature of decision or choice-making and description of household fuel use, the fuels stacking model does not provide a way to measure households consumption, preference of one fuel over another or offer a prescriptive basis for the household choice of fuel, or offer any approach to influence or manage the transition to cleaner household energy. In this study, I acknowledged using multiple fuels in societal transition, but its focus is on LPG's transition as the primary source of fuel for cooking in Nigeria's households.

Transition Management Approaches to Energy Policymaking

Transition management (TM) approaches developed with a focus on sustainability. Policymakers use their translated framework to manage the complex interactions, processes, and long-term structural change governance. Transition management is a prescriptive and complexity-based framework that encourages collaborative policymaking designed to create space for innovation and long-term sustainability visions of desired transition outcomes (Loorbach, 2010). As an approach based on insights from governance and complex adaptive systems 'thinking' theory, the field of transition management has evolved into several variants of analytical methods in sociology, economics, policy, political, and organizational sciences (Loorbach, 2010). Researchers use variants of transition management like the multi-level perspective of socio-technical transition (Geels, 2002, 2011, 2016, 2019; Hess, 2014; Rip & Kemp, 1998) and system dynamics to analyze historical transformations and to order the

organization and complexity of adaptive systems to successfully adjust to societal changes (Grin et al., 2009; Mazur, 2015).

Multilevel Perspective of Socio-Technical Transition

The MLP of sociotechnical transition provides useful ways to analyze or guide a technical transition from one regime to another. Socio-technical transition describes a moving assembly of alliances and substitution and the reknitting of configuration elements by technology, policy, markets, consumer practices, infrastructure, cultural meaning, and scientific knowledge. Authors of the MLP list the actors in socio-technical transitions to include firms and industries, policymakers and politicians, consumers, civil society, engineers, and researchers (Geels, 2019). The sociotechnical transition architecture is multiple levels of a nested hierarchy – the micro, meso, and macro levels that Geels (2002) described as the niche, regime, and landscape levels. The niche serves as an incubation room for market forces and provides space and time to support networks and supply chains to foster innovation. The regime represents the rule-set of processes, technologies, skills, corporate cultures, and artifacts embedded in institutions and infrastructures. The landscape is the external structure or context for the interaction of actors. According to Osunmuyiwa et al. (2018), since the government is central in the collective decision-making process and relates with actors whose activities pressurize the system, government and landscape actors can introduce policy, program or actions to stimulate the adoption of a niche innovation and cause its diffusion to become the dominant regime within a gradual process. MLP approach to transition in systems may take any of four different pathways – Transformation, Reconfiguration, Technological

Substitution, De-alignment and, Re-alignment. Researchers have used the MLP in analyzing the transition of energy fuels like the Dutch transition from coal to gas (Elzen et al., 2004) and other transitions (Arapostathis et al., 2019; Kungi & Geels, 2018; Sovacool & Geels, 2016).

Critics of the MLP claim that the MLP focus on technologies and artifacts with little emphasis on sustainability outcomes (Gillard et al., 2016; Temper et al., 2018). Feola (2015) argued that MLP suffers a lack of empirical grounding and rigorous conceptualization of transformation, while Røpke (2016) frowned at the MLP for not addressing socio-ecological or distribution systems. Due to the rentier state nature of Nigeria (Osunmuyiwa et al., 2018) argued that the assumptions and findings of transition management and the MLP studies might not easily translate to developing countries like Nigeria as transition contestation is unduly influenced by Nigeria's political system, which favors centralization against the decentralization approach of transition management.

MLP provides analytical and heuristic concepts to understand the complex dynamics of sociotechnical change or a means to explain how technological transitions of energy fuels like that of kerosene to LPG come about due to the interaction of actors, environment, and innovations (Geels, 2002). Nevertheless, the need to support MLP with insights from the rentier theory or system dynamics framework model to answer the research questions presents a greater challenge, and the MLP will not align well with this study for its focus on a narrative understanding of transition (Mazur, 2015) not given to quantitative measurement.

System Dynamics

System dynamics (SD) is an interdisciplinary approach grounded in the theory of nonlinear dynamics used to address real-world problems of complex and dynamic nature. Modeling with SD helps describe a system and serves as a technique to simulate scenarios to address complex system problems (Musawa, 2016). Over the years, SD has been an impressive methodology in energy research. Researchers (Akinbami & Mulugetta, 2017; Emordi, 2015; Momodu et al., 2016) have used SD models to describe systems, simulate scenarios, and address problems in energy policy dimensions, economy, and sustainability. SD relies on information obtained from system actors using qualitative means to elicit and validate data to develop a robust model (Musawa, 2016), rendering the framework less valid for this quantitative study.

Nigeria's Energy Poverty and Household Cooking Fuels

Nigeria's national electricity grid generates and distributes an average of 4,000 MW of electricity, which is a fraction of its electricity need estimated at 180,000MW, considering its huge 190 million people. Private power generators deliver up to 72% of electricity consumption (Emordi, 2015). Heavy reliance on environmentally unsustainable solid fuels is common at the household level. Poor access to clean energy has continued to be a difficult problem in Nigeria, constraining human and economic development (Bazilian et al., 2014; Megbowon et al., 2018). According to Buba et al. (2017), household cooking fuels used in Nigeria are animal dung, crops, grass, wood, charcoal, coal, kerosene, biogas, natural gas, LPG, and electricity (see Table 1). Biomass residue and solid fuels like wood, coal, and charcoal burnt on open fires or incompletely

combusted in traditional cookstoves emanate poisonous gases, suspended liquids, and solid particles that create major public health problems, impact the environment and significantly contribute to climate change (Noubiap et al., 2015).

Table 1

Distribution of Households' Choice of Cooking Fuel in Nigeria, 2013

Type of fuel	Percentage
Electricity	0.45
LPG	0.74
Natural gas	1.26
Biogas	0.23
Kerosene	19.84
Coal, lignite	0.26
Charcoal	3.13
Wood	72.18
Agriculture residue	1.91

Note. From "Socio-Economic Determinants of Households Fuel Consumption in Nigeria," by A. Buba, M. Abdu, I. Adamu, and Y. I. Usman., 2017, *International Journal of Research—Granthaalayah*, *5*(10), p. 353. Copyright 2017 by Abdullahi Buba. Reprinted with permission.

The World Economic Forum (2019) ranked Nigeria 109 out of 115 countries on its energy transition index. The forum reported persistent gaps in universal access to clean cooking fuels in Sub‑Saharan Africa, where the affordability and reliability of power supply are still critical challenges due to poor policy governance and policy stability, and noted Nigeria as lagging in the transition to clean energy. Ozoh et al. (2018)

detailed the distribution of household cooking energy in the large metropolitan city of Lagos in Table 2.

Table 2

Choice of Primary Household Cooking Fuels

Fuel type use in households	Primary fuel *n* (%)
Kerosene	364 (70.1)
Charcoal	88 (17)
LPG	63 (12.1)
Electricity	2 (0.4)
Wood	2 (0.4)

Note. From "Cooking Fuels in Lagos, Nigeria: Factors Associated With Household Choice of Kerosene or Liquefied Petroleum Gas (LPG)," by O. B. Ozoh, T. J. Okwor, O. Adetona, A. O. Akinkungbe, C. E. Amadi, C. Esezobor, O. O. Adeyeye, O. Ojo, V. N. Nwude, and K. Mortimer, 2018, *International Journal of Environmental Research and Public Health*, *15*(4), p. 5 (https://doi.org/10.3390/ijerph15040641).

LPG had a share of only 12.1% as the primary fuel in the city's household cooking energy mix. Taken from the 2013 demographic and health survey of Nigeria (DHS), Buba et al. (2017) estimated the distribution of household cooking choice of energy. They computed 2.68% as the total contribution of clean energy - Electricity, LPG, Natural Gas, and Biogas combined. The estimates were not different from the year 2004 distribution of household cooking energy extracted by Ogwumike et al. (2014). According to Buba et al. (2017), 76% of sampled households depend primarily on solid fuels, reinforcing the need to foster the transition to clean energy and to grow LPG

consumption nationwide. Despite the recent upsurge in LPG uptake in the urban areas, the unsustainable use of solid fuels is still endemic, and government intervention in policy and programs is required to improve LPG access throughout the nation.

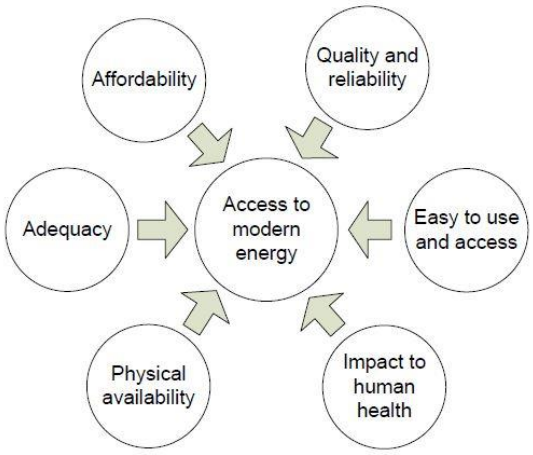
The Determinants of Household Choice of Cooking Fuel and Energy Transition

Researchers classify the determinants of the household choice of energy into endogenous and exogenous factors in the literature. Endogenous factors are household economic, non-economic, and behavioral characteristics like household income, expenditure, composition, education, and cultural preference. Exogenous factors impact the household from external conditions, including the physical environment, government policies, energy, and energy device characteristics, and the energy supply factors of affordability, accessibility, availability, and reliability (Kayode et al., 2015) see Figure 3.

A case study to understand how rural LPG adopters differ from other rural households assessed the impact of affordability, accessibility, and awareness of LPG in rural households and found out that multiple factors of accessibility, awareness, and affordability influence the adoption of LPG in rural India, even though the study did not establish a causal relationship (Kumar, 2017). Baiyegunhi and Hassan (2014) used the consumer economic theory to evidence fuel transition in rural households in Giwa Local Government area of Nigeria. The authors analyzed the impact of household socioeconomic characteristics on cooking fuel choice using a multinomial logit model (MNL) built on consumer utility to estimate fuel choice.

Figure 3

The Dimension of Modern Fuel Access



Note. From "An Analysis of Household Transition to Modern Fuel Under Indonesia's Energy Conversion Programme," by S. P. Astuti, 2017, University of Birmingham (https://etheses.bham.ac.uk/id/eprint/7192/). Copyright 2017 by Septin Puji Astuti. Reprinted with permission.

The authors estimated the dependent variable - household fuel choice using fuelwood as a reference category in the MNL. They interpreted the results as the odds ratio of choosing one outcome category (kerosene, LPG, and electricity) over the reference category (Fuelwood). Baiyegunhi and Hassan (2014) found that fuelwood and kerosene are the main sources of fuel energy in the area and that the share of fuelwood, kerosene, LPG, and electricity in the energy mix of households, with each as the principal fuel choice, is 72%, 86%, 69.9%, and 35% respectively. The MNL model provided parameter estimates and marginal effects, which predicted household use of fuel in the rural area as 73.4%, 18.8%, 2.6%, and 5.2% for fuelwood, kerosene, LPG, and electricity, respectively. The author's model depicted a three-stage linear switching process. The starting stage is the reliance on biomass fuels. In the second stage, households moved to

"transition" fuels like kerosene, coal, and charcoal, and the third is a switch to the use of LPG, natural gas, or electricity. The researchers found that household fuel choice switch is a function of increased household income and other factors such as deforestation and urbanization. The authors noted that other factors included the demand and supply side of energy fuels such as accessibility and shortages, socioeconomic factors of age, family size, education of family head, and type and taste of food as influencers of household choice of cooking fuel. In Nepal, forest characteristics influence fuel choice, wood being the primary household fuel for cooking. Joshi and Bohara (2017) conducted a study on the impact of forest management on fuel choice. They found that the transfer of property rights of government-owned forests to the communities encouraged households' fuel switching to cleaner cooking fuels and other social variables like household head's education, distance to the firewood sources, energy access status, and household income.

In research to explore the economic and socio-demographic factors that influence households' choice of switching from firewood to LPG in northern Cameroon, Nlom and Karimov (2015) explained consumers' fuel choice with the aid of the energy ladder model built on consumer behavior. The authors ran a discrete choice probit model on Cameroon's national survey data to construct cooking patterns and fuel choices among firewood, kerosene, and LPG. The authors found that fuel prices, age of household heads, educational level of household heads, and household dwelling type significantly impact fuel-switching decisions and that fuel switching followed a linear pattern of inefficient to efficient fuels as income increases. Amoah (2019) mixed-method study of households' determinants of cooking energy used probit estimates on the derived survey data of 120

households randomly selected to measure the proportion of determinants in household cooking energy choice. The probit estimates determined the proportion of the household determinant in the choice of cooking fuel. Consistent with previous research findings (Heltberg, 2003, 2005) and the energy ladder theory, Amoah (2019) confirmed income and the relative price of fuel as significant determinants of fuel choice. The author also found that kitchen location, educational attainment of the head of household, convenience of energy, distance to fuel source, and the effect of fuel sources were statistically significant at various levels on the choice between traditional and modern cooking fuels. According to Bisu et al. (2016), individual consumer characteristics cannot explain the variations in consumer behavior related to household fuel choice and argued that situational factors might also contribute to the observed variance rather than actor-related factors. The author's t-test on the response obtained from a semi-structured questionnaire revealed that household size and ownership status, income, level of education, season, and affordability are all significant attributes of fuel choice in Bauchi, Nigeria. Simultaneously, taste, quantity, house owner's rules, scarcity, and gender were not significant in influencing household fuel choice. Other studies that confirmed the positive influence of household income and socioeconomic status on fuel choice in Nigeria using microeconomic theories include Adeyemi and Adereleye, 2016; Buba et al., 2017; Emagbetere et al., 2016; Ifegbesan et al., 2016; Ogwumike et al., 2014.

Hanna and Olivia (2015) disagreed that a change in income necessarily impacts fuel consumption composition. Through a persistent asset transfer to 429 treatment households in a randomized experiment that included a control group of 388 households

in rural India, Hanna & Oliva (2015) found that, while fuel consumption significantly increased, there were no observed shifts towards a better stove technology or to a better cooking fuel type by the treatment group. The authors suggested that the intervention only changed the source of household lighting to electricity and did not influence any change towards the choice of cooking fuel. Hence the need for policy to target intervention towards determinants that will lead to desired outcomes.

The Importance of Fuel Transition Attributes

Ghana's government distributed LPG stoves to the rural population in 2013, but accessibility issues in terms of cost and distance to distribution point limited and impaired LPG adoption (Abdulai et al., 2018). Peru noted a similar experience in its Fondo de Inclusión Social Energético (FISE) LPG Promotion Program (Pollard et al., 2018). Access, affordability, and reliability of modern fuel supply are critical determinants when making transition decisions, according to Schunder and Bagchi-Sen (2019). Lack of supply stability leads to fuel stacking, which may impair adoption despite policy intervention. A study conducted on a sample population of 78 households in Botswana evidenced a reliance on multiple energy sources regardless of household wealth and social status due to supply fluctuations (Schunder & Bagchi-Sen, 2019). Affordability, operationalized as a combination of fuel cost, opportunity cost, cost of associated accessories, and cost of a competing fuel, is also a critical factor in the transition of households to modern fuel. While government policy may target fuel cost with price subsidy, a high initial startup cost can be a disincentive to switch to modern fuel (Schunder & Bagchi-Sen, 2019). A study by Hollada et al. (2017) of 31 participants

in Peru found that the initial cost of an LPG stove and cylinder exceeded household affordability despite the $6 per month subsidy on LPG applied by the government. In India, a combination of the initial LPG adoption cost and subsidy provision resulted in sustained LPG use (Gould & Urpelainen, 2018; Schunder & Bagchi-Sen, 2019). The difference in policies accounted for the difference in adoption in similar countries (Troncoso & Soares da Silva, 2017). Governance functions and its use of economic instruments to influence LPG adoption risks, opportunities, consumer preferences in terms of initial cost underwriting, market, infrastructural development incentives, subsidy, and partnerships to guarantee demand and supply are critical to the diffusion and adoption of LPG. The government's role is to select and foster household energy fuel consumption that is conducive to sustainability.

Policy Frameworks for Rapid Transition of Household Cooking Fuel From Traditional to Modern Fuels

Due to environmental issues and climate change concerns, a natural transition dictated by social and ecological factors from high polluting fuels to modern fuels is no longer tenable for many developing countries, Nigeria inclusive. The major policy of the last 40 years on cooking energy in Africa and Asia of improving biomass combustion efficiency through clean, improved cookstoves has failed. Due to policy implementation issues, inability to keep up with population growth, urbanization, and the different from expected health effects of the cookstoves (Batchelor et al., 2019), governments of some countries have successfully intervened using different policy frameworks to transit household fuel from traditional to modern fuels rapidly.

Indonesia

Until 2006, 60% of Indonesian household fuel consumption was kerosene. By 2015, the share of kerosene consumption had declined to 15%, while LPG domestic utilization increased to 49% (Destyanto et al., 2017). In 2007, Indonesia started the implementation of an ambitious program to convert 50 million domestic consumers from kerosene to LPG in her Energy Conversion Program: Kerosene to LPG (ECPKL); (Astuti, 2017). Research showed that a liter of kerosene delivers the same energy as 0.39kg of LPG to provide Indonesia with a subsidy savings of 2.17 USD (Budya & Yasir, 2011) and regards the Indonesian government's policy of petroleum fuel subsidy reduction to be the main factor for the acceleration of the people's adoption of LPG for domestic cooking. According to Destyanto et al. (2017), the government is a facilitator, stimulator, and coordinator of a program where policy intervention significantly impacted the size and speed of energy transition. Astuti (2017) explained the purpose and constituents of energy policy as a pyramid of five goals - access to modern energy, supply security, cost efficiency, the efficiency of natural resources, and social acceptability. By a system of provisioning modern energy infrastructure which is essential to alleviating energy deprivation (Astuti, 2017), the government of Indonesia, through the ECPKL helped families to convert from kerosene to LPG by

- giving free LPG cylinder and supporting accessories – stove and connecting hose to families.
- incentivizing investment to increase production capacity of supporting equipment

- promoting investment to build LPG infrastructure
- easing the license to construct LPG infrastructure and
- withdrawal of kerosene subsidy and supply (Destyanto et al., 2017).

Brazil

The large migration of households from traditional fuels to LPG occurred between 1960 to late 1970's when about 95% of households in Brazil transited from solid fuels and kerosene to LPG. Brazil's government anchored the transition to LPG through subsidies on LPG price that benefited everyone and later targeted only low-income families, efficient distribution and logistics, and efficient and effective regulations (Coelho et al., 2018; WLPGA, 2018). According to Coelho et al. (2018), Brazil's policy framework addressed key challenges related to supply, regulation, distribution, and affordability of LPG for the poor.

India

The rising adoption rate of LPG in India is credited to abundant supply, household preference, and accessibility of the product locally. Spurning LPG accessibility is at least one distributor within a radius of 50 km throughout India. According to Patra (2015), the number of distributors in an area indicated the level of LPG penetration in the area. Oil marketing companies, by practice, attach customers to the nearest distributor, and every household enrolment by a distributor is a lifetime assured business. By the year 2010, 64.5% of urban households principally use LPG for cooking, rising from 29.6% of households in 1994. Users in rural India rose from 1.9% to 11.5% during the same time. The rural-urban dichotomy results from the difference in disposable income, the fact that

refineries producing LPG situate in the urban cities, and the urban areas have less access to firewood, charcoal, and dung compared to the rural areas.

- Tagged Vision 2015, India's policy targeting rapid adoption of LPG in its rural areas announced in 2009 mandated the following; Oil marketing companies (OMC) to enroll 55 million households by providing LPG connection through LPG distributors by 2015.
- A part of the OMC's corporate social responsibility funds to provided installation costs to low-income households identified by State governments
- Development of a low-cost distributorship model - Rajiv Gandhi Gramin LPG Vitaran Yojana (RGGLVY). The program owns the stocking warehouse to reduce the cost of distributorship that would typically cost 30 lakhs in the urban city to only three lakhs in the rural areas within the proximity of habitation. A new scheme Pradhan Mantri Ujjwala Yojana (PMUY or Ujjwala), targeting 50 million users by March 2019, took effect from the financial year 2016 and applied subsidy to only those below the poverty line
- Excise duty exemption for imported LPG and subsidized domestic selling price in aid of energy access and affordability
- Households were either connected, received cylinders on home delivery, or pick up from the distributors' warehouse (Panda, 2017; Patra, 2015).

India's government approach to universal energy access comes by ensuring affordability and availability. India's policy focused on removing start-up costs and supply-side barriers through tariff subsidies and infrastructure development that

guaranteed access proximity. The policy targeted the affordability of cooking LPG by altering consumer price for connection or consumption to enable India to meet its goals of transiting from traditional fuels to clean LPG. India met the Ujwalla goal of 50 million additional users in August 2018 (Soman et al., 2018). The high cost of subsidy led to the reforms of the subsidy scheme with programs such as Direct Benefit Transfer for LPG (DBTL) and mandatory exclusion, in which case poor consumers buy LPG at market price, and the differential from a fixed price is paid directly into their bank accounts to ensure that only those below poverty line benefited from the subsidy.

World Economic Forum

Although not explicitly tailored towards the household cooking energy transition, the World Economic Forum (2019) Energy Transition Index (ETI) for the assessment of energy systems proposes a long-term, flexible policy framework that adapts to the challenges and opportunities of addressing increased energy productivity, and the demands of energy transition along three dimensions of economic development and growth, universal access to secure and reliable supply, and environmental sustainability. World Economic Forum (2019) policy framework proposed the removal of fossil-fuel subsidies to create an enabling environment for the energy transition, identified key enablers and support for decision-making towards creating a robust environment for transition, and proposed policy needed to integrate new technologies and business models effectively that would attract capital to finance the energy transition, incentivize multilateral partnerships, and consumer behavior for the adoption of the new energy systems

Nigeria

Nigeria did not plan a natural gas distribution network for household cooking like countries in Europe and other world temperate regions. Generally, in the tropics, the heating demand of individual consumers is too small and can rarely justify the household distribution pipeline network's cost. Domestic LPG distribution was through branded gas cylinders. Until 2015, the country did not articulate a clear policy on the accessibility and affordability of LPG to grow the domestic market and attract private sector interest to attain full commerciality of LPG.

National Gas Policy

Authors of the National Gas Policy (NGP) paid close attention to clean energy for household cooking and the domestic LPG market. The NGP identifies LPG as an important gas product and an alternative avenue for growing the domestic gas market to induce a positive effect on job creation, end gas flares, and gain carbon credit in its vision of gas-based industrialization for Nigeria. The NGP LPG policy made provisions for the government to facilitate LPG plants' development, tackle the inefficient distribution chain, and the insufficiency of LPG availability in the domestic market. The NGP also targets a broader penetration of LPG into households – low income and rural.

Strategic Domestic LPG Penetration Program

The Ministry of Petroleum Resource's proposed domestic LPG penetration program provides appropriate governance and intervention framework to expand domestic LPG penetration to urban, rural, and low-income households throughout Nigeria. The DLPGPP targets a substantial increase in the number of households using

LPG as their primary cooking fuel through a series of government initiatives aimed at growing demand by 500% and converting 7 million low-income and poor households to LPG in seven years. The program aims to stimulate domestic LPG by fostering LPG accessibility, availability, affordability, and acceptability (Suleiman, 2019). The goals of the program are to

- resolve supply chain barriers by addressing inland production problems, and improve on supply infrastructure at jetties and storage terminal
- provide an LPG intervention fund to promote access to finance for LPG infrastructure project
- provide LPG conversion schemes to address start-up affordability challenges
- provide microloans to 2 million low-income households for the acquisition of starter packs and conversion of 5 million poor households who have LPG affordability challenge
- target campaigns to improve levels of LPG awareness and acceptability in the country and educate consumers on the economic, health and value benefits of LPG
- develop an effective regulatory compliance framework that ensures long term sustainability (Suleiman, 2019)

Assessing Household Fuel Transition Using the General Framework of Consumer Economic Theory and the Energy Ladder Model

Common pattern and methods used by researchers to analyze household energy choice and provide an understanding of how various factors influence households' choice and substitution of energy fuel in empirical literature are

- use of univariate and bivariate analysis, including simple frequencies, averages, and percentages, and correlation coefficient for the analysis of consumer behavior;
- use of ordinary least square (OLS) to study a single energy source;
- use of logistic regression (logit)/probit model to review factors that influence the probability of household decision to substitute energy source in an ordered manner; and
- use of logit/probit model. (Danlami et al., 2015)

This study used the binomial logistic regression to analyze accessibility and affordability on fuel choice in Nigeria's households. Simple frequencies and correlation coefficients were not adequate to answer the research questions because the study was not analyzing consumption patterns. Pearson's Chi-square and Pearson's correlation analysis helped determine the relationship between the dependent (LPG adoption) and independent variables (LPG accessibility and LPG affordability). The logit/probit models are more valid approaches to analyzing determinants of fuel choice. If there are multiple fuels (more than two) from which consumers can choose, the multinomial regression is the appropriate predictive analysis to perform. The use of the various logit/probit models

is popular in the analysis of energy transitions. The difference between a logit or probit analysis lies in the assumptions underlying their error terms. Although the logit model is easier to interpret, the probit model deals with heteroscedasticity better when necessary. The models are econometric analytical tools usually performed to test, support, or strengthen varying hypotheses and theories proposed by researchers to analyze and assess consumer choice, household transition, product substitution, and preference determinants in the literature.

Nlom and Karimov (2015) investigated other factors apart from income and price by performing an ordered probit model on the dataset obtained from the Cameroonian household energy survey in 2005 to order the fuel types and assess the effect of attributes on fuel choice. The probit model assumed that the household's choice of fuel types are latent or exogenous variables, and describes the function by $Y_i = X_i\alpha + Z_i\delta + \varepsilon_i$ where *Yi* is the dependent fuel choice variable and X_i is the price variable, Z_i is the vector of user attribute, α and δ are the parameters of the model, and ε is the unobserved heterogeneity – the stochastic normal distribution disturbance term or error. Amoah (2019) also performed probit analysis on a dataset of household demographic characteristics that included gender, age, education, occupation, housing type, income, and energy source to highlight how different factors beyond the conventional price factor affected the household choice of energy fuel. In Amoah's study, a consumer's decision to use a particular fuel is dichotomous of two mutually exclusive outcomes. The consumer will choose kerosene or LPG, not both. The equation $P_i\ (y_i = 1/x_i\alpha_i) = 1 - F(-x_i\alpha_i)$ gives the probability of using LPG over kerosene where F is the cumulative distribution function,

and x_i is the hypothesized attribute or characteristic that is influencing the probability choice of fuel energy, and αi is the estimate parameter. The parameters of the probit model do not provide the direct effect of the changes in the influencing attributes on the choice of energy fuel. It, however, provides the relative or marginal effect of the explanatory variables obtained using the function $\delta p_i / \delta x_{ij}) = \alpha_{ij} * f(Z_i)$. The marginal effects of determining factors like education level depict the strength of the variable in predicting fuel choice. This method is valid for this study when replaced with the multinomial model to cater for more than two dependent variables.

Denis et al. (2017) performed a regression analysis on Nigeria's General Household Survey data of 2013. They found education, expenditure for food, and per capita expenditure on fuel as significant determinants of LPG choice for household cooking. Investigating household determinants of fuel choice in Ondo State of Nigeria (Adeyemi & Adereleye, 2016) conducted a multinomial regression analysis on data obtained from a well-structured questionnaire served on 409 households randomly sampled from both rural and urban areas of the Ondo State. The researchers found affordability, level of education, household size, occupation of the respondent, and the nature and ownership of the dwelling house significantly influence fuel choice. Joshi and Bohara (2017) used multinomial and binomial logit models for the empirical analysis of household preferences for cooking fuel and inter-fuel substitution in Nepalese households. The results obtained from performing multinomial logit on the cross-sectional data obtained from Nepal living Standard Survey indicated that accessibility operationalized as the time to collect firewood positively influences fuel switching. The

higher the time taken to collect wood or poor access to wood fuel sources can promote cleaner fuels like LPG. Buba et al. (2017) also investigated the determinants of household fuel consumption in Nigeria by performing multinomial logit analysis on the 2013 Nigeria's Demographic Health Survey. The researchers found that accessibility of forest wood and prevalence of poverty positively impacts the use of fuel woods in rural areas and that social variables, awareness, economic status, and demographic factors are significant determinants of fuel choice and concluded that government needs to apply policy interventions to ensure affordability of clean energy for household cooking. Bamiro and Ogunjobi (2015) also agreed that affordability is a positively significant factor determining fuel choice in Nigeria after performing a multinomial logit on data obtained from a stratified random sample of 150 households in Ogun State.

Summary and Conclusions

The literature is replete with studies of fuel consumption distribution, factors, and determinants of fuel choice and consumption patterns in industrialized and developing countries. Many studies have also highlighted the policy interventions in Latin America and Asia, supporting household energy access and affordability (Latin America Energy Organization, 2018; Schunder & Bagchi-Sen, 2019). However, few studies conducted to analyze and determine the factors that influence and foster fuel switching in Nigeria's households have derived the influencing factors' strengths. There is also an absence of records and distribution of fuel switching for cooking in Nigeria's households. This study derived the attributes influencing the switch from traditional fuels to LPG and measured the relative importance and strengths of attributes in promoting household fuel switch to

LPG in Nigeria to inform or support policy. By modeling demand in terms of underlying product characteristics and attitude models used in explaining brand preference (Ratchford, 1975), this study clarified consumer preferences for the attributes of considerations in policy intervention. The study aimed to analyze the factors that foster positive change from the use of hazardous fuming traditional fuels to LPG, which is a modern fuel with lower carbon emission abundant in Nigeria. There is the need to identify the relative strengths of attributes in influencing major progress in the expansion, diffusion, and adoption of LPG in Nigeria. The general framework of the consumer economic theory, the energy ladder, and fuel stacking transition model have been confirmed in the literature (Ogwumike et al., 2014) and appropriate to understanding what intervention policy should aim to do and the influencing factors to promote to deepen LPG penetration beyond the income factor. This study built on the energy ladder model to identify the strengths of accessibility and affordability as fuel switching attributes in Nigeria. The study assessed the relative strengths of the fuel preference determinants – accessibility and affordability in influencing an energy shift from traditional fuels to LPG in Nigeria to inform and support the domestic LPG penetration policy and program.

Chapter 3: Research Method

Introduction

The purpose of this quantitative study using a correlational cross-sectional survey design was to analyze the effect of LPG accessibility and affordability on households' adoption of LPG for cooking in Nigeria. The research questions were as follows: What is the relationship between LPG affordability and household LPG adoption in Nigeria? What is the relationship between LPG accessibility and household LPG adoption in Nigeria? The null hypotheses were that there is no relationship between LPG affordability and household LPG adoption and that there is no relationship between LPG affordability and household LPG adoption in Nigeria, in which case the correlation coefficient will equal zero. A zero-correlation value will indicate a lack of relationship between the dependent variable, LPG adoption, independent variables, LPG accessibility, and LPG affordability.

In this chapter, I provided information on the research design and methodology, offered a justification for their adoption, and explained the consistency of the design with the literature. The chapter also detailed the study population, sampling design, and procedure for data collection, followed by a discussion of data collection ethics and the internal and external validity issues of data collection.

I chose the nonexperimental correlational design because there was no comparison basis. The implementation of the policy program, DLPGG, recently commenced, and it was impossible to conduct a pretest–posttest or posttest-only control group experiment or conduct treatment of groups to cause a variable to occur. The

research questions and the program's status were key drivers of the correlational approach to the study.

Study Design and Rationale

Assessing the relationship between LPG accessibility and affordability with LPG adoption for cooking required a design framework that enabled the research problem's resolution. The dependent variable was LPG adoption, and the independent variables were LPG accessibility and LPG affordability.

Variables and Operationalization of Constructs

Table 3 provides details on the variables and their measures in this study.

Table 3

Description of Variables and Measures

S/N	Variable name and description	Description of use in the study	Type of measurement
1	Age	Demographic control variable	Ratio (years)
2	Marital status	Demographic control variable	Nominal Married Single Divorced Widowed
3	LPG adoption	Dependent variable	Nominal Yes No (R*)
4	Education	Demographic control variable	Ordinal Primary Secondary Postsecondary
5	Accessibility	Independent variable	Relative (coded) Highly inconvenient Slightly inconvenient Not a problem
6	Affordability	Independent variable	Nominal Catastrophic Affordable

Note. R* implies reference category.

According to the Global Alliance for Clean Cookstoves (GACC, 2016), LPG adoption refers to the initial uptake of LPG independent of the sustained use of LPG, households that are using LPG as the primary fuel or have shifted to LPG as the primary fuel, or substituted other fuels for LPG. LPG adoption was measured as a dichotomous variable with the values *Yes/No*.

I operationalized accessibility as the convenience of fuel procurement, measured as the perceived ease of access to the dispensing point and carrying home the LPG bottle on a nominal scale of *highly inconvenient*, *slightly inconvenient*, and *not a problem*. Accessibility indicates the factors impacting households' procurement of LPG cylinders and stoves when needed, including the distance to distribution outlets and LPG cylinders' delivery mechanism (Kumar, 2017).

Affordability is not an exact term in economic theory and has many normative definitions. The definition of affordability adopted for this study was the one proposed by the World Health Organization concerning the affordability of medicines, in which household affordability was defined as securing a standard of living at a price that does not place an unreasonable burden on household income in the perception of a third party such as the government or an institution (Niëns et al., 2012). LPG affordability is a function of disposable income to purchase LPG cooking technology. The operationalization of affordability usually entails knowledge of household income, price of the product (LPG), and an assigned value for unreasonable burden or arbitrary assignment of a value for unreasonable burden.

Two approaches in the literature for determining unreasonable burden are (a) the catastrophic payment method, which is based on the ratio of payment for the product to household income, and (b) the impoverishment method, which uses residual household income after payment of goods (Neins et al., 2011). In this study, I used the catastrophic method to determine "unreasonable burden." To that end, the study adopted an informed arbitrarily assigned threshold of 5% of total household income as an unreasonable burden. Because affordability measure components are lacking in Nigeria's general household socioeconomic surveys, the choice of 5% as the value of unreasonable burden for cooking energy fuel expenditure in relation to household expenditure was informed by a 2010 World Bank report on the expenditure of low-income households on energy. The World Bank report provided household expenditure on cooking and lighting energy using data from nationally administered household expenditure surveys in developing countries of Asia and Africa similar to Nigeria (Bacon et al., 2010). Figure 4 shows the household expenditure share on cooking and lighting energy in Brazil, Ghana, Guatemala, India, Nepal, Nicaragua, South Africa, and Vietnam. The minimum threshold applied for LPG consumption per person per annum informed by the literature was 35 kg (Astuti, 2017; Tennakoon, 2008), as described in Table 4.

The following formula gives the rigorous computation of household LPG affordability as

$$\frac{\text{Household size x Unit price LPG x 35 x 100}}{\text{Annual Household Income}} < 5\%$$

Based on the above threshold for unreasonable burden, affordability is, therefore, operationalized as a dichotomous variable in the study with the values "catastrophic and affordable."

Figure 4

Shares of Total Household Expenditure on Energy for Cooking and Lighting in Various Countries

Country	Rural	Urban
	Purchased energy	
Brazil (1996–97)	3.2	3.4
Ghana (1998–99)	3.1	5.0
Guatemala (2000)	6.2	6.7
India (1999–2000)	4.1	7.5
Nepal (1995–96)	2.1	6.0
Nicaragua (1998)	2.5	4.8
South Africa (1993–94)	5.9	3.7
Vietnam (1997–98)	2.9	5.6
	All energy including collected firewood	
India	8.3	8.0
Nepal	2.4	6.2
Vietnam	4.8	5.9

Note. From *Expenditure of Low-Income Households on Energy: Evidence From Africa and Asia*, by R. Bacon, S. Bhattacharya, and M. Kojima, 2010, World Bank (http://documents.worldbank.org/curated/en/771881468170973400/Expenditure-of-low-income-households-on-energy-evidence-from-Africa-and-Asia). Copyright 2010 by World Bank.

Research Design

The design of this study was nonexperimental, quantitative, and cross-sectional survey research. The use of the cross-sectional design in conjunction with surveys through questionnaires is also referred to as survey research (Burkholder et al., 2016).

According to O'Sullivan et al. (2017), the cross-sectional design is best for finding relationships and showing trends.

Table 4

Quantity Threshold of Basic Energy Need

Proposed by	The minimum level of energy received by people	
	Lighting	Cooking
Modi et al. (2005) and Barnes et al. (2010)	10 kgoe per person per annum	40 kgoe per person per annum
Tennakoon (2008)	120 kWh per person per annum	35 kg per person per annum of LPG or equivalent
AGECC (2010)	100 kWh per person per annum	100 kgoe per person per annum of modern fuel

Note. Adapted from *An Analysis of Household Transition to Modern Fuel Under Indonesia's Energy Conversion Programme* [Doctoral thesis, University of Birmingham], by S. P. Astuti, 2017 (https://etheses.bham.ac.uk/id/eprint/7192/). Copyright 2017 by Septin Puji Astuti.

National economic data generally do not tend to experiment (Kayode et al., 2015). The cross-sectional research design of this study involved a physical cross-section of the population of interest. An evaluation of potential research designs—experimental, cross-sectional, case study, and longitudinal—indicated that the cross-sectional approach was the appropriate design to test theory and establish, describe, express, and explain a relationship among the social variables of affordability, accessibility, and LPG adoption at a point in time. The cross-sectional design is particularly useful for studies whose subjects are dispersed geographically (O'Sullivan et al., 2017). A survey was suitable for examining the relationships among LPG accessibility, affordability, and adoption and the effect of LPG adoption variables in Nigeria's wide sample area. The administration of the

questionnaire was such that it enabled data collection from educated, uneducated, and illiterate participants and young and elderly participants and participants of both genders.

This study would have benefited from a comparative analysis of pre and post-gas policy implementation fuel-consumption status of households using secondary data from a nationwide general survey. However, the implementation of the DLPGPP commenced in 2018, and the last general household survey conducted in Nigeria dated back to 2013. Nigeria generally lacks reliable and continuous data useful for modeling techniques, and obtaining such data is difficult. Therefore, this study was constrained to use some thresholds and values from surveys carried out in other developing countries such as Ghana.

The study was also under constraint to survey households in the FCT rather than follow the initial plan to use secondary data for analysis. The FCT is Nigeria's "melting pot," and its population is easy to stratify by vital socioeconomic, geographic, and ecological indices. Due to the lack of readily available data and the recent commencement of implementing the policy program under study, it was impossible to conduct a longitudinal study of socioeconomic variables such as income and affordability. The cross-sectional design reduced the time necessary to conduct this dissertation study. Limiting data collection to the FCT also reduced the financial cost of the study.

The study used deductive reasoning to test the propositions of the ELT with the following research questions and hypotheses:

1. What is the relationship between LPG affordability and LPG adoption for household cooking in Nigeria?

    H01: There is no relationship between LPG affordability and LPG adoption for household cooking in Nigeria.

    Ha1: There is a statistically significant relationship between LPG affordability and LPG adoption for household cooking in Nigeria.

2. What is the relationship between LPG accessibility and LPG adoption for household cooking in Nigeria?

    H02: There is no relationship between LPG accessibility and LPG adoption for household cooking in Nigeria.

    Ha2: There is a statistically significant relationship between LPG accessibility and LPG adoption for household cooking in Nigeria.

Given this logical problem and the research questions, I used the binomial regression model to test the effect of LPG affordability and accessibility factors on LPG adoption. A regression model tested the effect of aggregated accessibility and affordability factors on LPG adoption. Cross-sectional survey research is appropriate for evaluating policy programs, setting policy agendas, and solving real-world problems (Burkholder et al., 2016).

Methodology

The methodology of data analysis for the study was quantitative. The study employed a household survey using a questionnaire as the instrument of data collection. A survey using an in-person questionnaire of participants ensured the presentation of the

same questions in the same order for each respondent. The survey questionnaire helped in collecting data from all willing participants in the sample. The IBM software Statistical Package for Social Science (SPSS) served to automate data analysis and to present results of descriptive statistics, correlational analysis, and logistic regressions.

Data Analysis

Univariate, Bivariate, and Multivariate Analysis

I conducted a univariate analysis to examine the data distribution, descriptive statistics of continuous variables, and categorical variables' frequency distribution. I used Pearson's correlation analysis to answer Research Questions 1 and 2 and fitted binomial logistic regression models to answer Research Questions 3 and 4.

Tests of Pearson's Correlation and Binomial Logistic Regression Assumptions

I confirmed the assumptions of Person's correlation to ensure the absence of outliers before performing Pearson's correlation analysis to test the first and second research questions. Before building binomial logistic regression models to test the third and fourth research questions on whether LPG affordability and LPG accessibility predict LPG adoption, I ascertained the levels of variables' measurement and linearity. Pearson's chi-square and Cramer's V tested the relationship between nominal variables. I also performed the following tests of assumptions for binomial logistic regression:

- I performed univariate analysis to test respondents' independence and exclusivity and confirmed that the dependent variable was nominal. The number of responses for each regression model variable also exceeded 50, which was the expected minimum number of observations for a valid

regression model. The results of the bivariate analysis then confirmed the association of the dependent and independent variables.

- Multicollinearity assesses the regression modeling requirement that the independent variables are not related by a linear function that will cause problems in estimating their independent effects on the dependent variable (O'Sullivan et al., 2017). I checked multicollinearity by assessing, in turn, the variance inflation factor for each independent variable against the other independent variables. Multicollinearity is the degree of intercollinearity among explanatory variables (Warner, 2013). Two variables are collinear if there is a linear relationship between the variables (Midi et al., 2010). The general rule is that if the correlation coefficient between two predictor variables or regressors is greater than 0.8, then multicollinearity becomes a problem in linear or logistic regression. Multicollinearity does not allow a valid prediction of the response variable by any of the individual predictors. Multicollinearity inflates the variances of the parameter estimates (Midi et al., 2010).
- A goodness of fit test helps determine how a regression model fits the data (O'Sullivan et al., 2017). I used SPSS to assess each regression model's goodness of fit by the Hosmer-Lemeshow function, which showed whether the regression models fit the data.

- The binomial logistic regression model has fewer assumptions and does not suffer from homoscedasticity, linearity, and error distribution normality (Harrell, 2015).

Binomial Logistic Regression Models

LPG adoption was a dichotomous variable with the values *Yes* and *No*, internally coded as 1 and 0, respectively. I built and analyzed the binomial logistic regression model to predict LPG adoption from each of the characteristics of the independent variables of affordability and accessibility, controlling for each other and the demographic variables. I then performed binomial logistic regression predicting LPG adoption variation from LPG affordability and LPG accessibility, individually and collectively controlling for the demographic variables to answer the research questions.

Participants

Population

A research population is the total of the individuals or events of interest in the study. This study's population was approximately the total of household individuals living in the Federal Capital City that met the sampling criteria. The criteria to participate in the survey were as follows:

- The participant has LPG awareness.
- The participant is either the household head, the spouse of the household head responsible for cooking, or the household financial decision-maker.

The sample was taken from the General Household Database of the FCT.

Sampling Method

The sampling method was probability sampling that allowed every FCT household after a stratified random sampling to address the urban-suburban-rural trichotomy subset proportions and the random sampling of households in the habitation to have an equal chance of inclusion in the sample. The sample was the subset of the population drawn from the FCT. The eligible household heads emerged from the FCT stratification into urban, suburban cities, and rural areas. The urban city of the FCT covers the entire Abuja Area Municipal Council (AMAC), which includes Asokoro, Central Area, Garki, Wuse, Guzape, Kado, Life Camp, Gwarimpa, Mbora, and Maitama. The suburban areas include the area councils of Bwari, Kuje, Gwagwalada, and Kwali, such as Kubwa, Mpape, Lugbe, and Nyanya. The Abaji Area Council of the FCT consists mainly of rural villages, including Agyana, Bago, Ebagi, Gbogbogo, Kebba, Nuku, and Yawule. To facilitate the random selection of samples after stratification, I generated a large list of habitations with the considered variables of distance to the nearest LPG retail outlet, the number of households in the habitation, and the presence of LPG adopters in the area.

Sample Size

I performed a priori power analysis using G*Power 3.1.9.4 (Buchner, Faul, & Erdfelder, 2019) using an effect size or odds ratio of 1.7, required power $(1 - \beta) = .95$, the specified significance level $\alpha = 0.05$, and a critical $z = 1.64$ to determine the sample size for binomial logistic regression. The G*power tool provided a sample size of 247 households, which is achievable, given that the FCT is a large population from which I

planned to draw potential participating households for a sample size of 300 households. I, however, drew a larger sample size of 554, as shown later in chapter 4. If I used a smaller effect size like 1.3, it becomes difficult, expensive, and untimely to conduct a structured interview for 1000 households. The chosen effect size was reflective of past observations of similar studies and an indication of the importance attached to the predictors' strength in the agenda of the domestic LPG policy and the DLPGPP. The planned sample size of 300 households was, therefore, adequate for the large effect size required. Previous studies found large effect sizes. Adkins (2017) performed logistics regression and found that Maryland Police Department doubled the odds of injury using soft hand tactics. In an analysis of factors influencing the adoption of Biogas in Uganda, Walekha et al. (2009) found that increasing household income influenced households to use biogas energy by an odds ratio = 1.9. Bello (2011) also performed multinomial logistics on fuel adoption determinants and found a significant positive influence of household income on cooking gas adoption with an odds ratio = 2.33.

Procedure for Recruitment, Participation, and Data Collection

Recruitment

The recruitment of participants came from the three strata of the FCT. I used the FCT household population data set to randomly select 250 households from each of the strata of urban, suburban, and rural councils.

Study Participants

There were 250 participants selected from each group of urban, suburban, and rural households. To qualify for selection to participate in the study, the respondent must

have lived in the participating household and be an adult older than 18 years who can consent for the study. The respondents were either the household head, decision-maker, or spouse responsible for cooking in the house and must have LPG awareness.

Informed Consent and Voluntary Exit

I administered informed consent for all the participants in the study. The study questionnaire bore the consent message on the first page. Participants who self-administered the survey through the paper questionnaire granted their informed consent by proceeding to respond to the questionnaire after reading the consent page and then returning the completed survey. Respondent's consent was obtained when structured interview participants via face-to-face oral presentation heard the interviewer read out the consent page. The respondent acknowledged understanding, consented, and then proceeded to answer the questionnaire. The informed consent form described the voluntary nature of the survey and the privilege to terminate the study and exit at any time.

Data Collection

To collect the data for LPG adoption, I used section 'A' of the LPG adoption questionnaire provided in Appendix 'B.' To collect the data for LPG affordability; I used section 'B' of the LPG adoption questionnaire provided in Appendix 'B.' To collect the data for LPG accessibility, I used section 'C' of the LPG adoption questionnaire provided in Appendix 'B.'

The structured household adoption questionnaire provided in Appendix A records respondents' socioeconomic and demographic characteristics and data about the ease of

LPG access, LPG affordability, and LPG adoption. Location data used in stratification and random sampling includes the household's local government area, enumeration area, and LPG retail outlets in or closest to the household or its enumeration area. The demographic control variables to collect from the questionnaire included respondents' age, educational achievements, average household income, number of people living in the household, and education of the household head. I used Google forms to build the questionnaire and to save and manage respondents' data. Respondents were able to self-administer the questionnaire and return it. I administered the forms, collect respondents' self-administered paper questionnaires, and conducted an oral interview for those who prefer to respond via the structured interview, in which case I read out to the respondents and obtained their informed consent. In the oral interview, I recorded the interview and entered the responses into the paper questionnaire.

Instrument Pretest and Pilot Study

Pre-testing of survey instrument or research materials before its use on a large-scale survey provides an opportunity to ensure that the survey instrument tests the respondent's real status; it is less biased, accurate, and reliable. The pilot test offered an opportunity to test the adequacy and feasibility of the data collection plans, conduct personnel training, and adjust the survey instrument further if necessary (Burkholder et al., 2016; O'Sullivan et al., 2017). The pilot test also included an analysis and interpretation of collected information to ensure that collected data can answer the research question and meet study objectives.

I conducted a pilot study with a sample of 20 households taken from the FCT dataset to ascertain the feasibility of the research design, test the duration of the questionnaire, review the clarity of the questions in the questionnaire and the adequacy of its response options, and also to ensure that the instructions and participant's informed consent were unambiguous. The pilot study helped minimize disruptions in the main study from poor instructions and technical hitches (O'Sullivan et al., 2017).

Instrumentation

The method of data collection is by the household survey. The survey instruments were in-person questionnaires and structured interviews of participants. The structured interview was a conversion of the survey questionnaire to cater to respondents who could not read and write. The researcher can ask participants the same questions in the same sequence without probing for clarification or additional information using a structured interview (Burkholder et al., 2016). According to Burkholder et al., structured interviews are appropriate to conduct quantitative Likert scale surveys. This study's design and the descriptive variables under analysis formed the basis for employing the survey method using both the face-to-face administered questionnaire and the structured interview.

The questionnaire or structured interview form used in this study is an adaptation of the World Bank and the National Bureau of Statistics (NBS)'s multi-topic Living Standards Measurement Study (LSMS) instrument. The LPG Adoption Questionnaire is an adaptation of the LSMS - General Household Survey (GHS) Panel questionnaire to examine the influence of the predictors – affordability, awareness, and accessibility on LPG adoption. Researchers have adapted the GHS to various studies. Kumar (2017) LPG

household adoption questionnaire exemplifies such adaptations. The measures of the LSMS-GHS have been extensively tested for reliability and validity across countries and found to be reliable with a high degree of internal consistency (Grosh, 2000). I minimized the threats to instrument internal validity by deriving the variable constructs and building this questionnaire from the indicators used for collecting accessibility and socioeconomic data in the LSMS-GHS (NBS, 2018) questionnaire. The pilot test outcomes served as a test of reliability and criterion validity of the survey instrument (Burkholder et al., 2016). Reliability refers to the consistency of responses over time, while validity is the extent to which the survey instrument can achieve its purpose and design to measure variables (Burkholder et al., 2016; Frankfort-Nachmias & Leon-Guerrero, 2015).

Threats to Validity

Validity reflects measurement errors that are either systematic or constant (O'Sullivan et al., 2017). A valid measure, therefore, accurately quantifies its designed measure. Evidence of validity can come from face logicality or the instruments' reflection of the adequacy of questions to measure the dimension under study (O'Sullivan et al., 2017).

Instrument Reliability and Study Validity

A key external validity threat to the study is the generalization of study findings to the target population and Nigeria. Drawing probability samples carefully allows the generalization of sample measures and characteristics to the population (O'Sullivan et al., 2017). Randomly selecting samples from a randomly ordered FCT household list stratified into rural, urban, and suburban trichotomy helped ensure that the sample

represents all households and enhanced the study's external validity and generalization to the target population. According to O'Sullivan et al. (2017), probability sampling allows the accurate estimation of parameters. In the instrument, I indicated questions representing the measures of the dimensions of accessibility, affordability, and LPG adoption. I conducted a face and content validation by consulting with two survey methodology experts who reviewed the survey instrument. Another way to confirm instrument reliability is to test and retest the instrument by administering the questionnaire to the same participants after three weeks. Obtaining a similar response demonstrates the instrument's stability, temporal validity, and statistical reliability (Drost, 2011; Frankfort-Nachmias & Leon-Guerrero, 2015).

Statistical Reliability

The reliability of a measure is high if it produces the same result under the same circumstances. The determination of a reliable sample size from a z-score corresponding to a 95% confidence interval is a popular approach to determining a study's sample size. The z-score of 1.64 is the mean's error estimate that expresses a high statistical reliability factor (O'Sullivan et al., 2017). In addition to the sample size, reliability was further tested through Spearman's correlation (ρ) coefficient to measure the correlation between variables (Drost, 2011). Cronbach's Alpha tested the instrument consistency and how well the instrument questions measure the characteristic constructs through their intercorrelations that gave an overall internal consistency and reliability of the study (Drost, 2011).

External Validity

The generalization of a study from sample to population or beyond the study itself raises external validity issues that may be addressed by properly drawing probability samples from the population (O'Sullivan et al., 2017). Therefore, external validity is the evidence of the extent to which a study can replicate to the larger population, other persons, settings, times, or cases outside the study. This risk is, however, more pronounced in experimental and quasi-experimental research to establish a causal relationship. This study was less threatened by external validity because there were no experiments, and it did not attempt to establish any causal relationships.

Internal and Construct Validity

The threat to construct validity arises from common method variance - an overlap in variance between variables caused by instrument measure rather than a true relationship between the constructs (Drost, 2011). This study mitigated the threats to construct validity due to the single operationalization of dimensions through careful scale generation for the dimensions of affordability, acceptability, and LPG adoption by brainstorming and an extensive review of the literature. The approach resulted in the generation of 40 questions reflecting the dimensions of the study. Expert researchers helped to review and remove items that could confuse and thereby establish the validity of constructs operationalization as reflecting the true meaning of the constructs, establishing the face and content of the instrument and study (Drost, 2011).

Criterion Related Validity—Concurrent and Predictive Validity

The literature review provides measures agreed by researchers to measure the dimensions of accessibility and affordability used in the LPG adoption questionnaire to determine both concurrent and predictive LPG adoption and answer the research question. The questionnaire employed a combined validity inference check of income using asset-based, and household expenditure approaches to proxy household income and wealth as instrument validation against the external criterion. The asset-based approach is rated by attaching weights to assets and calculating household total assets score, while the expenditure approach estimates income with total household expenditure. Morris et al. (2000) tested the strength of association and found Pearson's coefficient $r \geq 0.74$ of both measures high and valid inferences of household wealth and income.

Ethical Procedures

Researchers have an ethical responsibility to safeguard the information obtained from research participants. The ethos of respect for study participants, anonymity, reciprocity, or giving back to research participants, cooperation, and maintenance of privacy is critical to all data collection methods, including surveys collected online or in face-to-face administered questionnaires. Ethical research should mitigate and minimize risk factors to participants, including factors that could lead to anger, anxiety, or humiliation (Mba, 2019). Universities have ethical standards for researching human beings that faculty and students should adhere to before involving human participants in any study (Rudestam & Newton, 2015). The Institutional Review Board (IRB) review and approval (Walden IRB Approval number 08-21-20-0626882) of the research process

provides important safeguards and prevents ethics violations. Walden University IRB mandates that researchers receive training on handling human participants in research. In compliance with the IRB's and Nigeria's National Code of Health Research Ethics (National Health Research Ethics Committee of Nigeria, 2007) guidelines for studying human participants, I took the training course of the National Institutes of Health (NIH) Office of Extramural Research on handling human participants in research and obtained the certificate of completion—see Appendix B.

The consent of participants to the study derives from the ethical principles and conditions for protecting human participants outlined in the Nuremberg code includes an informed, voluntary consent, avoidance of harm, respect for persons, and the right to withdrawal (Burkholder et al., 2016). Participants in this study voluntarily provided their consent before their engagement in the study and data collection. The consent request, which was free of any form of coercion, included a request for consent to record participants' voice, confirmation of the confidentiality of participants' information and anonymity, assurance of due care to protect participants from distress, information regarding avenues for communication, and information on the risks and benefits of the research (Rudestam & Newton, 2015).

I avoided personal bias by ensuring that no one working in or affiliated with the oil and gas industry participated in the study in a manner that can threaten the study's internal validity.

Summary

Chapter 3 detailed the design and rationale, data collection method, threats to validity, and the study's ethical considerations. I employed quantitative survey methods to evaluate the relationships between LPG accessibility and affordability and household LPG adoption in Nigeria. I adopted the research questions and the cross-sectional design to facilitate useful findings for the DLPGPP. The questions were as follows:

1. What is the relationship between LPG affordability and LPG adoption for household cooking in Nigeria?
    - H01: There is no relationship between LPG affordability and LPG adoption for household cooking in Nigeria.
    - Ha1: There is a statistically significant relationship between LPG affordability and LPG adoption for household cooking in Nigeria.
2. What is the relationship between LPG accessibility and LPG adoption for household cooking in Nigeria?
    - H02: There is no relationship between LPG accessibility and LPG adoption for household cooking in Nigeria.
    - Ha2: There is a statistically significant relationship between LPG accessibility and LPG adoption for household cooking in Nigeria.

I used correlational analysis detailed in the data analysis section above to examine Research Questions 1 and 2.

3. Does LPG affordability predict LPG adoption for household cooking in Nigeria?

H03: LPG affordability does not predict LPG adoption for household cooking in Nigeria.

Ha3: LPG affordability predicts LPG adoption for household cooking in Nigeria.

4. Does LPG accessibility predict LPG adoption for household cooking in Nigeria?

H04: LPG accessibility does not predict LPG adoption for household cooking in Nigeria.

Ha4: LPG accessibility predicts LPG adoption for household cooking in Nigeria.

I performed binomial logistic regression to analyze Research Questions 3 and 4 detailed in the data analysis section.

In Chapter 4, I discussed the details of the research and its findings.

Chapter 4: Results

Introduction

The purpose of this quantitative correlational research was to analyze the effect of LPG accessibility and affordability on households' adoption of LPG for cooking in Nigeria. The study aimed to ascertain whether LPG accessibility and affordability are key determinants for LPG adoption that the DLPGPP should address to catalyze LPG utilization in Nigeria's households. The research questions were as follows:

1. What is the relationship between LPG affordability and LPG adoption for household cooking in Nigeria?
   - H01: There is no relationship between LPG affordability and LPG adoption for household cooking in Nigeria.
   - Ha1: There is a statistically significant relationship between LPG affordability and LPG adoption for household cooking in Nigeria.
2. What is the relationship between LPG accessibility and LPG adoption for household cooking in Nigeria?
   - H02: There is no relationship between LPG accessibility and LPG adoption for household cooking in in Nigeria.
   - Ha2: There is a statistically significant relationship between LPG accessibility and LPG adoption for household cooking in Nigeria.
3. Does LPG affordability predict LPG adoption for household cooking in Nigeria?

H03: LPG affordability does not predict LPG adoption for household cooking in Nigeria.

Ha3: LPG affordability predicts LPG adoption for household cooking in Nigeria.

4. Does LPG accessibility predict LPG adoption for household cooking in Nigeria?

H04: LPG accessibility does not predict LPG adoption for household cooking in Nigeria.

Ha4: LPG accessibility predicts LPG adoption for household cooking in Nigeria.

Assessing the effect of critical factors influencing the adoption of energy fuel to impact policy formulation and implementation could crystalize transformative-scale adoption and LPG utilization for household cooking in Nigeria. For this study, affordability was defined as a function of a household's disposable income to purchase LPG cooking technology. It was operationalized as a dichotomous variable with the values catastrophic and affordable. Accessibility was a measure of convenience, which indicated the factors impacting households to procure LPG cylinders and stoves when needed, including the distance to distribution outlets and the delivery mechanism for LPG cylinders (Kumar, 2017). Accessibility in the study was operationalized as the convenience of fuel procurement, measured as the perceived ease of access to the dispensing point and of carrying home the LPG bottle on a nominal scale of *highly inconvenient, slightly inconvenient,* and *not a problem.*

This chapter provides an overview of the data recruitment timeframe, cleaning, and the timeframes of the pilot and main study. Following this introduction is a discussion of the pilot study and its impact on the main study. The next section presents the descriptive and inferential statistics and results of the statistical and hypothesis tests. The last section summarizes the findings of the study and contains a transition to Chapter 5.

Pilot Study

The pilot study was conducted to test the data collection's adequacy and feasibility and to ascertain that the instrument, collected data, and analysis could answer the research question. In the pilot study, I checked for ambiguity in the questionnaire and updated the main study questionnaire. Specifically, I added *cooking gas* in all places where the words *liquefied petroleum gas (LPG)* appeared in the questionnaire to clarify to participants who were not familiar with the term *liquefied petroleum gas* but knew the fuel better as *cooking gas*. The pilot also enabled me to test the instrument's validity and reliability and provided the experience of the logistical challenges that I used to review the budget for the main study.

Only 35 participants returned the completed questionnaire out of the 50 household heads who consented to participate in the study and collected the questionnaire. I presented the flyer and the consent form and explained the consent form to each prospective participant face to face. The pilot study, which lasted 3 weeks, took place in three communities selected from different area councils of the FCT. The three communities—Mbora, Katampe, and Bwari—were selected to meet the requirements for

the stratification and selection of participants from urban, rural, and suburban communities. Twenty-eight participants responded in the first week that I proposed that they participate in the study; however, seven participants returned the completed questionnaires to me in the second and third week. I visited the communities three times to collect data and remind the participants to obtain the 35 responses analyzed in the pilot. Nine of the participants returned their completed questionnaires during the main study. Still, five of the participants who earlier consented did not return the questionnaire until the end of the data collection period. Before proceeding to an analysis of the pilot, I eliminated three participants who responded: "no" to the screening question "Are you aware of the use of LPG (liquefied petroleum gas) as a cooking fuel" before proceeding to analyze the responses of the 33 qualified respondents.

I also used the pilot to ascertain the reliability and validity of the survey instrument by testing the consistency of participants' responses to questions in the instrument that were supposed to elicit similar answers from the same participant. I performed Cronbach's alpha on the income- and affordability-related questions measuring the same construct and scored in the same direction (Warner, 2013). Table 5 displays the interitem correlation matrix for the Income subscale consisting of three items (α -.95) demonstrating high reliability, as shown in Table 6.

Table 5

Income Interitem Correlation Matrix

	How much did you earn last month? (Naira)	What is your average monthly income?	Calculated income
How much did you earn last month? (Naira)	1.000	.990	.907
What is your average monthly income?	.990	1.000	.910
Calculated income	.907	.910	1.000

Table 6

Income Reliability Statistics

Cronbach's alpha	Cronbach's alpha based on standardized items	*N* of items
.954	.977	3

Further analysis was, however, limited by the pilot's insufficient data.

Data Collection

I spent a total of 8 weeks collecting the data for this study (August 27 to October 22, 2020). The sampling technique for the study was stratified random sampling. The FCT has six local government areas referred to as *area councils*: Abuja Metropolitan Area Council (AMAC), Bwari, Abaji, Gwagwalada, Kuje, and Kwali. NBS (2019) developed two sets of enumeration area frames—the Local Government Area Master Frame and the National Integrated Survey of Households (NISH)—from the master frame to carry out household surveys throughout Nigeria. The NISH separates

enumeration areas into the urban-rural domains for household surveys (NBS, 2016). An enumeration area averages 47 households in Nigeria (Performance Monitoring for Action [PMA], 2020), and the FCT has 3,590 enumeration areas (National Population Commission, 2019). I adopted the NISH sampling framework for this study. I randomly selected 700 prospective participants from 70 enumeration areas stratified into 50 urban and 20 rural clusters across the area councils of AMAC, Bwari, and Kuje in the NISH. I took all households in Bwari Local Government Area listed as urban in the NISH as suburban. Every household in each of the enumeration areas selected after stratification had an equal probability of being selected. Participating respondents were household heads, household spouses, or household decision-makers in households with subset households. A subset household occurs when a family patriarch takes financial responsibility for a progeny household and makes decisions for the progeny household.

I contacted and delivered the survey questionnaire by the face-to-face method to 619 households out of the 700 randomly selected households. For reasons highlighted in Table 7, I was unable to deliver the questionnaire to 83 households. The sample size of 554 participants was larger than the minimum of 247 participants recommended by G*power analysis to enable a binomial regression analysis with an effect size of 1.7 at the required power and the 300 participants proposed. The large data set helped to improve the external validity of the study.

Table 7

Status of Survey Questionnaires

Status	Frequency
Completed, returned, and analyzed	554
No person meeting the selection criteria in the household despite three visits	19
Respondent collected questionnaire but did not return form at the end of 8 weeks (nonresponsive) despite repeated visits and reminders	38
Returned questionnaire failed data screening	25
Respondent household did not consent to survey	64
Total	700

Univariate Analysis—Baseline Descriptive and Demographic Characteristics

The basic variables of this study were LPG adoption, LPG affordability, and LPG accessibility. The demographic control variables included age, marital status, and education. The questionnaire collected household income data and the number of people living and eating in the household to derive the affordability variable. Beyond these variables, I collected other data to validate and ensure the reliability and consistency of the variable data under study. I dropped respondents with inconsistent responses that failed screening in further analysis. The respondents' demography revealed that 451 were household heads while 99 were spouses of household heads, and four were household decision-makers, as shown in Table 8.

Table 8

Demography of Respondents—Household Status

Household status	Frequency	Percent	Valid percent	Cumulative percent
Household head	451	81.4	81.4	81.4
Household spouse	99	17.9	17.9	99.3
Household decision maker	4	.7	.7	100.0
Total	554	100.0	100.0	

Among the respondents, 85.2% were married and 14.8% were either single, widowed, separated, or divorced, as shown in Table 9.

Table 9

Marital Status of Respondents

Marital status	Frequency	Percent	Valid percent	Cumulative percent
Single	44	7.9	7.9	7.9
Married	472	85.2	85.2	93.1
Divorced or separated	15	2.7	2.7	95.8
Widowed	23	4.2	4.2	100.0
Total	554	100.0	100.0	

Table 10 shows that 54.7% of participants reported some form of postsecondary education. The highest educational attainment level for 21.5% of participants was secondary or high school, and 23.8% had completed only primary school or had no formal education.

Table 10

Highest Educational Achievements of Respondents

Educational achievement	Frequency	Percent	Valid percent	Cumulative percent
Primary	132	23.8	23.8	23.8
Secondary	119	21.5	21.5	45.3
Postsecondary	303	54.7	54.7	100.0
Total	554	100.0	100.0	

Only 38.1% of the respondents had and used a singular form of energy fuel to cook. Among respondents, 61.9% stacked a combination of stoves and could use different energy fuels, as described in energy stacking theory.

Table 11 shows that four households used only charcoal to cook, five used only electricity, 21 used kerosene as the single source of fuel for cooking, and 83 used only wood or biomass. Biomass is the least efficient form of energy fuel.

Fifty-three households depended solely on LPG. No household, however, used or depended on coal. Table 12 illustrates the adoption of LPG and other fuels. Among respondents, 45.5% used LPG mostly for cooking, while 31.9% mostly used wood fuel or biomass. The descriptive of LPG accessibility is in Table 13, which shows that only 30.3% of respondents found LPG accessible. In comparison, access to LPG was either highly or slightly inconvenient for 69.7% of the respondents.

Table 11

Household Stoves and Fuels for Cooking

Cooking fuel	Frequency	Percent	Valid percent	Cumulative percent
Charcoal	4	.7	.7	.7
Electricity	5	.9	.9	1.6
Electricity; wood fuel/biomass	1	.2	.2	1.8
Kerosene	21	3.8	3.8	5.6
Kerosene; charcoal	40	7.2	7.2	12.8
Kerosene; electricity	7	1.3	1.3	14.1
Kerosene; electricity; charcoal	1	.2	.2	14.3
Kerosene; electricity; wood fuel/biomass	1	.2	.2	14.4
Kerosene; electricity; wood fuel/biomass; charcoal	3	.5	.5	15.0
Kerosene; LPG	131	23.6	23.6	38.6
Kerosene; LPG; charcoal	19	3.4	3.4	42.1
Kerosene; LPG; electricity	13	2.3	2.3	44.4
Kerosene; LPG; electricity; charcoal	1	.2	.2	44.6
Kerosene; LPG; electricity; wood fuel/biomass; coal; charcoal	1	.2	.2	44.8
Kerosene; wood fuel/biomass	26	4.7	4.7	49.5
Kerosene; wood fuel/biomass; charcoal	67	12.1	12.1	61.6
LPG	53	9.6	9.6	71.1
LPG; charcoal	7	1.3	1.3	72.4
LPG; electricity	50	9.0	9.0	81.4
LPG; electricity; charcoal	2	.4	.4	81.8
LPG; wood fuel/biomass	6	1.1	1.1	82.9
Wood fuel/biomass	83	15.0	15.0	97.8
Wood fuel/biomass; charcoal	12	2.2	2.2	100.0
Total	554	100.0	100.0	

Table 12

Household Fuel Adoption

Cooking fuel	Frequency	Percent	Valid percent	Cumulative percent
LPG	252	45.5	45.5	45.5
Kerosene	52	9.4	9.4	54.9
Wood fuel/biomass	177	31.9	31.9	86.8
Electric induction	7	1.3	1.3	88.1
Charcoal	66	12.0	12.0	100.0
Total	554	100.0	100.0	

Table 13

Household Fuel Accessibility

Accessibility	Frequency	Percent	Valid percent	Cumulative percent
Highly inconvenient	240	43.3	43.3	43.3
Not a problem	168	30.3	30.3	73.6
Slightly inconvenient	146	26.4	26.4	100.0
Total	554	100.0	100.0	

The number of respondents who can afford LPG is 219 or 39.5% while purchasing LPG is unaffordable or catastrophic for 60.5% or 335 respondents. The burden factor for LPG affordability is the fraction of the cost of purchasing LPG for household cooking in a year over the household's annual income. A household can afford LPG when the burden factor is less than 5%. Table 14 provides a description of LPG affordability among the survey respondents.

Table 14

LPG Affordability

Affordability	Frequency	Percent	Valid percent	Cumulative percent
Affordable	219	39.5	39.5	39.5
Catastrophic	335	60.5	60.5	100.0
Total	554	100.0	100.0	

Respondents from the urban council of AMAC formed the largest sample size at 38.6% or 214, while valid samples from the suburban Bwari area council were 33.9% or 188 households. The balance 27.4% or 152 respondents reside in the Kuje area council, which is largely rural. This sample selection represents the FCT population and the number of enumeration areas in each of the councils. Out of the 3,590 enumeration areas of the FCT in the NISH, 2,452 are urban, and 1,138 are rural, informing the need to select more enumeration areas from the urban and suburban clusters than the rural clusters (PMA, 2020).

Table 15

Number of Respondents from Each Local Government Area

Local Government Area	Frequency	Percent	Valid percent	Cumulative percent
AMAC	214	38.6	38.6	38.6
BWARI	188	33.9	33.9	72.6
KUJE	152	27.4	27.4	100.0
Total	554	100.0	100.0	

Out of the 554 respondents, the LPG burden is affordable for 219 or 39.5% and catastrophic for 60.5%. LPG accessibility is highly inconvenient for 43.3% of

respondents, slightly inconvenient for 26.4% of respondents, and not a problem for the remaining 30.3%.

Study Results

I used SPSS to recode variable responses to derive the dependent variable LPG adoption, and the two covariates LPG Affordability and LPG Accessibility. To derive LPG Adoption, I recoded the response to question number 19 of the survey instrument "What type of fuel do you use most frequently in your household for cooking in the last one year assigning the value "Yes - 1" to the variable LPG Adoption if the response value to the question is LPG and "No - 2" for every other response value. I recorded the response variable "If you currently purchase or you were to purchase LPG - how do you see LPG purchase from the nearest retail outlet?" to LPG Accessibility by assigning the value "No problem to 1, slightly inconvenient to 2, and highly inconvenient to 3. "LPG Affordability is derived from the formula below and assigned a value "Affordable" where the Burden Factor is less than 5 and "Not affordable" when the burden factor is greater than 5.

$$\frac{\text{Household size x Unit price LPG x 35 x 100}}{\text{Annual Household Income}} = \text{Burden Factor}$$

Internal Consistency and Reliability of the Instrument

I did not administer the same survey twice to the same respondents, and therefore, could not use the test-retest reliability measure. Instead, I tested the alternative form reliability by using differently worded questions to measure similar attributes and construct (Bolarinwa, 2015). Reliability was measured as the correlation between results obtained on different questions from respondents. Therefore, it serves as repeated

administration of the same question, similar to a test-retest administration of the questionnaire. I performed Split-Half Reliability and Spearman-Brown Coefficient to test the instrument's internal consistency concerning the variables associated with LPG affordability. Respondent's household size subscale consisted of three items split into unequal lengths. Part one had two items and part two, one item; the split-half reliability was good (r_{sh} = .98; Spearman-Brown coefficient). Also, the equal length split-half reliability of the income subscale with four items was good (r_{sh} = .93). The reliability statistics and inter-correlation matrices are shown in Tables 16 and 17.

Table 16

Reliability Statistics—Household Size Subscale

Cronbach's alpha	Part 1	Value	.924
		N of items	2[a]
	Part 2	Value	1.000
		N of items	1[b]
	Total *N* of items		3
Correlation between forms			.956
Spearman-Brown coefficient	Equal length		.978
	Unequal length		.980
Guttman split-half coefficient			.902

[a] The items are as follows: How many people eat food prepared in the household every day? How many children do you have? [b] The items are as follows: How many children do you have? How many people have been living and eating in your household in the last 6 months (household size)?

Estimated income, which is the fourth item on the income subscale, is obtained by dividing the response to the question "Estimate how much you earned in the last year? (Naira)" by 12 to estimate the monthly income of the respondent.

Table 17

Reliability Statistics—Income Subscale

Cronbach's alpha	Part 1	Value	.830
		N of items	2[a]
	Part 2	Value	.466
		N of items	2[b]
	Total *N* of items		4
Correlation between forms			.877
Spearman-Brown coefficient	Equal length		.935
	Unequal length		.935
Guttman split-half coefficient			.845

[a] The items are as follows: How much did you earn last month? (Naira) What is your average monthly income? [b] The items are as follows: What was the average income of the household last month (husband and wife together) and any other income-earning person in the household? (Naira), estimated income.

Evaluation of Statistical Assumptions

Assumptions of Pearson's Chi-Square Correlation

Chi-square determines whether there is an association between categorical variables (Warner, 2013). Therefore, the independence of variables or their association can be tested by Chi-square. I performed Pearson's Chi-square correlation statistics to test the first and second research questions on the relationships between LPG affordability and LPG adoption and LPG accessibility and LPG adoption. According to Warner (2013), in applying chi-square to a contingency table, no cell should have an expected cell frequency less than 5. The cell expected frequencies are higher than the minimum value of 5 for all the variables, which validate the Chi-square test and its interpretation.

Assumption of Binomial Logistic Regression

Binary logistic regression does not assume a linear relationship between the dependent and predictor variable or homogeneity of the dependent variable's variance across the predictor variable (Warner, 2016). Logistic regression assumptions are linearity, independent errors, multicollinearity, and absence of outliers. Although multicollinearity does not reduce the predictive power of a logistic regression model, it is good to check for multicollinearity among predictor variables in a logistic regression model. According to Senaviratna and Cooray (2019), multicollinearity is mainly detected by the variance inflation factor (VIF). To assess the VIF, I performed a linear regression analysis to determine LPG adoption's prediction from the independent variables LPG affordability, LPG accessibility, respondent age, education, and marital status. I coded LPG accessibility into the dummy variables No-Problem and Slightly Inconvenient while leaving the third category Highly Inconvenient with value 0. I also coded education into new design variables Primary and Secondary while leaving the third category Post-Secondary with value 0. See tables 18 and 19. The computed Durbin-Watson used in evaluating the independence of error was 1.702, which is acceptable. The VIF factors for all the tested variables were below the value of 10, confirming that Multicollinearity was not a problem for the model. Computed Cook’s Distance of residuals was below one showing that there was no outlier wielding undue influence in the model.

Table 18

Linear Regression Model Summary

Model	*R*	*R* square	Adjusted *R* square	Std. error of the estimate	Durbin-Watson
1	.561[a]	.315	.292	.26122	1.702

[a] Predictors: (Constant), Divorced, Respondent age, No-PRoblem, Affordability, Slightly-Inconvenient, Secondary, Single, Married. [b] Dependent variable: LPG adoption.

Table 19

Model Variance Inflation Factor

		Unstandardized coefficients		Standardized coefficients			Collinearity statistics	
	Model	B	Std. Error	Beta	*t*	Sig.	Tolerance	VIF
1	(Constant)	-.010	.136		-.075	.940		
	Affordability	.154	.071	.157	2.188	.030	.551	1.814
	Respondent Age	-.002	.002	-.078	-1.335	.183	.835	1.197
	No-PRoblem	.324	.046	.407	6.975	.000	.830	1.205
	Slightly-Inconvenient	.088	.047	.107	1.868	.063	.861	1.162
	Secondary	.115	.037	.186	3.129	.002	.804	1.243
	Single	.026	.125	.021	.205	.838	.276	3.618
	Married	.059	.102	.064	.583	.560	.235	4.258
	Divorced	.162	.138	.086	1.172	.242	.523	1.912

[a] Dependent variable: LPG adoption.

Reports of Statistical Analysis

Research Questions One and Two (Bivariate Analysis). To test the first research question's hypothesis: What is the relationship between LPG affordability and LPG adoption for household cooking in Nigeria?

H01: There is no relationship between LPG affordability and LPG household adoption in Nigeria.

Ha1: There is a statistically significant relationship between LPG affordability and LPG adoption for household cooking in Nigeria.

A Pearson's Chi-square test was performed and I found a relationship between LPG adoption and LPG accessibility, $\chi^2 = (1, N = 554) = 168.49$, $p < 0.01$. The smallest expected frequency was 99.6. The cross-tabulation of the dichotomous LPG adoption against the dichotomous variable LPG affordability revealed a high LPG adoption of 80% when LPG affordability was positive and a lower LPG adoption of 23% when LPG affordability was catastrophic. Similarly, only 20.5% of respondents who can afford LPG do not use LPG, compared to 77% of respondents who found LPG affordability catastrophic and did not adopt LPG, as shown in tables 20, 21, and 22.

Table 20

Case Processing Summary

	Case processing summary					
	Cases					
	Valid		Missing		Total	
	N	Percent	*N*	Percent	*N*	Percent
LPG adoption * Marital status?	554	100.0%	0	0.0%	554	100.0%
LPG adoption * Highest level of education?	554	100.0%	0	0.0%	554	100.0%
LPG adoption * LPG accessibility	554	100.0%	0	0.0%	554	100.0%
LPG adoption * affordability	554	100.0%	0	0.0%	554	100.0%

The result of the Pearson Chi-square test was significant at $p < 0.01$. The null hypothesis that there is no relationship between LPG adoption and LPG affordability was therefore rejected. If there were no relationship, the percentage of LPG adoption would have been similar for both categories of LPG affordability, "Affordable" and "Catastrophic." However, only 23.3% of households who find using LPG catastrophic will adopt LPG for cooking, unlike 76.7% that will not use LPG for cooking. A further test to assess the effect size of the relationship was computed with the nominal symmetric measures phi (φ) and Cramer's V. φ (.51) and Cramer's V = .51, $p < 0.01$. The result indicated a strong association between LPG adoption and LPG affordability. Cramer's V was reported because it is a symmetric index of association and appropriate for contingency tables with varying sizes of rows and columns (Warner, 2013). This result, shown in Table 23, instructs that LPG affordability is critical to Nigerian households' decision-making to adopt and use LPG as cooking fuel. Therefore, the answer to research question one is that a relationship exists between LPG adoption and LPG affordability, and the alternative hypothesis is correct that there is a statistically significant relationship between LPG affordability and LPG adoption.

Table 21

*LPG Adoption * LPG Affordability Crosstab*

			Affordability		
			Affordable	Catastrophic	Total
LPG adoption	Yes	Count	174	78	252
		Expected count	99.6	152.4	252.0
		% within affordability	79.5%	23.3%	45.5%
	No	Count	45	257	302
		Expected count	119.4	182.6	302.0
		% within affordability	20.5%	76.7%	54.5%
Total		Count	219	335	554
		Expected count	219.0	335.0	554.0
		% within affordability	100.0%	100.0%	100.0%

Table 22

*LPG Adoption * LPG Affordability Chi-Square Tests*

	Value	*df*	Asymptotic significance (2-sided)	Exact sig. (2-sided)	Exact sig. (1-sided)
Pearson chi-square	168.491[a]	1	.000		
Continuity correction[b]	166.233	1	.000		
Likelihood ratio	177.430	1	.000		
Fisher's exact test				.000	.000
Linear-by-linear association	168.187	1	.000		
N of valid cases	554				

[a] 0 cells (.0%) have expected count less than 5. The minimum expected count is 99.62. [b] Computed only for a 2x2 table.

Table 23

*LPG Adoption * LPG Affordability Symmetric Measures*

		Value	Approximate significance
Nominal by nominal	Phi	.551	.000
	Cramer's V	.551	.000
N of valid cases		554	

To test the research question's hypothesis: What is the relationship between LPG accessibility and LPG adoption for household cooking in Nigeria?

H01: There is no relationship between LPG accessibility and LPG household adoption in Nigeria.

Ha1: There is a statistically significant relationship between LPG accessibility and LPG adoption for household cooking in Nigeria.

A Pearson's Chi-square test was performed and I found a relationship between LPG adoption and LPG accessibility, $\chi^2 = (2, N = 554) = 144.81$, $p < 0.01$. The cross-tabulation of the dichotomous LPG adoption against the ordinal variable LPG accessibility revealed a gradient increase in the percentage of LPG adoption as the count of LPG accessibility changed from the category "Highly Inconvenient" to the category "Not a problem." See Tables 24 and 25. The percentage of LPG adoption was 16% when the value of LPG accessibility was "Highly Inconvenient." The percentage value of LPG adoption increased to 72% when LPG accessibility was not a problem. The result, however, varied inversely for the dichotomous category "No LPG adoption" when matched with the categories of LPG accessibility. The result of the Pearson Chi-square test was significant at $p < 0.01$.

Table 24

*LPG Adoption * LPG Accessibility Chi-Square Tests*

	Value	*df*	Asymptotic significance (2-sided)
Pearson chi-square	144.806[a]	2	.000
Likelihood ratio	154.632	2	.000
Linear-by-linear association	130.663	1	.000
N of valid cases	554		

[a] 0 cells (.0%) have expected count less than 5. The minimum expected count is 66.41.

Table 25

*LPG Adoption * LPG Accessibility Crosstab*

			LPG accessibility			
			Not a problem	Slightly inconvenient	Highly inconvenient	Total
LPG adoption	Yes	Count	121	91	40	252
		Expected count	76.4	66.4	109.2	252.0
		% within LPG accessibility	72.0%	62.3%	16.7%	45.5%
	No	Count	47	55	200	302
		Expected count	91.6	79.6	130.8	302.0
		% within LPG accessibility	28.0%	37.7%	83.3%	54.5%
Total		Count	168	146	240	554
		Expected count	168.0	146.0	240.0	554.0
		% within LPG accessibility	100.0%	100.0%	100.0%	100.0%

A further test to assess the effect size of the relationship was computed with the nominal symmetric measures phi (φ) and Cramer's V. φ (.51) and Cramer's V = .51, $p < 0.01$. The result indicates a strong association between LPG adoption and LPG accessibility. Cramer's V is reported because it is a symmetric index of association and

appropriate for contingency tables with varying rows and columns (Warner, 2013). This result, shown in Table 26, is instructive that LPG accessibility is critical to Nigerian households' decision-making to adopt and use LPG as cooking fuel. Therefore, the answer to the second research question is that a relationship exists between LPG adoption and LPG accessibility. The study has also affirmed the alternative hypothesis that there is a statistically significant relationship between LPG accessibility and LPG adoption. Therefore, I reject the null hypothesis that there is no relationship between LPG adoption and LPG accessibility. If there were no relationship, the percentage of LPG adoption would have been similar for all categories of LPG accessibility, "Not a Problem," and "Slightly Inconvenient," and "Highly Inconvenient."

Table 26

*LPG Adoption * LPG Accessibility Symmetric Measures*

		Value	Approximate significance
Nominal by nominal	Phi	.511	.000
	Cramer's V	.511	.000
N of valid cases		554	

Test of Association of Demographic Predictor Variables—Age, Marital Status, and Education

Correlation statistics were computed to confirm the association of demographic variables in the study with LPG adoption. A Point-biseral correlation analysis was performed to assess the relationship between dichotomous LPG adoption and respondent's age measured on the interval scale. There was no statistically significant

relationship or correlation between LPG adoption and the respondents age *rpb* = -.004, *p* = .92 as illustrated in table 27. Unlike in previous research results found in the literature review, there was no relationship between age and LPG adoption.

Table 27

*LPG Adoption * Respondent's Age Correlations*

		Respondent age	LPG adoption
Respondent age	Pearson correlation	1	-.004
	Sig. (2-tailed)		.921
	N	544	544
LPG adoption	Pearson correlation *N*	-.004	1
	Sig. (2-tailed)	.921	
		544	554

A Chi-square test was performed to assess the relationship between LPG adoption and the marital status of respondents shown in Table 28 and found a positive, statistically significant relationship $\chi^2 = (3, N = 554) = 8.48$, $p < 0.05$.

Table 28

*LPG Adoption * Respondent's Marital Status Chi-Square Tests*

	Value	*df*	Asymptotic significance (2-sided)
Pearson chi-square	8.479[a]	3	.037
Likelihood ratio	8.595	3	.035
Linear-by-linear association	5.045	1	.025
N of valid cases	554		

[a] 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.82.

I also performed a Chi-square correlation analysis on LPG adoption and respondent's highest education and found that education is positively associated with LPG adoption $\chi^2 = (2, N = 554) = 236.23$, $p < 0.01$. See Table 29.

Table 29

*LPG Adoption * Respondent's Highest Education Chi-Square Tests*

	Value	*df*	Asymptotic significance (2-sided)
Pearson chi-square	236.233[a]	2	.000
Likelihood ratio	290.411	2	.000
N of valid cases	554		

[a] 0 cells (.0%) have expected count less than 5. The minimum expected count is 54.13.

The tests showed that LPG adoption is associated with LPG affordability and LPG accessibility as operationalized in the study. The results also showed a positive, statistically significant association between LPG adoption and marital status and education. The relationship between LPG adoption and age was negative and not statistically significant. In the next section, I answered Research Questions 3 and 4.

Answering Research Questions 3 and 4 (results of the binomial logistic regression models). In this section, I fitted a series of logistic regression models to answer the research questions three and four listed below:

Does LPG affordability predict LPG adoption for domestic cooking in Nigeria?

H01: LPG affordability does not predict LPG adoption for household cooking in Nigeria.

Ha1: LPG affordability predicts LPG adoption for household cooking in Nigeria.

Does LPG accessibility predict LPG adoption for domestic cooking in Nigeria?

H01: LPG accessibility does not predict LPG adoption for household cooking in Nigeria.

Ha1: LPG accessibility predicts LPG adoption for household cooking in Nigeria.

A logistic regression model is a tool for predicting dummy or dichotomous response variables like LPG Adoption (Midi et al., 2010; Warner, 2013). Further to the test of assumptions made earlier, it was found that the sample responses were mutually exclusive, exhaustive, and independent. The multicollinearity among the predictor variables was not a problem. The bivariate analysis's earlier results also confirmed a statistically significant relationship of LPG adoption with multiple factor variables, including LPG affordability, LPG accessibility, respondent age, education, and marital status. The univariate analysis also showed that the minimum observation of the variables was higher than 50 to ensure the regression models' reliability (Warner, 2013). Lastly, the response variable –LPG adoption is a dichotomous variable.

Binary logistic regression models were fitted to analyze the predictive effects of LPG affordability and LPG accessibility on LPG adoption. The first model assessed the effect of LPG affordability on LPG adoption. The second model examined the effect of LPG accessibility on LPG adoption. The third model combined both LPG affordability and LPG accessibility to assess the relative contribution of both LPG affordability and LPG accessibility controlling for each other. The fourth model assessed the effect of LPG affordability and LPG accessibility on LPG adoption, controlling for the demographic control variables of age, marital status, and education.

The outcome variable LPG adoption was coded 1 if the respondent used only LPG for household cooking or mostly used LPG, and 0 if the respondent uses more of any other fuel or does not use LPG at all. The predictor variables of interest were LPG affordability and LPG accessibility.

Table 30

Description of Recoded Dummy Dichotomous Variables and Measures

S/N	Variable name and description	Description of use in the study	Type of measurement
1	Age	Demographic control variable	Ratio (Years)
2	Marital status	Demographic control variable	Nominal Married = 1 Not Married = 0
3	LPG adoption	Dependent variable	Nominal Yes = 1 No = 0
4	Education	Demographic control variable	Ordinal Educated = 1 Not Educated = 0
5	Accessibility	Independent Variable	Nominal Inconvenient = 0 Not a problem = 1 (reference category)
6	Affordability	Independent variable	Nominal Catastrophic = 0 Affordable = 1 (reference category)

Categorical predictor and control variables were recoded to dichotomous variables to ease the complexity of the analysis and interpretations of results, as shown in table 30.

Model 1. A binary logistic analysis was conducted to investigate if LPG affordability predicts LPG adoption. Table 31 shows the model's categorical variable coding, while Table 32 shows the prediction classification of the model.

Table 31

Model 1 Categorical Variable Coding

			Parameter coding
		Frequency	(1)
Affordability	Catastrophic	335	1.000
	Affordable	219	.000

Table 32

Model 1 Prediction Classification of Variables

			Predicted		
			LPG adoption		
	Observed		No	Yes	Percentage correct
Step 1	LPG adoption	No	257	45	85.1
		Yes	78	174	69.0
	Overall percentage				77.8

[a] The cut value is .500.

Table 33

Model 1 Coefficients of Variables in the Equation

		B	S.E.	Wald	*df*	Sig.	Exp(B)
Step 1[a]	Affordability (1)	-2.545	.211	144.934	1	.000	.078
	Constant	1.352	.167	65.392	1	.000	3.867

The predictor variable was tested priori to verify that the assumptions of logistic regressions were not violated. The predictor variable LPG affordability in the logistic regression analysis was found to contribute to the model. The Hosmer-Lemeshow goodness-of-fit showed no difference between the expected and predicted proportions showing a model that fits perfectly. The -2 Log Likelihood = 586.058 and the Nagelkerke

R squared = .366. The model result was significant $p < 0.01$. The unstandardized Beta weight for the constant B = 1.352, standard error SE = .167, Wald Statistics Wald = 65.392, $p < 0.01$. The unstandardized Beta weight for the predictor variable LPG affordability was B = -2.545, SE = .211, Wald = 144.93, $p < 0.01$. The coefficient B exponentiated is the log odds ratio Exp (B) = 0.078 95% CI [-0.052, 0.119] implied that the odds of adopting LPG in households where LPG affordability is catastrophic is 92% lower than those of households where LPG is affordable (the reference category of the model is Affordable, internally coded as 1 in the dummy variable Affordability) or put another way, households that can afford LPG (LPG affordability = affordable) are 12 times more likely to adopt LPG for household cooking compared to those that find affordability catastrophic as detailed in Table 33. According to Wuensch (2013), $\ln (ODDS) = \ln (\hat{Y}/ 1- \hat{Y}) = a + bX$. This equation implies that $1- \hat{Y}$ is the predicted probability of the alternative decision coded as "1" or affordable, as in this study.

Model 2. The LPG adoption with LPG accessibility model with 554 cases was statistically significant, $p < 0.01$. The predictor variable was tested priori to verify that the assumptions of logistic regressions were not violated. The predictor variable LPG accessibility in the logistic regression analysis was found to contribute to the model. The -2 Log Likelihood = 693.72 and the Nagelkerke R squared = .158. The model result was significant $p < 0.01$. The unstandardized Beta weight for the predictor variable LPG accessibility was B = -1.612, SE = .203, Wald = 63.21, $p < 0.01$. The odds ratio Exp (B) = .200 favored a decrease of 80% in LPG adoption where LPG accessibility is inconvenient or adopting LPG in households where LPG affordability is inconvenient is

lower to those of households where LPG accessibility is not a problem (the reference category of the model is "Not A Problem," internally coded as 1 in the dummy variable LPG accessibility) or put another way, households where LPG accessibility is not a problem are 5 times more likely to adopt LPG for household cooking compared to those that find accessibility inconvenient. The results of the regression model Block 1 are shown in Tables 34 and 35. Table 34 is the classification table, while the variables in the equation are shown in Table 35.

Table 34

Model 2 Classification Table

			Predicted		
			LPG adoption		
	Observed		No	Yes	Percentage correct
Step 1	LPG adoption	No	255	47	84.4
		Yes	131	121	48.0
	Overall percentage				67.9

[a] The cut value is .500.

Table 35

Model 2 Variables in the Equation

		B	S.E.	Wald	*df*	Sig.	Exp(B)
Step 1[a]	LPG accessibility (1)	-1.612	.203	63.208	1	.000	.200
	Constant	.946	.172	30.271	1	.000	2.574

[a] Variable(s) entered on Step 1: LPG accessibility.

Model 3. This regression model was fitted to investigate the relative contribution of LPG affordability and LPG accessibility in predicting LPG adoption. The Hosmer-Lemeshow goodness-of-fit was not significant p = .144, which showed that the model

was correctly specified and was a good fit. The -2 Log Likelihood = 532.39 and the Nagelkerke R squared = .456. Both independent variables LPG affordability and LPG accessibility, contributed to the model controlling for each other. The overall model result was significant $p < 0.01$. The unstandardized Beta weight for the constant B = 2.558, SE = .263, Wald = 94.26, $p < 0.01$. The unstandardized Beta weight for the predictor variable LPG affordability was B = -2.592, SE = .227, Wald = 130.49, $p < 0.01$. The estimated odds ratio favored a decrease of nearly 93% Exp (B) = 0.075 in LPG adoption for every household where LPG affordability is catastrophic, controlling for LPG accessibility. The unstandardized Beta weight for the predictor variable LPG accessibility was B = -1.688, SE = .241, Wald = 49.157, $p < 0.01$. The coefficient B exponentiated or the log odds ratio Exp (B) = 0.185 controlling for LPG affordability. The odd ratio decreases by 82% for each household's LPG adoption, where LPG accessibility is inconvenient, controlling for LPG affordability in the household. Table 36 shows the variables in the equation for the model.

Table 36

Model 3 Variables in the Equation

		B	S.E.	Wald	*df*	Sig.	Exp(B)
Step 1[a]	Affordability (1)	-2.592	.227	130.494	1	.000	.075
	LPG Accessibility (1)	-1.688	.241	49.157	1	.000	.185
	Constant	2.558	.263	94.262	1	.000	12.911

[a] Variable(s) entered on Step 1: Affordability, LPG accessibility.

Model 4. A binary logistic analysis was conducted to investigate LPG accessibility and LPG affordability's contributions to predict LPG adoption controlling for demography variables. The control variables age, marital status, and education were

tested priori to verify that there were no violations of the assumption of the logit's linearity. The outcome of interest was LPG adoption.

Table 37

Model 4 Summary

Step	-2 log likelihood	Cox & Snell *R* square	Nagelkerke *R* square
1	422.224[a]	.451	.603

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

The Hosmer-Lemeshow goodness-of-fit was not significant, $p = .462$, indicating that the model was correctly fitted. The -2 Log likelihood = 422.22 and the Nagelkerke $R^2 = .603$. Education was not significant in the model p = .995, see table 37. However, the independent variables LPG affordability and LPG accessibility were found to be significant, and the control variables age and marital status were also found to be significant in the model. Controlling for the demography variables age, marital status, education, and the independent variable LPG accessibility, the predictor variable LPG affordability was found to contribute to the model. The unstandardized $B = -2.466$, $SE = .277$, $Wald = 79.418$, $p < 0.01$. The estimated odds ratio $Exp = .085$ favored a relationship of nearly 92% decrease for every household adopting LPG where LPG's affordability is catastrophic, controlling for age, marital status, education, and LPG accessibility. See Tables 38 and 39 for the model classification table and the variables equation, respectively.

Table 38

Model 4 Classification Table

			Predicted		
			LPG adoption		
	Observed		No	Yes	Percentage correct
Step 1	LPG adoption	No	244	56	81.3
		Yes	40	204	83.6
	Overall percentage				82.4

[a] The cut value is .500.

Table 39

Model 4 Variables in the Equation

		B	S.E.	Wald	*df*	Sig.	Exp(B)
Step 1[a]	Respondent age	-.026	.012	4.476	1	.034	.974
	Marital status(1)	-1.300	.361	12.970	1	.000	.273
	Education(1)	-20.572	3378.895	.000	1	.995	.000
	Affordability(1)	-2.466	.277	79.418	1	.000	.085
	LPG accessibility(1)	-1.414	.263	28.955	1	.000	.243
	Constant	3.948	.651	36.750	1	.000	51.853

[a] Variable(s) entered on Step 1: Respondent age, Marital status, Education, Affordability, LPG accessibility.

The predictor variable LPG accessibility in the logistic analysis was also found to contribute to the model. The unstandardized B = -1.414, SE = .263, $Wald$ = 28.955, $p < 0.01$. The estimated odds ratio Exp = .243 predicted a relationship of nearly 76% decrease for every household adopting LPG where accessibility to LPG was inconvenient, controlling for age, marital status, education, and LPG affordability.

Consistently, the binary logistic regression analysis of models 1 through 4 showed that LPG affordability and LPG accessibility have predictive effects on LPG adoption in Nigeria's households. The logistic analysis predicted a negative effect of catastrophic

affordability on LPG adoption and predicted a negative effect of inconvenient access on LPG adoption in Nigerian households. The odds for households where LPG affordability is affordable to adopt LPG is nearly 12 times higher than for households where LPG affordability is catastrophic. Similarly, the odds of households where LPG accessibility is not a problem to adopt LPG is four times higher compared to households where LPG accessibility is inconvenient. The regression analysis results, therefore, provided the grounds to reject the null hypotheses in Research Question 3 that LPG affordability does not predict LPG adoption for household cooking in Nigeria and to reject the null hypothesis in Research Question 4 that LPG accessibility does not predict LPG adoption for household cooking in Nigeria.

Summary

This chapter justified the research questions for the study. On Research Questions 1 and 2, the bivariate analysis confirmed that there was a relationship between LPG affordability and LPG adoption. Similarly, the correlational analysis also confirmed a statistically significant relationship between LPG accessibility and LPG adoption. Therefore, with analysis, the null hypotheses of Research Questions 1 and 2 were rejected, and the alternative hypotheses accepted.

Binary logistics regression models were fitted to evaluate Research Questions 3 and 4. The regression analysis results indicated that LPG affordability predicts LPG adoption and that LPG accessibility predicts LPG adoption. The next chapter focused on the imperatives of the findings and proffered recommendations for the DLPGPP to enhance LPG adoption for cooking in Nigeria's households.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this quantitative method research was to analyze the effect of LPG accessibility and affordability on households' adoption of LPG for cooking in Nigeria. The research objective was to fill a gap in the literature regarding LPG transition and guide the government's intervention preferences for transiting Nigeria's households from hazardous energy fuels to LPG, with limited resources available to support this outcome. Many factors determine the choice of energy fuels in Nigeria and other countries. The research answered the following question: How do the determining factors of accessibility and affordability of LPG compare on the scale for customer decision making to adopt or not adopt LPG for household cooking? An answer to the above question will help the government to tailor its policy and intervention program, DLPGPP, to obtain a quicker sustainable outcome for households' LPG adoption.

The correlational design helped determine the direction of the relationship of accessibility and affordability with LPG adoption and predict their individual and combined effect on LPG adoption in Nigeria's households. The study used a multistage sampling technique for data collection. It stratified the FCT household population into rural, urban, and suburban areas and then randomly selected sample households.

Based on the study participants' responses, there was a statistically significant relationship between LPG affordability and LPG adoption. There was also a statistically significant relationship between LPG accessibility and LPG adoption. Both factors are predictors of LPG adoption and have large effects on LPG adoption in Nigeria's

households. However, LPG affordability has a larger effect size on LPG adoption than LPG accessibility.

Interpretation of the Findings

Most research on energy and fuel transition has focused on the ELT and used respondents' income to determine energy fuel transition and adoption. This study weighed in to extend the theory to focus on affordability as a better determinant of fuel adoption, relating income to fuel price. The study is the first to quantitatively measure affordability as a factor of income and price, not as a qualitative perception in energy transition research.

The study agrees with the ELT and shows that affordability and accessibility are strong predictors of LPG adoption in Nigeria's households. The study confirmed that accessibility in terms of distance to a distribution point limited and impaired the adoption of LPG in Ghana (Abdulai et al., 2018). It also confirmed the finding of similar studies in Peru and other countries that fuel and affordability are critical determinants of transition decisions (Kayode et al., 2015; Kumar, 2017; Pollard et al., 2018; Schunder & Bagchi-Sen, 2019). The results also agreed with Amoah's (2019) finding that income and the relative price of fuel are significant determinants of fuel choice. The study complements the ELT and contributes to knowledge by replacing income with affordability, operationalized as a combination of fuel cost, opportunity cost, and associated accessories relative to income as the critical factor in the transition of households to modern fuel. The study findings indicate that affordability has a larger effect on consumer decisions for LPG choice as cooking fuel than accessibility. The findings differ

from those of Kumar (2017), who reported a larger effect size of accessibility than affordability on LPG adoption in rural India. This study predicted a 92% influence of affordability on LPG adoption when compared to accessibility's 76% controlling for each other and demographic control variables. In contrast, Kumar found that accessibility predicted LPG adoption by 12%, compared to the 6% influence of affordability on LPG adoption in rural India.

The results indicate that the DLPGPP policy instrument may be used to influence LPG adoption by steering consumer preferences through increased accessibility of LPG and LPG's affordability in practical terms of initial cost underwriting, market and infrastructural development incentives, subsidy on LPG, and partnership. The results also indicate that the DLPGPP should emphasize enabling LPG affordability above LPG accessibility to speed the transition to LPG in Nigeria's households. It is recommended that the DLPGPP position interventions addressing the affordability of LPG as a critical factor in LPG adoption for cooking in Nigeria's households.

Limitations of the Study

The study design was correlational. It utilized stratified random sampling and collected a large sample size to enhance its external validity, reliability, and the generalization of its findings to all of Nigeria's households. The study also used existing indicators to collect data and thereby ensure internal and construct validity. The study had limitations in its correlational design, as the DLPGPP was yet to take off at the time of the study. The high standard for evaluating the influence of a determinant of energy

adoption is through an experimental design that would compare pretest and posttest groups to evaluate the effect of the factor.

Recommendations for Future Research

This study is seminal in its assessment of LPG affordability using quantitative measures. The accessibility measure is, however, a qualitative perception of the respondents. An assessment of accessibility through quantitative means would provide better insight into the effect of accessibility on energy fuel adoption. Comparing the effect size of affordability against a quantitatively defined accessibility in LPG adoption decision-making would further guide the DLPGPP.

There are more predictors of decision-making regarding energy fuel adoption by households in Nigeria. This study focused only on the accessibility and affordability of LPG. Future research may quantitatively evaluate the marginal effect of those factors to guide the DLPGPP. There is also a research opportunity to evaluate the DLPGPP post-implementation to make recommendations for future energy conversion or transition programs in developing Sub-Saharan African countries.

Implications for Social Change

The study analyzed factors to guide a government intervention toward energy fuel transition to modern energy. Such conversion to LPG will reduce the emission of hazardous gases during household cooking, improve citizens' health, reduce the emission of ozone-depleting carbon monoxide, and therefore impact Nigeria’s contribution to global warming. This study's findings may contribute to positive social change by guiding the performance and accountability of the government intervention to reduce the

environmental pollutants critical to addressing many of today's developmental challenges, including human health, climate change, food security, and general household welfare. Although the government might not increase household income immediately, it can foster LPG adoption in households by putting measures in the DLPGPP to address affordability. One way to do this is to provide LPG accessories and stoves for free to those who cannot afford LPG. The government should also incentivize manufacturing companies to make LPG stoves, gas cylinders, and gas hoses locally to drive down these accessories' costs. Further, the government should provide differential LPG subsidies to households where LPG adoption will cost above 5% of household income—or, to put it another way, to households that cannot afford LPG. The federal government should remove all kerosene subsidies and place penalties on tree felling and biomass use in urban and suburban areas.

To improve the accessibility of the LPG fuel supply, the government should incentivize all petrol filling stations, which are often closer to households and usually dispense kerosene, to convert a section of their facilities to dispense LPG into gas cylinders throughout Nigeria.

Conclusion

This study analyzed the implications of affordability and accessibility for LPG adoption for cooking in Nigeria's households. The study may inform Nigeria's DLPGPP—a policy instrument designed to transition Nigeria away from traditional fuels to modern LPG. Nigeria has abundant gas resources, and it is anathema that Nigeria's households should predominantly consume biomass and other conventional fuels for

cooking. The study may guide the penetration program to address the affordability and accessibility of LPG throughout the nation to achieve effectiveness and the desired outcome. The finding that affordability has a 92% effect on LPG adoption indicates that addressing the affordability and accessibility of LPG is critical to deepening LPG adoption and consumption in Nigeria and achieving effective energy transition to LPG throughout the nation.

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Appendix A: Liquefied Petroleum Gas Adoption Household Survey Questionnaire

Section A: Demographic, Criteria Data and LPG Adoption (I will pre-fill Questions 1–4)

1. Household Survey ID: _____
2. Household Local Government Area: _____
3. Household Enumeration Area: _____
4. Dwelling House Coordinates:

5. How old are you?
6. Indicate the evidence of age you showed or provided.

   (Mark only one oval)

   Birth certificate

   Driver's license

   National ID card

   International passport

   Non-Government ID card

   Self-report

7. What is your status in your household?

   Household Head

   Household Spouse

   Household Decision-Maker

   (Maybe grand-parents, family sponsor)

8. What is the ownership status of your house?

   (Mark only one oval)

   Self-owned

   Rented apartment

9. Is your household connected to the electricity grid?

   Yes

   No

10. What is the primary source of lighting in your Household?

    (Mark only one oval)

    Off-grid renewable like solar

    Electricity from grid

    Electricity generator

    Traditional means of lighting

11. What is your marital status?

    (Mark only one oval)

    Single

    Married

    Divorced or Separated

    Widowed

12. Are you aware of the use of LPG (Liquefied Petroleum Gas) as a cooking fuel?

    Yes

No

13. Do you know where to buy LPG?

Yes

No

14. What is the type of unit is your house?

Whole House

Flat

Self-contained Studio

Family Compound

Multiple Household (Face me - I face you)

15. Where is the kitchen in your household?

Outside the household in open space

Inside the household

There is no kitchen in the house

16. What type(s) of stoves do you currently have in your household?

(Mark all that applies)

LPG Stove

Kerosene stove

Improved biomass stove

Electric induction stove

17. What is your highest level of education?

Primary

Secondary

Post-secondary

18. Which type(s) of fuel do you use for cooking?

Check all that apply:

Kerosene

LPG

Electricity

Wood fuel/biomass

Coal

Charcoal

19. What is your spouse's highest level of education?

Primary

Secondary

Post-secondary

20. What type of fuel do you use most frequently in your household for cooking in the last one year? (Mark only one oval)

LPG

Kerosene stoves

Wood fuel/ biomass stoves

Electric induction stoves

Charcoal

Coal

21. Where do you normally cook?

    Outside the kitchen

    Inside the house in the kitchen

    Inside the house but no in the kitchen

22. Estimate the number of hours you use in cooking every day in your household?

    1

    2

    3

    4

    5

    Above 5

23. How many people eat food prepared in the household every day?

24. How many children do you have?

Section B: Determinant of LPG Adoption—Affordability (Questions 25–49)

25. Do you have to purchase your cooking fuel?

    Yes

    No

26. Estimate how much you spend on fuel purchase every month? ₦

27. Estimate how much you spend on food for the household every month?

    ₦

28. Do you have employment outside your house?

    Yes

No

29. What is your current occupation?

30. What is the industry of your occupation?

31. Are you self-employed?

Yes

No

32. How much did you earn last month? ₦

33. What is your average monthly income? ₦

34. How regular has been your income in the last one year?

Regular

Not regular

35. Estimate how much you earned in the last one year?

36. How many people have been living and eating in your household in the last six months (Household Size)?

37. What is the amount of debt you owe? ₦

38. Are you living in your personal house?

Yes

No

39. Do you own farmland?

Yes

No

40. Do you own land to build your house?

Yes

No

41. Over the past 30 days, did the household purchase or paid for any fuel?

Yes

No

42. What is the volume/size/weight of fuel can/cylinder (KC) (Choose the nearest that apply)?

3

5

12

Other: _____

43. Estimate the total amount the household spent on fuel in a year? ₦

44. Estimate how much your household spent IN TOTAL for the education of all the children last year

45. What were the average income of the household last month (Husband and Wife together) and any other income earning person in the household?

₦

46. What expenditure takes most of your money?

Transport

Food

Rent

Education

Clothing

Charity

Medical

Other: _____

47. Estimate how much you spend on the highest expenditure household item

₦ _____

48. If you are not using LPG for cooking, would you say you can afford LPG if you wish?

Yes

No

49. If you cannot afford LPG, do you have access to financial loans to purchase a LPG stove and accessories?

Yes

No

Section C: Determinant of LPG Adoption—Accessibility

50. Coordinates of the nearest LPG Outlet to the household:

_____ _____ _____ _____ _____ _____

(You may leave the above question for the survey administrator if you don't know it)

51. Estimated distance of LPG outlet to Household: _____ (Km)

    (Use Google Map to find the distance between household and the nearest LPG depot in KM. You may leave the above question for the survey administrator if you don't know how to use google map)

52. Is there a tarred road close to your house?

    Yes

    No

53. Estimate the distance of your house from where you collect the fuel you use for cooking (Choose the nearest figure below)?

    < 1 km

    < 3 km

    < 5 km

    < 7 km

    < 10 km

    > 10 km

54. What is your mode of transportation to where you collect fuel for cooking?

    Foot Walk

    Personal bicycle

    Personal motorcycle

    Personal tricycle

    Personal car

    Commercial cycle

Commercial bus

Taxi

55. If you currently purchase or you were to purchase LPG - how do you see LPG purchase from the nearest retail outlet?

Highly inconvenient

Slightly inconvenient

Not a problem

56. If not using LPG, what do you think the government can do to promote your change to LPG (Choose your most preferred)?

The government should subsidize upfront LPG cost (stove and Cylinder)

The government should subsidize LPG fuel cost

The government should facilitate the establishment of LPG outlet near your house

The government should provide free LPG cylinder, stove, and accessories

Section D: For Pilot Test Only

For us to be able to contact you in the future, please provide us with your contact details?

57. Name of Respondent:

58. Phone Number of Respondent:

59. Name of Respondent's Spouse:

60. Phone Number of Respondent's Spouse:

Appendix B: National Institutes of Health Certification of Completion

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that **Saheed Lasisi** successfully completed the NIH Web-based training course "Protecting Human Research Participants".

Date of completion: 07/01/2017.

Certification Number: 2427637.

Appendix C: Interviewer's Records Sheet

1. Household Survey ID: _____
2. Household Local Government Area: _____
3. Household Enumeration Area: _____
4. Dwelling House Coordinates:

   ☐ ☐ ☐ ☐ ☐ ☐

5. Able to locate household:

   Yes ⬭

   No ⬭

6. Did the respondent give consent to be interviewed:

   Yes ⬭

   No ⬭

7. Date of Interview: _____ Example: January 7, 2019
8. Time Interview Started: _____ Example: 8:30 AM
9. Time Interview Ended: _____ Example: 8:30 AM
10. In the case of oral interview, what was the language used:

    (Mark only one oval)

    English ⬭

    Yoruba ⬭

    Hausa ⬭

    Igbo ⬭

11. What was the language used by the respondent:

(Mark only one oval)

English

Yoruba

Hausa

Igbo

12. Was a translator used at any point during the interview:

(Mark only one oval)

Never

Sometimes

Always

13. Coordinates of the nearest LPG Outlet to the household:

14. Estimated distance of LPG outlet to Household: _____ (Km)

Interviewer should use Google Map to find the distance between household -- and nearest LPG depot in KM

15. How old is the respondent?

Mark only one oval

Above 18

Below 18

16. What is the respondent's household status?

Household Head

Household Spouse

Household Decision-Maker

(Maybe grand-parents, family sponsor)

17. Is the respondent eligible?

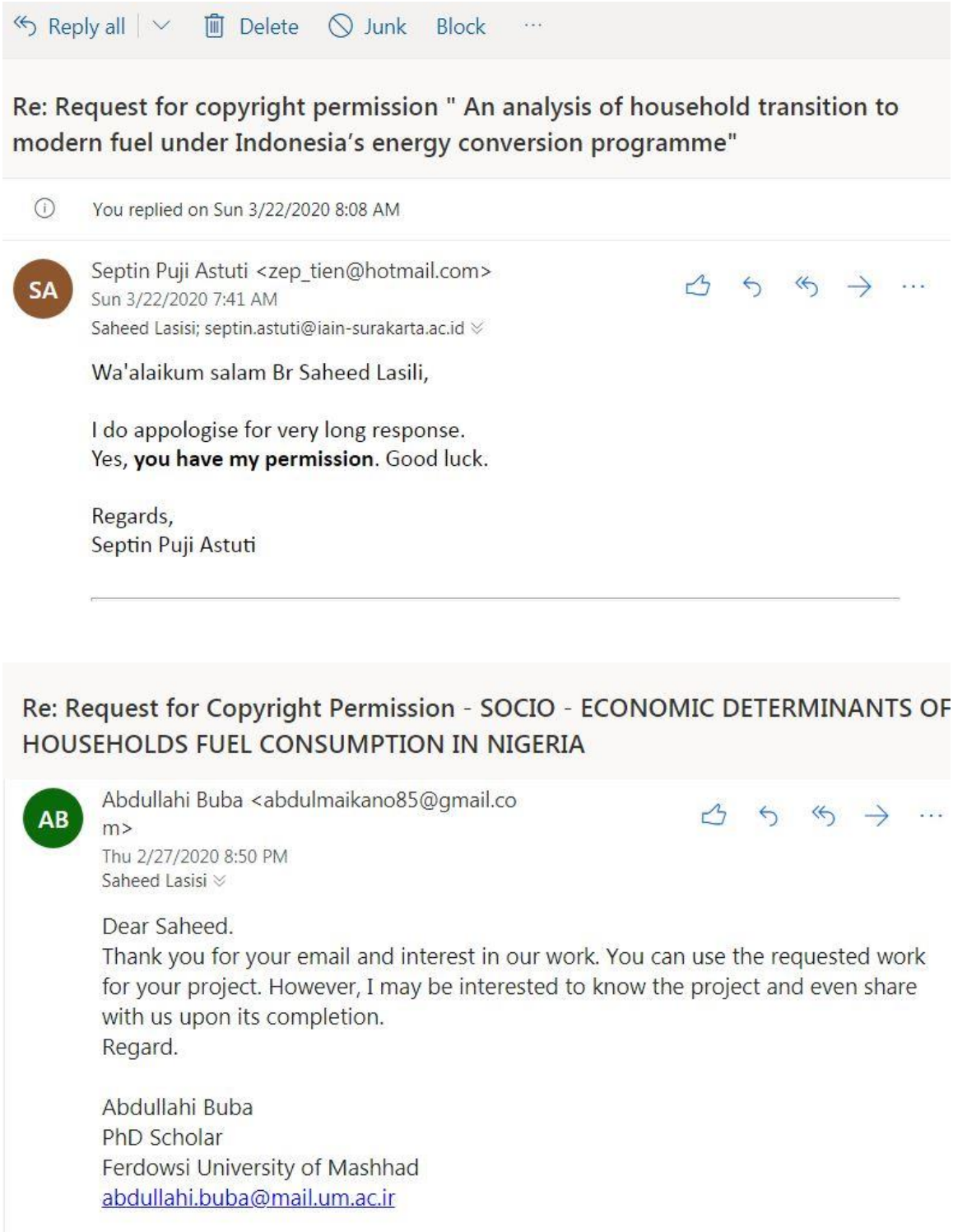
To be eligible, the respondent must be an adult, head of household, spouse, or decision-maker, must give consent, and must have LPG awareness.

Mark only one oval

Yes

No

Appendix D: Copyright Permissions



Reply all | Delete | Junk | Block | ···

Re: Request for copyright permission " An analysis of household transition to modern fuel under Indonesia's energy conversion programme"

You replied on Sun 3/22/2020 8:08 AM

SA

Septin Puji Astuti <zep_tien@hotmail.com>
Sun 3/22/2020 7:41 AM
Saheed Lasisi; septin.astuti@iain-surakarta.ac.id

Wa'alaikum salam Br Saheed Lasili,

I do appologise for very long response.
Yes, **you have my permission**. Good luck.

Regards,
Septin Puji Astuti

Re: Request for Copyright Permission - SOCIO - ECONOMIC DETERMINANTS OF HOUSEHOLDS FUEL CONSUMPTION IN NIGERIA

AB

Abdullahi Buba <abdulmaikano85@gmail.com>
Thu 2/27/2020 8:50 PM
Saheed Lasisi

Dear Saheed.
Thank you for your email and interest in our work. You can use the requested work for your project. However, I may be interested to know the project and even share with us upon its completion.
Regard.

Abdullahi Buba
PhD Scholar
Ferdowsi University of Mashhad
abdullahi.buba@mail.um.ac.ir

Re: Request for Copyright Permission - Cooking Fuels in Lagos, Nigeria: Factors Associated with Household Choice of Kerosene or Liquefied Petroleum Gas (LPG)

UO

Uju Ozoh <ujuozoh@yahoo.com>
Thu 2/27/2020 1:33 PM
Saheed Lasisi

Dear Saheed,
You have my permission.
Regards,
Uju

Sent from my iPhone

On Feb 27, 2020, at 12:22 PM, Saheed Lasisi <saheed.lasisi@waldenu.edu> wrote: