DETERMINANTS OF ADOPTION OF COOKING GAS AS DOMESTIC FUEL IN KANO METROPOLIS, NIGERIA

BY

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BEING A DISSERTATION SUBMITTED TO THE DEPARTMENT OF GEOGRAPHY, FACULTY OF EARTH AND ENVIRONMENTAL SCIENCES, BAYERO UNIVERSITY, KANO, IN PARTIAL FULFILMENT FOR THE REQUIREMENT OF THE AWARD OF MASTER OF SCIENCE DEGREE IN NATURAL RESOURCES MANAGEMENT AND CLIMATE CHANGE

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25th July, 2018

DECLARATION

I hereby declare that this research work was undertaken under the supervision of Professor Ibrahim Baba Yakubu and has not been presented and will not be presented elsewhere for the award of a degree. All sources have been duly acknowledged.

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CERTIFICATION

This is to certify that the research work for this dissertation was undertaken by Bilyaminu Ali Tofa (SPS/14/MGE/00013) under my Supervision.

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APPROVAL PAGE

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ACKNOWLEDGEMENTS

First and most importantly, all thanks and praises are to Almighty Allah alone. Peace and blessings on the last prophet Muhammad, his family and his companions. Indeed, I remain divinely grateful to Almighty Allah, the provider and sustainer of life in whose hands we put all achievements and success. Because without the help and guidance of Allah; the success of completion of this work would have been impossible. I am so much grateful, thank you Allah

My profound gratitude goes to my able supervisor and my internal examiner in person of Professor Ibrahim Baba Yakubu and Professor Adamu Idris Tanko the current Deputy Vice Chancellor Bayero University whom logical and constructive criticisms, patients and understanding made the success of this research work easier than otherwise, despite their tight commitments. Sir, may Allah reward both of you abundantly. Am also thankful to my external examiner in person of Professor Mala M. Daura all the way from University of Maiduguri, who also made all the necessary corrections in the write up to improve the quality of the work. Sir, may Allah assist you in all your life endeavors.

To my parents and the entire Ali Tofa's family for their prayers, courage and financial support given to me for the accomplishment of this great task. Though I lost my dad, may Allah forgive and reward him with Al-jannatul Firdausi, Ameen.

I wish to express my appreciation to all my lecturers in the Department of Geography who contributed to the success of this work directly or indirectly, most especially Dr. Ibrahim Lambu, Dr. Tasiu Yelwa, Mal. Murtala Uba, Mal. Maikudi Lawan, Mal. Muzammil Ahmad, Mal Ishaq, Dr Mansur Mohammad, Dr Bello Gambo, Professor Maharazu, and Mal. Abdulhakeem Kiyawa.

To my elders, relatives, friends and colleagues who contributed a lot to the success of this work. Salisu Ali Tofa, Mansur Ali Tofa, Malam Rabiu Ali Tofa, Haidar Abubakar, Musa Muhammad Gombe, Khamis Ali Tofa, Yusuf Ali Tofa, Abdulwahab Auwal Jos, Malam Mustapha Kaduna, Hajia Habiba Gezawa, Malam Nasiru Fagge, Malam Umar Isa Baba, Malam Bashir, Ahmad Mustapha, Malam Mahrazu, Muktar Idris Muhammad, Faisal Mansur Shuaibu, Hafsa Ali Tofa, Saidu Ali Tofa, Sadiya Dahir Salman, Juwairiyya Abdullahi Hamza, Ummukulthum Hassan, Dr. Abubakar Ibrahim Hassan, Yusuf Ali Tofa and Almisky Ali Tofa our last born in the family.

Lastly, I wish to acknowledge the support of the entire respondents who sacrifices their time in filling the questionnaires.

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DEDICATION

This dissertation is dedicated to my late father Alhaji Ali Tofa and my lovely mother Hajiya Mariya Rabiu.

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ABSTRACT

This study is focused on the determinants of adoption of cooking gas for domestic household utilization among the residential density zones of Kano metropolis, Nigeria. The data were gathered through the administration of questionnaire whereby 400 households were sampled through multi stage sampling technique. Simple random sampling was used to select three localities from each local governments areas followed by proportional sampling technique was used to determine the sample size from each local government. Purposive sampling technique was also adopted to select the required respondents from each stratum for ease of administration of the questionnaire. And finally the selected sampled localities from each local government within the metropolis were reclassified into clusters division based on population density and socioeconomic status. The data collected were analyzed using descriptive statistics, thus use of simple frequency counts, percentages and tables using Statistical Package for Social Sciences (SPSS V 20) for the analysis. The result obtained reveals that income and education level of household, family size and status of the household, cheaper source of domestic fuel for cooking, clean energy source and time savings for cooking are the major determinants for the adoption of cooking gas as domestic fuel. The study also observed that kerosene is ranked first as the most preferred alternative cooking energy used in place of liquefied petroleum gas by households in the metropolitan Kano, while the major challenges for the adoption of LPG in the study area were leakages from the cylinder, poor literacy, and psychological fear of explosion and high cost of start-up among others. The study recommends that prices of LPG should be made affordable and product highly available. Also awareness campaign about environmental education should be intensify on preservation of our forest resources that is been depleted at the expense of our domestic energy needs. Safety and public sensitization campaigns should also be organized to educate households on the use of LPG and negative impact of solid fuels usage. This will help ease the psychological barrier to adoption of cooking gas.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Liquefied Petroleum Gas is a mixture of gaseous hydrocarbons produced from natural gas and oil extraction as well as oil refining. According to the Intergovernmental Panel on Climate Change (2007); LPG is not a greenhouse gas, meaning it is assigned a global warming potential factor of zero. The IPCC lists the global warming potential factor of CO_2 as 1 and C_4 as 25 (Intergovernmental Panel on Climate Change, 2007).

LPG is the generic name for compressed hydrocarbon gases, typically butane and propane, a by-product of crude oil refining or from natural gas production. These gases have the unusual property of becoming liquid at room temperature when moderately compressed and reverting to gases when the pressure is sufficiently reduced. This gives them a considerable advantage over other fuels because they can be easily transported and stored in the liquid state. Inkoom and Biney (2010) stated that because it is clean, safe and very efficient in generating heat, the use of LPG represents major progress and contributes to quality of household life. LPG has a high energy content compared to most other oil products and burns readily in the presence of air(World Liquefied Petroleum Gas Association (WLPGA) 2001).The history of LPG can be traced back to the beginning of the 20th Century. In the early production of gasoline, one problem faced was that gasoline quickly evaporated when in storage (Barnett, 1999).

Energy is essential for economic and social development, yet for all the invaluable benefits that energy access brings, its consumption can also have a negative effect on the environment, particularly with regard to climate change. However not all kinds of energy have the same impact on the climate. It is therefore important that consumers are informed and able to choose clean energy sources that are environmentally friendly (Barnes and Halpern, 2000). A study, conducted by Sokona (2003) in accordance with the Intergovernmental Panel on Climate Change (IPCC) methodologies, demonstrated that compared to many other energy sources, Liquefied Petroleum Gas (LP Gas) can help minimize greenhouse gas (GHG) emissions and therefore mitigate climate change in many applications and regions around the world today. Continued over-dependence on unsustainable wood fuel and other forms of biomass as the primary sources of energy to meet household energy needs has contributed to serious environmental drawbacks. These drawbacks include deforestation, soil erosion, air pollution and global warming resulting to climate change (Inter Governmental Authority on Development, IGAD 2007). Moreover, in Africa, the consumption of wood fuel and charcoal continue to increase, with wood fuel consumption predicted to increase by 2030 to over 137% of the 1970 base rate, while charcoal consumption is expected to increase to over 5 times the 1970 base rate (IGAD, 2007). This presents a crisis, as the process of charcoal production means that more wood needs to be used in providing energy from charcoal than would be needed for wood fuel.

Environmental degradation due to collection of wood fuel, fodder and shelter materials has resulted in the increase in soil erosion, surface water pollution, flash- flooding, and loss of natural habitats, which limits livelihoods opportunities. It is predicted that by 2030 the number of people in Africa relying on biomass for cooking and heating is expected to increase to over 140% of the 2000 rate (International Energy Agency I.E.A, 2008).

The primary source of energy includes electricity, coal, gas, wood fuel and solar energy. The most dominant traditional sources of energy in developing countries are wood fuel and charcoal, which are used primarily for cooking and heating homes (CAD, 1991). According to Fecher *et* *al.,* (2005), the main challenges facing the global energy sector are two – fold, (i) to increase access to affordable modern energy services to poor countries that lack them; (ii) to find the energy mix sources, technology, policies and behavioral changes that will adverse environmental impact of providing the necessary energy services.

The energy for cooking can be classified into solid fuels and non-solid fuels. The solid fuels include fossil fuels (coal, peat) and biomass (wood, dung and agricultural products), while the nonsolid fuels consist of kerosene, liquefied natural gas and electricity (Sathaye, *et al.,* 1997) Continued over dependence on unsustainable wood fuel and other forms of biomass as primary sources of energy to meet household energy needs has contributed to negative impacts on the environment. In addition, continued use of traditional biomass fuels contributes to poor health among users due to incomplete combustion and smoke emissions in poorly ventilated houses common in rural areas (Biogas for Better Life, An Africa Initiative (BBLAI, 2007).

According to Arthur *et al.,* (2011), the associated harmful environmental, health and social effects with the use of traditional biomass and fossil fuel have enhanced the growing interest in the search for alternate cleaner sources of energy globally.

The cooking problem is intensifying because rapid growth of population in many developing countries create increasing demands for wood fuel and charcoal due to high cost of conventional source of energy. (Lambu and Bashir, 2016).

In Africa, wood fuel accounts for about 90% of the total energy use and two-third of this consumption is household energy for the most part procured by women (FAO, 2010). In Nigeria, about 86% of low income earners are primarily dependent on wood fuel as their source of energy (Ayuba, 2004). A biomass fuel has remained the commonest source of household energy in

Nigeria. More than half of the 9.6 million hectares of rain forest belt in the south of Nigeria has been used to meet the demand for wood fuel in rural and urban areas. Studies on wood fuel supply in developing countries have concluded that wood fuel scarcities are real and will continue to exist, unless appropriate approaches to resource management are undertaken (Arnold 1991;SADCC, 1992 quoted in Nura, 2001). Increased efficiency of utilization through efficient technologies can therefore be considered as one of the major prerequisites for attaining sustainable development in developing countries.

In Nigeria, about 65 % of the total energy consumption is taken by the household, probably due to under development of the industrial sector. Cooking accounts for about 91 % of the total domestic energy consumption(Oyedepo, *2012)*.Moreover, the demand for wood fuel in Nigeria is very high because more than 80% of households use wood fuel for their cooking; making it the most used form of cooking energy (Sambo, 2008). The over-dependence on wood fuel in the country has been attributed to its availability and affordability compared to the other sources of energy (Maconachie *et al*., 2009). Nigeria has already shown a tendency towards excessive total wood fuel consumption which, according to Sambo (2008), is due to population growth, low technical efficiency of the traditional cooking style and the lack of adoption of other sustainable cooking methodologies. While Sambo's (2008) claims cannot be denied as part of the overall problem of wood fuel in Nigeria, one key factor he does not consider is the unreliability in the supply of alternatives to wood fuel in the country such as cooking gas.

In 2005 UNDP report on Millennium Development Goals (MDGs) indicates that the majority of the countries participating in the MDGs project take little notice of the energy requirements of poor people, by only treating energy development within the context of large-scale infrastructure projects, without taking on board the traditional sources of energy in their policy decisions. The continued lack of commitment shown by most of the countries participating in the MDGs' programmed, to address the problem of energy deprivation, is reflected in the energy poverty seen today in many developing countries (Florini and Sovacool, 2009; Cherp *et al*., 2011 and Scott, 2012).

Generally speaking, Olise and Nria-Dappa (2009) emphasized that the energy situation in Nigeria is actually worse than has been revealed to the outside world. They presented their arguments on the basis of the household income ratio to their spending on energy and revealed that the poorest households earn about 1-2 US dollars per day and spend about 0.4 dollars per day on energy. This represents about 20-40 percent of the household's income spending one energy alone.

There is a trend of over-dependence on biomass for fuel, and wood fuel is widely consumed in Kano city and rural areas which is having a detrimental effect on most densely populated areas in the state (Ahmad, 2006). Out of several domestic energy sources to choose from, wood fuel happens to be the popular choice. This can be attributed to the purchasing power of the majority of people living in the study area, and thus opting for wood fuel as a major domestic energy source. Studies in Nigeria showed that; the urban poor and the rural households still depend on biomass for their energy needs.

Therefore, there is need to have a kind of public private partnership in terms of access and affordability of cooking gas to the poor dwellers of both rural and urban at subsidized rate since they constitute the majority of the population that are faced with the challenges of adoption and utilization of cooking gas household fuel type.

1.2 STATEMENT OF THE RESEARCH PROBLEM

Some of the major environmental problems related to energy production, distribution and consumption are deforestation, air and land pollution. Excessive wood fuel consumption arises due to population growth, low technical efficiency (using traditional three stones stove) and lack of adoption of other sustainable cooking technologies. These contribute to deforestation which is a very serious issue, because of the important roles forest resources play in the ecosystem. They serve as sinks for carbon dioxide, maintain diverse plants and animals life as well as regulate the flow of water. Loss of forest resources leads to soil erosion, desert encroachment and loss of soil fertility (Abubakar and Babangida, 2011).

The problems related to wood fuel as energy source has been an issue of concern for more than three decades in Nigeria. Efforts at encouraging households to make substitution that will result in more efficient energy use and less adverse environmental, social, and health impacts are advocated. Many programmes have been implemented by public authorities to decrease household wood-energy consumption and to substitute it by alternative conventional fuels such as cooking gas. But despite all the policies, the rate of consumption of wood-energy (and other biomass fuels) and its attendant negative environmental and health impacts are still alarming (Adeyemi and Adereleye, 2016).

Williams (2007), opined that if average African household switched to LPG, each family would have saved 120 kg of wood fuel annually. In addition, it is estimated that if half of the number of households currently cooking with solid fuels switched to LPG, it can provide health and productivity gain of more than USD 900 billion over the next ten years (WHO, 2002).

Fortunately for Nigeria, she is blessed with a proven gas reserve of more than 187 trillion cubic feet (Nigeria Liquified Natural Gas (NLNG, 2011). This suggests that Nigeria can stabilize carbon emission through massive development, investment and utilization of LPG thereby entrenching Low Carbon Economy (LCE).

According to Okonjo-Iweala (2014) the multiplier effect of investment and savings from the sale of gas and associated LPG is estimated to yield a net present value of $7.5 billion over the next 25 years, besides the environmental impacts. Despite resources availability and other empirical benefits, only about 5 percent of Nigeria's households use LPG, with total annual consumption of paltry 150,000 metric tonnes. This translates into 0.9 kg per capita, compared to Senegal annual per capita consumption of 13 kg with its 12.77 million and the West Africa regional average of 3.5 kg. Without doubt, Nigeria is ranked among the lowest consumers of LPG in Africa. Reliable data shows that Nigeria recorded about 39 percent growth in domestic consumption of LPGbetween2005–2012, indicating a very slow growth over the years not withstanding government interventions. (Nigeria Liquefied Natural Gas (NLNG, 2011).

Most of the studies carried out on domestic fuel consumption in Kano metropolis such as: Cline-Cole *et al.,* 1990, Firdausi, 2008, Maconachie *et al.,* 2009, Yakubu, 2014 and that of Kiyawa, (2016); none of these prominent works emphasizes on the determinants factors for the adoption of cooking gas as a domestic fuel in Kano metropolis.

In the absence of studies as related to determining factors for the adoption of cooking gas as domestic fuel in Kano metropolis, this research aimed to consolidate the findings of previous studies on household energy consumption in Kano metropolis and also to fill the existing gaps. This study is therefore, an inventory of the adoption of cooking gas, challenges faced by households and measures to encourage switching from solid fuels to cooking gas as domestic household fuel in Kano metropolis, Nigeria.

1.3 RESEARCH QUESTIONS

Below are some of the questions the study will attempt to address:

i. What are the socioeconomic characteristics that affect the adoption of cooking gas as domestic fuel choice?

ii. What are the factors determining the adoption of LPG as domestic household energy?

iii. What are the challenges faced by households in utilizing cooking gas (LPG) as domestic energy source?

iii. What are the measures stakeholders could take to enable more households shift away from solid fuels to LPG?

1.4 AIM AND OBJECTIVES

The aim of this study is to identify and explain the determinants factors for adoption and utilization cooking gas as domestic fuel in Kano metropolis, Kano state with a view to providing key information to policy makers for sustainable management. While the specific objectives were to:

i. Identify socioeconomic characteristics influencing the adoption of cooking gas as domestic fuel choice

ii. Identify the factors determining the adoption of LPG as domestic household energy

iii. Find out the challenges of adoption of cooking gas as household energy

iv. Identify the measures to enable more households to shift away from solid fuels to LPG.

1.5 JUSTIFICATION OF THE STUDY

The choice of domestic cooking energy in Nigeria is an issue that would address deforestation, and health hazards resulting from indoor air pollution, as result of wood fuel consumption. (Adeyemi *et al*., 2016). Household energy consumption is a necessity considering its importance on household welfare, public investments, and environments. The pattern of household energy consumption indicates the state of welfare and economic development of an individual and of a particular country (Arowosoge and Faleyimu, 2011).

Access to affordable and modern energy services is a pre-requisite for sustainable development and poverty alleviation, and more specifically, for achieving each of the Millennium Development Goals (MDGs). Lack of access to reliable, safe and mostly environmentally friendly energy is a strong constraint on human development.

The use of cleaner and least polluting energy for cooking can play a variety of direct and indirect roles to help achieve MDGs. Access to cleaner energy reduces diseases and reduces child mortality. It facilitates the achievement of Universal Primary Education for children and empowerment of women by reducing the time spent by women and children on gathering firewood from the forest (UN-Energy 2005). Also as stated by the Nations' Sustainable Energy for All Initiative(SE4All) that increasing use of liquefied petroleum gas (LPG) is one of several pathways to meet the goal of universal access to clean cooking and heating solutions by 2030.

Clean cooking fuels are important for combating the high levels of indoor air pollution encountered whenever traditional solid fuels are used for cooking or heating. The use of clean cooking fuels can also have positive effects on the external environment by reducing outdoor air pollution from venting of kitchen smoke as well as by combating forest degradation; collection of wood for wood fuel or charcoal production is thought to contribute to forest degradation in certain locations, especially near cities and major roads (Cline Cole *et al.,* 1987; Maconachie *et al.,* 2008; Friends of the environment, 2005; Bolaji, 2012).

Modern fuel and energy use can improve productivity in numerous ways, for example by re-directing scarce labor, biomass and land resources away from fuel collection and production towards agricultural and other uses.

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Table1.1. Airborne emissions for household cooking, India (g/MJ delivered energy)

Fuel	CO_2	N_2O
L P G	126	0.002
Biogas	144	0.002
Kerosene	138	0.002
Wood fuel	305	0.018
Crop residues	565	0.028
Charcoal	710	0.018
Dung cake	876	0.022

Source: UNDP/World LP Gas Association (2003)

Table 1.1 above, LPG emissions of the main noxious gases is the lowest of all other cooking fuels including biogas. As a low carbon and particulate energy able to replace less clean sources, LPG can contribute to improving quality of life by helping to reduce the social cost of energy use on the Nigerian population. Due to its characteristics LPG provides a useful tool for national policy makers and international actors. LPG is portable, multi-purpose and has a high volume-to-energy yield ratio. As a result it can rapidly be introduced in the aftermath of natural disasters and humanitarian crises where local availability of energy for heating, cooking or power generation is required.

According to a joint study conducted by World Bank and World LPG Association (2001), described the potential of LPG utilization as domestic cooking fuel:

"Liquefied Petroleum Gas (LPG) is a clean and environmentally-friendly source of energy. To protect the environment, LPG could be made available to replace wood and biomass in all households in all developing countries."

This study intended to find out the determinants and challenges of adoption of cooking gas so as to profound some suggestions and recommendation on how this modern and environmentally friendly source of domestic fuel would be accepted by the various families' households regardless of their size, status and preferences in the choice of fuel utilization for domestic purpose.

1.6 SIGNIFICANCE OF THE STUDY

The importance of cooking fuels in the life of every household cannot be overemphasized because most of the food items must be cooked, smoked, dried or heated before consumption. Cooking fuels plays an indispensable role in Kano, looking at the population of the study area, there is need for efficient and environmentally friendly source by which households could utilized for their daily routine activities. Therefore, the findings of this research would serve as a framework and reference that highlighted the major challenges household faced as regards to the adoption and utilization of cooking gas domestic fuel and measures to be addressed for the house hold switched from using wood fuel and other energy sources that are harmful to the environment and human health. It is hoped that the study will provide a valuable information for policy makers especially in the energy sector by looking at the findings and overcome some the challenges as relates to the adoption of LPG as a domestic fuel in Kano and Nigeria at large. Lastly, the study will serve as a frame work for further research into the subject matter especially by providing handy information to those who may research further into it.

1.7 SCOPE AND LIMITATIONS OF THE STUDY

This study seeks to identify and explain the determinants and the challenges face by households in adopting and utilizing cooking gas as domestic fuel in Kano metropolis. The study specifically looks at socioeconomic characteristics that affect the adoption of cooking gas domestic energy, the factors that influence the adoption of cooking gas domestic fuel use, challenges of adoption of cooking gas and identify measures to be taken for household to switch from solid fuels to liquefied petroleum gas. Other energy sources were also included since cooking gas is one of the sources of household energy. The study was limited to the metropolitan Kano comprises of eight local government areas such as Dala, Fagge, Gwale, Kano municipal, Nassarawa, Tarauni, Ungogo and Kumbotso. The studies rely on both primary and secondary data as the major sources of information.

1.8DESCRIPTION OF THE STUDY AREA

1.8.1 Location and Extent

The study area is Kano metropolis which is located between latitude $11^{0}.52^{1}$N and $12^{0}.07^{1}$N and longitude $8^{0}.24^{1}$E to $8^{0}.38^{1}$E. It is relatively at the center of Kano state which is also the administrative center of the Kano State and the third largest city in Nigeria after Lagos and Ibadan. Kano metropolis is a conurbation of eight cities around the main city which includes; Dala, Fagge, Gwale, Municipal, Nassarawa, Tarauni, Kumbotso and Ungogo and occupies an insignificant landmass of about 300 Sq. Km compared to the state's total land mass of 21,000 Sq. Km (FRN,2009).

1.8.2 Population and Settlement

Kano metropolis has a population of 2,828,861 (2006 population census) while the 2018 projected population is about 4,331,790 (NPC, Kano office, 2018)

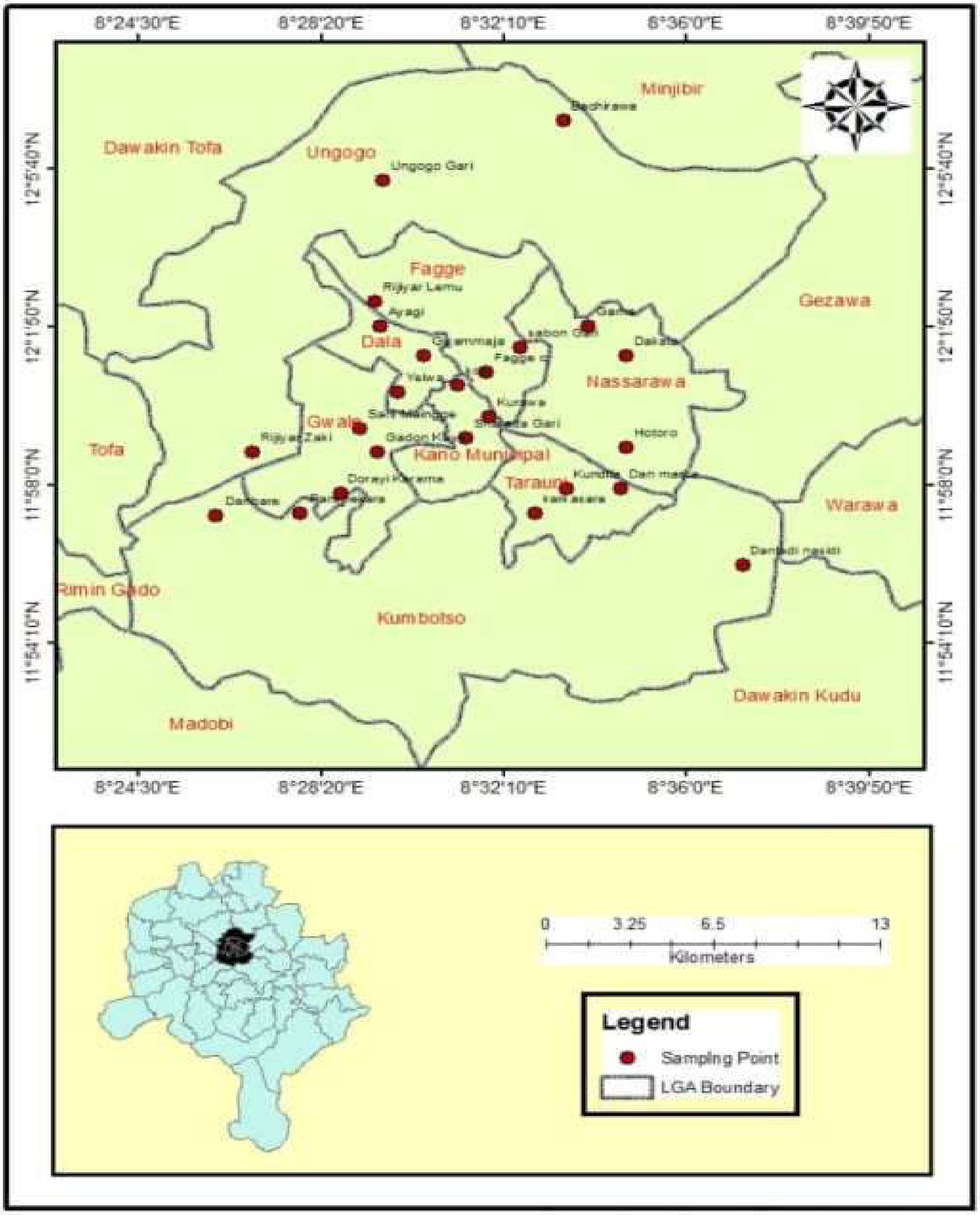
Hausa – Fulani are the major tribe in the state. According to Garba (2007) in Kiyawa(2016), Hausa-fulani accounts for almost 90% population of the state. They are usually extended family. It is estimated that the metropolitan Kano harbours about 3.5 million. (Nabegu, 2010 in Kiyawa, 2016). Other ethnic nationalities and groups of Kano excluding the dominant Hausa and Fulani include the following: Kanuri,Yorubas,Arabs, Chinese,Nupe, Shuwa Arab, Ebiras, Igalas, Tivs, Jukuns, Angas, Kataf, Igbo, Edos, Gwaris, Ghananians etc. Kano metropolis consists of eight local government which includes; Dala, Fagge, Gwale, Municipal, Nassarawa, Tarauni, Kumbotso and Ungogo has population density of about 1000 inhabitant per Km^2 within the Kano closed-settled zone compared to the national average of 267 inhabitant per Km^2 (Kiyawa, 2016)

Metropolitan Kano been an urban settlement, it is usually heterogenous population comprises of different people whom are socially and economically stratified. The pattern of settlement of the metropolitan Kano according to Maiwada (2000) in Kiyawa (2016) categorises it into three different categorization. Viz:

i. High and very high density area: this included the old walled city(Birni), fagge, Sabon Gari and the newly developed areas such as Kurna, Dakata etc

ii. Medium density areas: Tarauni, part of Hotoro, Gadon Kaya, Gwammaja and the housing estate of kundila etc.

iii. Low density areas: comprises of GRA and the institutional lands



Source:Cartography Lab Geography Department BUK(2018)

FIG 1.1 MAP OF KANO METROPOLIS SHOWING THE STUDY AREAS

1.8.3 Socio-economic Categorization of Kano Metropolis

Kano metropolis been one of the cosmopolitan cities in Nigeria aggregate people of different social and economic background. According to Cline-cole *et al.,* (1990, in Kiyawa, 2016), that the heterogeneous metropolitan population of Kano in terms of social and economic settings is relevant to energy utilization as different socio-economic clusters exists. These include the Birni (walled city), Tudunwada, Sabon Gari, Gyadi-Gyadi, Nasssarawa and suburban neighborhoods. This study adopted Kiyawa's (2016) categorization of socio-economic divisions within the metropolitan Kano. There by divided the study area based on residential density. Some areas are high density planned, high density unplanned, medium density planned, medium density unplanned, low density planned and low density unplanned. For example, high density part of old city like Kurawa, Koki, and Ayagi could form one cluster to represent high density unplanned part of the city (old city/Birni). Areas like Gadon kaya, Sani mainagge, Yelwa could form high density planned layout. While areas such as Dakata, Bachirawa, Gama, etc are high density unplanned new areas.

CHAPTER TWO

CONCEPTUAL, THEORETICAL FRAMEWORK ANDLITERATURE REVIEW

2.1 CONCEPTUAL FRAMEWORK AND DEFINITION OF TERMS

2.1.1 Concept of Energy

Energy is generally defined as the ability or capacity to do work (Cunningham & Saigo, 2001; odhi, 2005; Owate, Nte&Nna, 2005). Sodhi (2005) identifies different forms in which energy exists as follows:

i. Heat Energy: energy of random motion of atoms and or molecules that constitute matter;

ii. Mechanical Energy: energy of organized motion of matter. This exists in two forms-kinetic and potential energies. Kinetic energy is the energy due to the motion of a body while potential energy is the energy of a body at rest by virtue of its height above some reference level;

iii. Chemical Energy: energy of chemical bonds in the molecules;

iv. Nuclear Energy: energy that binds the nucleons within the atomic nuclei; and

v. Electrical Energy: energy of electromagnetic radiation.

2.1.2 Sources of Energy

Energy resources according to Sodhi (2005) are explored from four major sources namely fossil fuel, solar, nuclear and geothermal sources.

i. Fossil Fuels: These are energy resources which originated from the organisms that lived millions of years ago. After their death, they became covered with layers of sediments and were ultimately subjected to high temperatures and pressures in the depths of the earth's crust. In the absence of oxygen, their decomposition proceeded only partially. Under these conditions, the once living tissue became fossilized. When the fossilized materials are extracted and burnt, the energy stored in their chemical bonds is released as heat, hence the term fossil fuels. Examples are coal, petroleum oil, natural gas and shale oil.

ii. Solar Energy: This is the energy from the sun and the largest pool of energy.

iii. Nuclear Energy: This is the energy produced through either the fusion or fission of radioisotopes such as uranium-235, plutonium-239, deuterium and tritium (for fusion) with the help of a nuclear reactor.

iv. Geothermal Energy: This refers to the energy available from natural underground reservoirs of steam and hot water. On the other hand, Sharm (2009) groups energy sources into conventional and nonconventional energy sources.

v. Conventional Energy Sources: These are energy sources that have been explored, exploited and have been put to use maximally for the satisfaction of human needs. They are the common and popular sources of energy resources used by nations to drive their economy. Examples are the wood fuel (firewood), coal, petroleum oil, and water and nuclear energy sources.

vi. Non-Conventional Energy Sources: These are energy sources that are new and have not been harnessed and developed by nations to drive their economy. The reason behind the exploration and development of these sources of energy is to conserve the fast-declining nonrenewable energy resources which are also major sources of environmental degradation. They are pollution-free, environmentally-clean and socially relevant. They include among others: urban wastes, agricultural wastes, animal and human wastes, sun, wind, tide and geothermal sources.

2.1.3 Types of Energy Resources

A resource is any material which can be transformed in a way that it becomes more valuable and useful for the satisfaction of human needs (Sharma, 2009). According to him, energy resources are categorized into renewable and non-renewable resources.

i. Renewable Energy Resources are energy resources that are available in unlimited amount in nature. They can reproduce themselves in nature over relatively short period of time and can be harvested continuously through a sustained proper planning and management. They include wood fuel (firewood), animal dung, solar energy, wind energy, water energy, geothermal energy etc.

ii. Non-Renewable Energy Resources are energy resources that are available in limited amount in nature and develop over a long period of time. As a result of their limited nature, they are likely to be exhausted one day. These include coal, crude oil, natural gas, nuclear power etc. Coal, crude oil, natural gas, the common energy resources being organic (biotic) in their origin are also called fossil fuels.

2.2 CONCEPT OFHOUSEHOLD

According to National Population Commission (2006), household consist of a person or group of persons living together usually under the same roof or in the same building/compound, who share the same sources of food and recognize themselves as a social unit with household head. In another dimension, Isaac and Ephraim (2004) defined a household as a person or a group of persons, related or unrelated, who live together in the same dwelling unit, who make common provisions for food and regularly take their food from the same pot or share the same grain store, or who pool their income for the purpose of purchasing food. Therefore, both the above meaning of household has co-residence in common, a pooling of income and resources, the sharing of expenditure (which included joint provision of the necessity of living like food) and finally, the existence of family or emotional ties. (Dabo, 2015)

2.3 DETERMINANTS OF HOUSEHOLD FUEL CHOICE AND ADOPTION

It has been found that as household's income increases, households not only increase their consumption of their fuel choice, but they also use multiple fuels. Most empirical studies have found contradicting results for this. In Ethiopia for instance, the income effect dominates so that households consume more of all energy sources as budgets grow (Kabede et al., 2002).

Barnes and Quian (1992),using the actual survey of Urban household energy consumption in developing countries, found that as income increases wood fuel does not disappear completely as households continue to increase its use thus reflecting the utility of these fuels in urban households. Increasing levels of income tends to result in decrease in the share of biomass in total energy consumption (Wayuan et al., 2008).

The World Bank explains using the Guatamala household survey to explain the relationship between household size and fuel use. Using the logit and multinomial logit regressions, the results found a positive relationship (World Bank 2003).Meconnen and Kohlin found similar results in Ethiopia where households with more members were more likely to use charcoal and firewood and less likely to use kerosene.

Pundo and Freser (2003) analyzed the data from Kisumu, Kenya using multi-nomial logit model and they found that the level of education improves knowledge of fuel attributes, tastes and preferences for better fuels. Opportunity cost of time becomes an aspect of concern with regard to household participation on various activities. According to them, a highly educated woman is likely to lack time to collect firewood and may opt for firewood alternatives. Wayuan et al.

(2003) explains that when resident's education level is higher, they use less biomass or more commercial fuels because the opportunity cost of biomass collection is increasing.

Several studies attest to the fact that household age is a key in making decisions on household energy choices. Pundo and Freser (2003) note that a woman's age influences fuel choice through loyalty to firewood so that the older the woman (when all factors are held constant),the more likely the household will continue using firewood. This has been found to be true by Mekonnen and Kohlin (2008) in Ethiopia. They demonstrated that older household heads prefer the use of solid fuels while non-solid fuels are more likely to be adopted by the younger household heads.

Preference of a given type of fuel is another factor. This preference can be associated with a stronger attachment to indigenous culture and traditional cooking. Attitude of people influences the choice of household fuel in that some people believe that some fuels are faster than the others which is true of course, some fuels such as the food cooked using charcoal has a tasty flavor (Israel, 2002) and that some fuels are dirty to use and have low efficiency.

The type of dwelling unit and the house ownership has been identified by Pandu and Fraser (2003) to be another important factor affecting household fuel switch. They argue that if a household owns the main dwelling unit, it is more likely to use occupancy rules. If a dwelling unit is a permanent house, the household is likely to use firewood alternatives that do not stain the walls and the roofs of the unit.

In most empirical studies accessibility to electricity as one of the factors has been omitted. The World Bank (2003) found out that for the households that were connected to electricity grid tended to use less wood fuel. These studies also explain that electricity access triggers fuel use to LPG and adoption of cleaner energies such as solar and biogas. They further argue that access to electricity is associated with a higher probability of using LPG and a lesser likelihood of firewood usage.

Results from Albebaw (2007) show that housing expenditure is higher for those who are non-home owners and this limits households from switching to cleaner fuels as hypothesized by the energy ladder model.

2.4 CONCEPT OF ADOPTION OF INNOVATION- DECISION

According to Rogers (2003), adoption is a decision of "full use of an innovation as the best course of action available" and rejection is a decision "not to adopt an innovation". He also defines diffusion as "the process in which an innovation is communicated through certain channels over time among the members of a social system".

a. Adopter Categories

Rogers (2003) defined the adopter categories as "the classifications of members of a social system on the basis of innovativeness". This classification includes: *innovators, early adopters, early majority, late majority, and laggards.* In each adopter category, individuals are similar in terms of their innovativeness: "Innovativeness is the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a system" (Rogers, 2003,). For Rogers, innovativeness helped in understanding the desired and main behavior in the innovation-decision process. Therefore, the categorization of adopters is based on innovativeness.

Below is a diagram that shows the adopters category as Figure 2.1

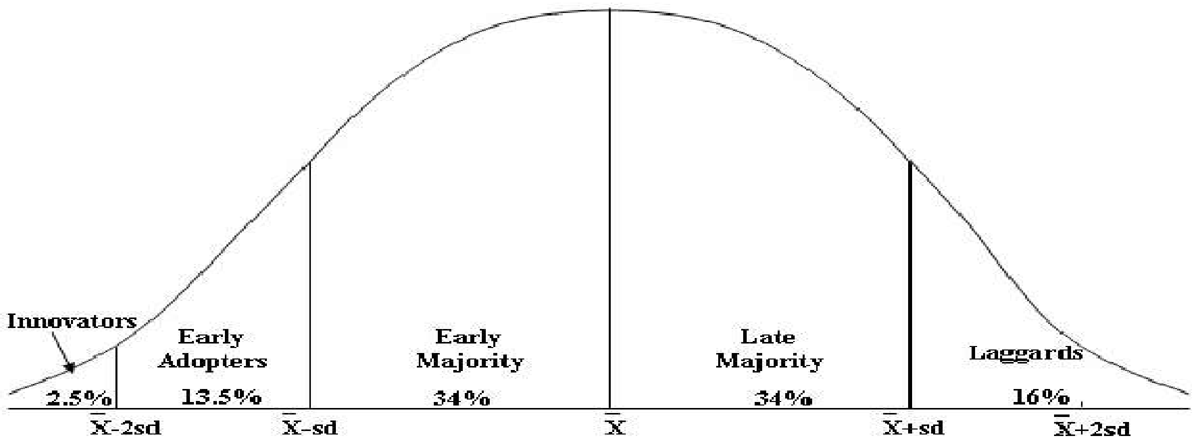


Figure 2.1 Adopter Categorization on the Basis of Innovativeness   Source: Adapted from SAHIN 2006.

i. Innovators

For Rogers (2003), innovators were willing to experience new ideas. Thus, they prepared to cope with unprofitable and unsuccessful innovations, and a certain level of uncertainty about the innovation.

ii. Early Adopters

On the other hand, early adopter according to Rogers (2003) argued that they are more likely to hold leadership roles in the social system, other members come to them to get advice or information about the innovation. Therefore, Early adopters' leadership in adopting the innovation decreases uncertainty about the innovation in the diffusion process. Furthermore, "early adopters put their stamp of approval on a new idea by adopting it" (Rogers, 2003,).

iii. Early Majority

Rogers (2003) stated that the early majority are deliberate in adopting an innovation and they are neither the first nor the last to adopt it. Thus, their innovation decision usually takes more time than it takes innovators and early adopters.

iv. Late Majority

Similar to the early majority, the late majority includes one-third of all members of the social system who wait until most of their peers adopt the innovation. Although they are skeptical about the innovation and its outcomes, economic necessity and peer pressure may lead them to the adoption of the innovation. To reduce the uncertainty of the innovation, interpersonal networks of close peers should persuade the late majority to adopt it. Then, “the late majority feels that it is safe to adopt” (Rogers, 2003,).

v. Laggards

As Rogers (2003) stated, laggards have the traditional view and they are more skeptical about innovations and change agents than the late majority. In facts they are conservatives, as the most localized group of the social system, their interpersonal networks mainly consist of other members of the social system from the same category. Moreover, they do not have a leadership role. Because of the limited resources and the lack of awareness-knowledge of innovations, they first want to make sure that an innovation works before they adopt. Thus, laggards tend to decide after looking at whether the innovation is successfully adopted by other members of the social system in the past.

2.4.1 Innovation- Decision Process of Adoption

Innovation-decision process according to Rogers (2003) described as “an information-seeking and information-processing activity, where by an individual is motivated to reduce uncertainty about the advantages and disadvantages of an innovation". For Rogers (2003), the innovation-decision process involves five steps:

(1) Knowledge, (2) persuasion, (3) decision, (4) implementation, and (5) confirmation.

Below is a diagram that shows the processes as in Figure 2.2

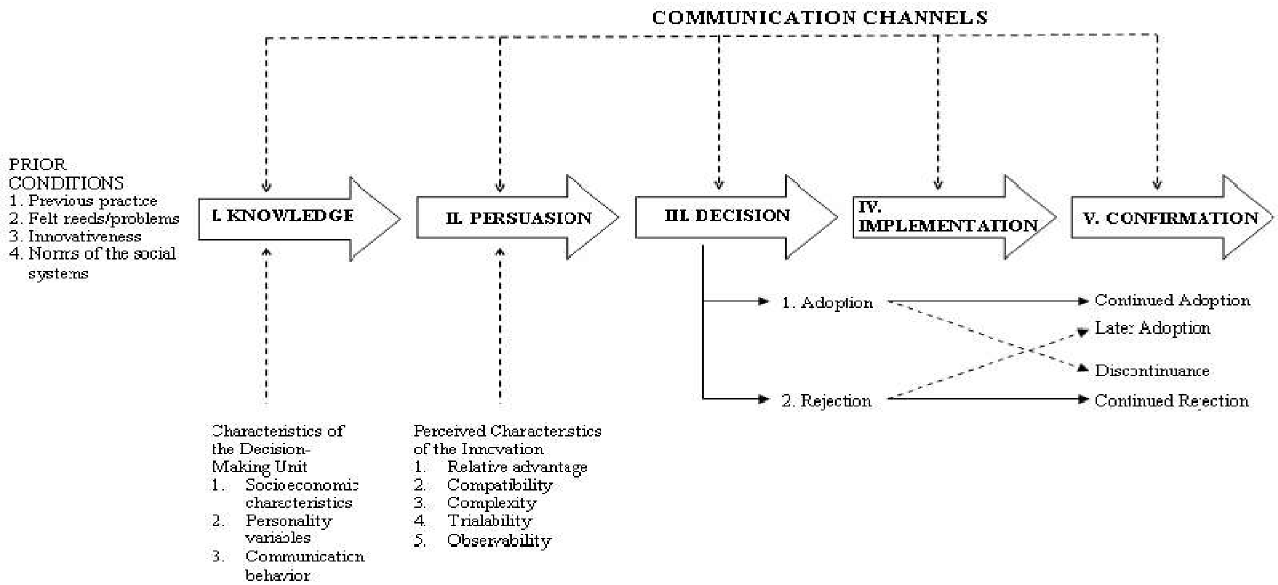


Figure 2.2 a Model of Five Stages in the Innovation-Decision Process

Source: Adapted from SAHIN 2006.

2.5 LIQUEFIED PETROLEUM GAS

Liquefied Petroleum Gas consists of hydrocarbons that are gaseous at normal atmospheric pressure, which can be condensed to the liquid state at normal temperature, by the application of moderate pressure. LPG is derived from two sources: from the processing of natural gas streams produced either alone or in association with crude oil, and from crude oil refining. Worldwide, natural gas processing currently accounts for roughly 60% of total marketed LPG supply and crude oil refining for the remaining 40% (World Bank and World Liquefied Petroleum Gas Association (WB and WLPGA), 2002).

LPG is produced from straight distillation which consists of “saturated” hydrocarbons, i.e. propane and butane, whereas LPG produced by both cracking and reforming processes has, in addition to hydrocarbons, some quantities of unsaturated hydrocarbons also (i.e. propylene and butylene). There is also moisture and some impurities (such as sulphur compounds) that -are removed by suitable treatment at the refinery. (Cheresources, 2002)

LPG burns cleanly, producing no particulate matter, with low emissions of CO, unburned hydrocarbons and NO_x, and less CO_2 than most other fossil fuels and less than unsustainable biomass. The exact composition of LPG can vary but it usually consists predominantly of propane (C3H8) and butane (C4H10), with a small proportion of propylene (C3H6) and butylene (C4H8). Commercial LPG also contains traces of lighter hydrocarbons like ethane (C2H6) and ethylene (C2H4) and heavier hydrocarbons like pentane (C5H12). (Cheresources, 2002)

Normally used as gas, LPG is stored and transported as liquid under pressure for convenience and ease of handling; liquid LPG evaporates to produce about 270 times its volume of gas. This facilitates storage and transportation in relatively small containers. In addition, unlike traditional fuels and other liquid fuels, LPG has an indefinite shelf life, not deteriorating over time.

(Cheresources, 2002)

LPG at about 45.5GJ/tonne, has a higher energy content than the fuels currently in use for cooking – kerosene (43.2 GJ/tonne), wood fuel (about 15 GJ/tonne), crop residues (13 – 14 GJ/tonne) and dung (12.5 – 13 GJ/tonne). In addition, the higher efficiency of LPG stoves (about 65%) as compared with traditional stoves (about15%) and even “improved” models of biomass-based stoves (up to 45%), makes the relative efficiency considerable.

2.6 THEORETICAL REVIEW

There are several numbers of theories that have been used in attempts to explain domestic fuel choice and utilization. One of such theories that have been used extensively in studying household energy choice is the 'energy ladder model'. Therefore, theoretical review of literature as reviewed by other authors will be presented below and also fuel stacking model as an alternative model will be adopted considering the nature of developing countries and due to the observed weaknesses of the energy ladder.

2.6.1 Energy Ladder Theory

The energy ladder model classifies household fuels into three groups: traditional, transition and advanced fuels. The model assumes that low-income households would use the traditional fuels until their socio-economic status improves and then they will rationally switch completely to the transition fuels. According to this theory, a further increase in household income will then lead to another rational transition to the advanced fuels (Barnes *et al.,* (2005),). In other words, the energy ladder model attributes household fuel choice and transition to only income.

It assumes that households will ascend the imaginary ladder in a somewhat linear progression pattern, by switching completely to higher level fuels as their income improved (Farsi et al., (2007).

The energy ladder, as also called as Fuel-Ladder by Veer and Enevoldsen (1993), illustrates the general point of 'upward shifting' of consumer's preferences for more convenient sources/devices of energy. As found by them, most of the energy policies focus, almost exclusively on the possibilities to influence the transition at, or towards the top of the ladder, and more for the urban users, than the rural.

The energy ladder model describes a pattern of fuel substitution as a household's economic situation changes (Hosier *et al*., 1987). The model was developed based on the correlation between income and up take of modern fuels (e.g. electricity). The energy preference ladder ranks fuels-modern fuels such as electricity and LPG are considered superior fuels due to their high efficiency, cleanliness and convenience of storage and usage and are located higher up the ladder than traditional fuels, or inferior fuels (Leach, 1992).

According to the concept of energy ladder, households switch from traditional energy systems to modern energy systems up the ladder at the speed and extent allowed by factors such as household income, fuel and equipment costs, availability and accessibility of fuels, reliability of modern fuel distribution, and, to a lesser extent, relative fuel prices(Masera et al.,2000).

The energy ladder concept relies on the micro economic theory of rational choice. It assumes that all forms of fuel (traditional and modern) are available, that there is a universal set of fuel preferences, and that households will choose to move up the ladder as soon as they can afford to do so. The major achievement of the energy ladder is its ability to capture the strong income dependency of energy choice in households, particularly in urban areas. However, the energy ladder concept assumes a linear progression of fuel adoption that implies moving up the ladder means a corresponding abandonment of the lower level fuels. This assumption is inconsistent with the findings from field research (Barnes and Douglas, 1992; Heltberg, 2004; Hosier *et al*, 1987; Masera *et al.,* 2000); thus, the energy ladder concept can only provide a very limited view of reality.

The concept of energy ladder is also closely connected with urbanization (it does not mean that the rural areas are becoming urban, but source consumption patterns, fuel consumption among them, follow the urban pattern with an increase in income. The fuel or energy shifts (carrier shifts) are stimulated by an increase in monetary income mainly and also because of the availability of better and superior fuel sources locally.

This shift in many cases becomes a status symbol also in the rural areas. For example, it is only the relatively better off farmers or land - owners who go for biogas plants, as not only they can afford it, but also because it indicates an upper shift in their fuel use (usually from wood fuel).

Other factors like non-availability of agricultural wastes, cow-dung or wood fuel also make the households to go in for fuel shifts and if the shift is from these fuels, then it is always for the better fuels as these fuels (wood fuel, agricultural and animal wastes) form the bottom part of the energy ladder.

The concept of energy ladder indicates that the pattern of energy use in different households varies with their economic status and each step of the ladder corresponds to different and more sophisticated energy carrier, and the step to which the household climbs the ladder depends mainly on its income. The ladder can be from wood fuel, cow dung, agricultural wastes, to coal, kerosene, charcoal to LPG and electricity. The height of the ladder step is determined by factors like capital cost of the fuel utilizing device, price of the energy and household energy consumption. In a way, the household shifts from a fuel of lower efficiency to higher efficiency, apart from a cheaper fuel to costlier fuel, in terms of money.

The underlying assumption for the energy ladder model is that the households are faced with an array of energy supply choices which can be arranged in the order of increasing technological sophistication. At the top of the list is electricity, while the low - end of the range includes fuel wood, dung and crop wastes. As a household's economic well -being increases, it is assumed to move 'up' the energy ladder to more sophisticated energy carriers. If the economic status decreases through either a decrease in income or an increase in fuel price, the household is expected to move 'down' the energy ladder to less sophisticated energy carriers.

Below is figure showing the energy ladder model.

Figure 2.3 showing Energy Ladder Model (WHO, 2012)

2.6.2 Weakness of Energy Ladder

Energy ladder model has been criticized heavily for its lack of consideration of the intricate interactions that characterize energy transition, family differences, cultural factors, personal preferences, etc.

2.6.3 Fuel Stacking Model

Fuel stacking is the term used to describe multiple fuel use patterns (Masera et al., 2000). The simple nature of the energy ladder model, placing emphasis on wealth and substitution is criticized by a number of studies. Some studies have provided evidences that rural households do not fully ascend the 'energy ladder' but rather prefer 'fuel stacking' which means traditional fuels are not completely discarded with an increase in income, but rather are used in conjunction with modern fuels (Inayatullah et al., 2011).

The Energy stacking model suggests households adopt a portfolio of energy systems and consider a range of factors affecting the household's energy portfolio; yet, it considers income as the major determinant of fuel choice, and also relies heavily on a universal hierarchy of fuels and energy services.

Masera (2000) proposed 'fuel stacking model', the model assumed that household energy use patterns depend on several factors(not only income) which could be social, economic, cultural, or even personal preferences.

Causes of fuel stacking include: keeping traditional energy systems as an insurance against modern energy supplier failure (ESMAP, 1999); decreasing vulnerability to modern energy price fluctuations by diversifying energy use (e.g. use electricity for lighting and wood fuel for cooking) (Leach, 1992; Thom and Cecile, 2000); inapplicability of alternative energy systems to cooking methods and preferences (ESMAP, 2003; Masera *et al*., 2000); high costs associated with using modern energy sources (e.g. electrical wiring and LPG containers) preventing people from fully adopting such energy systems (Davis and Mark, 1998); not having capital available to purchase modern energy conversion technologies (Elias *et al.*, 2005).

The energy ladder and fuel stacking models are different with regards to how energy sources are adopted, yet they both assume the existence of hierarchies in household energy services (IEA, 2002). Cooking and heating are the first services to be met, followed by lighting and later entertainment. Based on this hierarchy, using electricity for services other than lighting only happens after core demands are met. However, studies show that the household energy transition is not a step-like progress; Households often use, if available, higher ranked energy carriers (e.g. electricity) even in small quantity while satisfying their bulk of demand by lower ranked fuels (Victor, 2002).

2.7LITERATURE REVIEW

2.7.1 Liquefied Petroleum Gas in Nigeria

Liquefied Petroleum Gas (LPG or LP Gas) in Nigeria is a long-established, well-accepted, but minor component of energy supply. It is used principally as a cooking fuel in households and in catering. However, LP Gas is a clean, versatile fuel with a wide range of other uses in household, commercial, and industrial energy applications.

Originally, LP Gas was available only from the coastal refineries at Port Harcourt and Warri. Distribution was largely restricted to Lagos and to towns close to the supply sources. The opening of a third refinery in Kaduna created a source of LP Gas for northern states and the possibility of wider availability. To date, the "midstream" oil and gas sector (for example, gas processing) has not developed as a source of LP Gas supply for the domestic market. (Nigeria Liquefied Natural Gas (NLNG, 2011).

Initially, LP Gas distribution was handled only by those oil marketing companies with retail operations in the country. However, they were soon joined by a small group of "independents," that is, companies whose sole business was the marketing of LP Gas and the appliances and equipment associated with its use. All the marketers—oil companies and independents—purchased and maintained their own LP Gas cylinders which they branded and to which they fitted their distinctive valve. Consumers were given the use of cylinder (usually in exchange for cash deposit) which was refilled by the marketer on a full- for-empty basis. The distinctive valve and ownership of cylinders effectively discouraged consumers from changing suppliers. That system required that the marketer invest in "circulating" cylinders to support those being used by consumers, and thus maintain the supply chain. The marketer accepted the obligation to maintain the cylinders and had the opportunity to do so when they were returned to him for refilling. The cost was recovered through the margin on the LP Gas. Market penetration was low, partly because the initial cost (cooker, cylinder deposit, and LP Gas fill) was beyond the means of the majority of householders. (Nigeria Liquefied Natural Gas (NLNG, 2011).

In the 1980s there was growing awareness of social and environmental problems associated with the dependence on wood fuel, especially in the northern states. Given the popularity of LP Gas with those Nigerian households that had access to it, the potential for domestic LP Gas production and its widespread international use in rural energization, the government initiated a "butanization" program and authorized NNPC to construct a network of strategic depots for the primary distribution of LP Gas. An NNPC subsidiary, PPMC, already operated depots for the primary distribution of "white"petroleum products. The name “butanization” was borrowed from an earlier, and highly successful, LP Gas utilization project in Senegal. (Nigeria Liquefied Natural Gas (NLNG, 2011).

Nine butanization depots were constructed at strategic locations throughout Nigeria (at Lagos, Calabar, Enugu, Ibadan, Ilorin, Makurdi, Kano, Gombe, and Gusau). All but one—Apapa, Lagos—were situated alongside existing white products depots and (in common with them) were to be supplied from the refineries at Kaduna, Warri, and PortHarcourt. A Merox unit was added at Kaduna to enhance the output of LP Gas. However, while the white products are supplied to the depots by pipeline, road transportation was judged to be the practical mode for LP Gas supply to the inland butanization depots. There was an established coastal movement of LP Gas from the refineries to the marketers' storage terminals in Lagos port and the butanization depots at Calabar and Lagos were to be similarly supplied. (Nigeria Liquefied Natural Gas (NLNG, 2011).

The commissioning of the butanization depots, in the mid-1990s coincided with successive shutdowns at the NNPC refineries, which, in turn, led to large-scale importation of refined products for the domestic market. These problems are ongoing and are the principal reason that the butanization program has stalled. Only the two coastal depots—Calabar and Lagos—were brought into operation and, of these, Calabar has had very little throughput. Matters were not helped by the failure of PPMC to conclude satisfactory arrangements for LP Gas transportation to the inland depots partly because of supply inadequacies. Supply to Calabar and Lagos was hampered by congested ports and by the consistently low priority given to LP Gas ships on the loading/discharging berths.(Nigeria Liquefied Natural Gas (NLNG, 2011).

In 2000, PPMC relinquished the sole right to import LP Gas for the domestic market, thus giving marketers the opportunity to import. Simultaneously, restrictions were placed on the use of their private berthing facilities. In effect, the limited scale of the import facilities, along with the added costs and price manipulation at the retail level have made LP Gas prohibitively expensive for the majority of consumers.

Nigeria happens to be a net exporter of LPG in Africa, producing over 2 MTPA, consumes barely15% of the volumes & exporting the rest. LP Gas is the least utilized of the four major cooking fuels – Wood fuel, Kerosene, Charcoal, and Gas. Per capita consumption is just above 1kg in Nigeria which is comparatively less than other West African countries like Ghana(4.7kg) and Senegal (9kg) per capita(WLPGA).Nigeria spends over $1bn p.a. on kerosene subsidy and faces increasing environmental challenges with continuous deforestation as over 50% of households still rely on wood fuel as cooking fuel.(WB and WLPGA), 2002).

2.7.2 Liquefied Petroleum Gas (LPG) and its Socioeconomic Benefits

The use of LPG and more efficient devices can free women's time for productive endeavors, education, childcare and relaxation. Because it is clean, safe and very efficient in generating heat, the use of LPG will contribute to better quality of household life. Thus, of all the modern fuels available today, LPG is particularly well suited to domestic cooking and heating because of the following advantages:

i. **Cleanliness**: LPG burns efficiently, without producing smoke and with low pollutant emissions. These qualities reduce indoor pollution and therefore, LPG could be a major contribution to a better health of women and children.

ii. **Portability**: It is easily liquefied and stored in pressured containers. These properties make LPG portable, and hence, it can be easily transported in cylinders to end users.

iii. **Safety**: It is safer to use because of the packaging and less susceptible to adulteration as is the case of kerosene which has caused many explosions and deaths in the past.

iv. **Efficiency**: LPG is extremely efficient in generating heat, and therefore a major step up on the energy quality ladder.

v. **Environment friendly**: From an environmental point of view, LPG emits much less CO2 (a greenhouse gas and the primary source of global warming potential) per meal when burned than wood fuel and other traditional fuels. By reducing demand for wood, switching to LPG can reduce deforestation. Relative to most other non-renewable fuels, LPG produces low emissions of CO, HC and oxides of nitrogen (NOx), which are the principal precursors of ozone. Maduka (2011).

Table 2.1Overview of the Challenges of LPG utilization

Challenges	Characteristics
1. Regulation	• The absence of regulation leads to security risks and black markets • Lacking regulations discourage potential investors • Fraud may occur during refilling
2. Availability	• Storage capacities are insufficient to compensate demand fluctuations • Filling stations may not be available or have lacking capacities • Supply routes are not developed - the private sector is unlikely to develop LPG-access in remote areas • Dependence on LPG imports • Low availability of small systems and system components such as cylinders, connection hoses, regulators and cooking stoves
3. Affordability	• High initial costs compared to other fuels • High running costs esp. in remote areas • Low-income households have low disposable income - refill costs are high and at once
4. Awareness	• Health and environmental benefits of LPG are sometimes not known • Insecurity regarding price development of LPG • LPG can be dangerous - improper use and lack of maintenance of LPG cylinders leads to accidents • Sometimes bad reputation of LPG due to improper refilling of LPG cylinders
5. Supply security	• Fossil fuel derivative therefore limited availability of LPG • Increasing demand of LPG from different sectors will lead to conflicts in the middle- and long-term • Increased use may lead to the proliferation of unconventional sources

Source: energypedia.info/wiki/Liquefied_Petroleum_Gas_LPG (2014)

2.7.3 Empirical Review on domestic Cooking Fuel Adoption and Utilization

Pundo & Fraser (2006) in a study on the analysis of household cooking fuel choice in rural Kenya: The case of Kisumu District uses multinomial logit model to investigate the factors that determine household cooking fuel choice between wood fuel, charcoal, and kerosene. Variables captured are: age of respondent, household sizes, occupation of the household head and category of food cooked by household, level of education of husband and wife, whether or not the household own the dwelling unit and the nature of the dwelling unit. Empirical results indicate that level of education of husband and wife, type of food mostly cooked, whether or not the household owns the dwelling unit, and whether or not the dwelling unit is traditional or modern type are important factors that determine household cooking fuel choice.

Another empirical work reviewed in this study is the work of Njong and Johannes (2011) titled "An Analysis of Domestic Cooking Energy Choices in Cameroon". The study attempts to cast light on the distribution of households by cooking energy types and by region or zone of residence and investigate the main determinants of cooking energy choices in Cameroon. The study employs a multinomial logit model to test the statistical significance of the social and demographic factors that determine household cooking fuel choice in the country. Variables captured are: household size, occupation status, nature of the dwelling houses (proxy by wall materials), education, ownership of the dwelling house, and the distance of household from urban centre. Empirical results indicate that the level of education, distance of the household from urban centres, whether or not the household owns the dwelling unit and whether or not the dwelling unit is traditional or modern type are important factors that determine household cooking energy choice. The study also reveals that wood fuel is the principal cooking fuel for the majority of households in Cameroon. Boukary (2006) examines household energy preferences for cooking in urban Ouagadougou, Burkina Faso. Descriptive statistics and multinomial logit model were employed for the analysis. The descriptive analysis shows that the domestic demand for wood energy is strongly related to household income. The wood fuel utilization rate decrease with increasing household income. In other words, this fuel appears as a "transition good" for the households which aim for other sources of energy for cooking that are more adapted for urban consumption. The multinomial model analyses the sociological and economic variables of household energy preferences for cooking in Ouagadougou. The analysis shows that household energy preferences for cooking are determined by household size, income and high frequency of cooking certain meals.

Mekonnen and Kohlin (2008) is another empirical work titled "Determinants of Household Fuel Choice in major Cities in Ethiopia". The study looks at the fuel choice of urban household in major Ethiopian cities, using panel data collected in 2004 and 2006. It examines use of multiple fuels by households in some details. The determinants of household choice of energy consumption were investigated using multinomial logit model. Variables captured are: household total expenditure on energy, family size, level of education, age of household head and household location. The results suggest that as households' total expenditures rise, they increase the number of fuels used, even in urban areas and they also spend more on the fuels they consume. This study shows the relevance of fuels stacking (multiple fuel use) in urban areas in sub-Saharan Africa. While income is an important variable, the results of this study find other variables such as family size, household location and level of education as important determinants of household fuel choice in Ethiopia.

Bello (2010) is one of the empirical works in Nigeria titled "Impact of Wealth Distribution on Energy Consumption in Nigeria: A case of selected households in Gombe State". The study uses multinomial logit model to analyse the determinants of household choice of energy used for cooking. Income, size of household, price of stove or cooker, head of household level of education and house wife level of education are variables captured. Empirical results reveal that the choice of cooking energy is mainly determined by income, size of household, and level of education.

Arowosoge & Faleyimu (2011) is another empirical work that investigated household energy utilized for cooking and its determinants in Ado-Ekiti metropolitan area of Ekiti State. Simple descriptive statistics and chi-square test were employed for the analysis. The chi-square results established a significant relationship between income of household and the type of energy used for cooking.

Onyekuru and Eboh (2011) investigated the determinants of cooking energy demand in the rural households of Enugu State. Bivariate probit model was employed for the analysis. Wood Fuel and kerosene were the two different cooking fuel options available to the households. Occupation, family size, level of education and income are the variables captured. Empirical results show that occupation and income were the statistically significant factors affecting the choice of cooking energy demand.

Adetunji *et al.,* (2007) examined household energy consumption patterns in Osogbo Local Government Area of Osun State. Ordinary least square regression was employed to analyse the data obtained. Age, level of education, occupation, income and household size are variables captured. The regression results indicated that income and household sizes are the significant factors determining household choice of energy consumption while age, level of education and occupation of household are insignificant.

Okunade (2010) is another empirical work titled“charcoal as an alternative energy source among urban households in Ogbomoso Metropolis of Oyo State, Nigeria”. The study examined the type of energy sources available and the factors that determine their use. Ninety women were randomly selected from the household chosen. Simple descriptive statistics and ordinary least square regression were employed for the analysis. Variables captured are; age, level of education, occupation, income and household size. The regression result reveals that age, occupation, level of education and household size are the significant factors affecting household choice of energy used for cooking while income is insignificant.

Shittu *et al.,* (2004) examined the demand for energy among households in Ijebu Division, Ogun State, Nigeria. Primary data were obtained in a cross-section survey of ninety households selected across six communities in Ijebu-Division of Ogun State. Variables captured are; age, level of education, income and household size. Linear logit model was employed for the analyses. Empirical results indicated that the influence of education and household size on household energy used were insignificant, while income and age of household heads revealed significant influence. The study concluded that improvement in income would cause increase in demand for wood fuel alternatives. In synopsis, there are diverse results that characterized the above empirical works and none of these studies have investigated the challenges of adoption of cooking gas as an alternative domestic fuel for household’s utilization. This distinguished this study and makes it unique.

CHAPTER THREE

RESEARCH METHODS

3.1 INTRODUCTION

In this chapter, the procedures used in conducting the study are presented. They include reconnaissance survey, research design, target population, sample and sampling procedures, research instruments, data collection and data analysis procedures.

3.2 RECONNAISSANCE SURVEY

Reconnaissance survey was conducted for familiarization with the study area locations and whether the area is planned or unplanned. The survey assisted in the administration of the questionnaires to the selected sample locations in the study area for easier identification.

3.3 RESEARCH DESIGN

Descriptive survey research design method is used for this study. Descriptive survey research design method is adopted for this study due to the fact that the data (information) is gathered on the determinants of adoption of cooking gas as domestic fuel in Kano metropolis and employs structure questionnaire in order to determine the opinions, attitudes, preferences, and perceptions of persons of interest to the researcher.

3.4 STUDY POPULATION

The population for this study is the metropolitan Kano which comprises of eight Local Government Councils, namely:Tarauni, Fagge, Nassarawa, Gwale, Dala, Kano municipal, Ungogo and Kumbotso. Based on the figure of National Population Commission 2006, Kano metropolis has a total population of 2,828,861 (2006, National Population Commission) While 2018 estimate of the metropolitan population is projected to be about 4,331,790(NPC Kano Office, 2018). The sampling design employed for the study is a multi stage cluster design. In the first stage cluster samples would be taken on the basis of EAs (Enumeration Areas) from the 2006 EA census frame. A list of the Enumeration Areas and Enumeration Area maps is used from the National Population Commission Kano office. Each local government is divided into smaller administration units (Localities) from which three localities are randomly sampled for each of the local governments. One EA is randomly sampled from each of the three localities. Size of households sampled from each EA is determined after estimating the Sample Size (of households) to be taken for each LGA using the Sample Size Calculator by Steely Yamane formula, proportionate to the population of each local government area. A total of 400 households is used as sample size from the eight local governments by use of proportional sampling technique at 95% confidence level and 5% margin of error (Table3.1).

Table 3.1 Number of Sample Size (Households) in the Study Area

S/N	**STUDY LOCALITIES**	**1991 Census**	**Population 2006**	**Projected population 2018**	**Estimated no. of Households =popn/5**	**No. of Sampled size (households) {X/YxN}**
1	Tarauni	135,846	221,367	334,515	44,273	31
2	Fagge	156,342	198,828	246,021	39,766	28
3	Nassarawa	355,729	596,669	919,351	119,334	84
4	Gwale	177,437	362,059	643,829	72,412	51
5	Dala	316,137	418,777	529,910	83,755	59
6	KMC	270,764	365,525	483,547	73,105	52
7	Ungogo	168,373	369,657	700,305	73,931	53
8	Kumbotso	166,558	295,979	474,312	59,196	42
	TOTAL	**1,747,186**	**2,828,861**	**4,331,790**	**565,772**	**400**

Source: Derived from National Population Commission of Nigeria (website, 2018)

3.5 SAMPLE AND SAMPLING TECHNIQUE

Sample Size

The population sample for the study area is determine by use of Yamani's (1964) formula to calculate the sample size (grids) which will assist in determining the proportion of the respondents for questionnaire distribution as given below:

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

Where, n = Sample size e = error estimate

N = Population (Households') size 1 = Constant

The multistage sampling technique is used to select the sample size and affect the process of administration and collection of the questionnaire. The research work also adopted methods used by (Cline-Cole et al (1990) in Kiyawa 2016) in stratifying the study area into various residential zones on the basis of socioeconomic status and residential density. After the process of sample size selection using multistage sampling technique, a number of 24 localities were randomly selected (table3.2); the selected localities were reclassified into clusters division based on population density and socioeconomic status for easy comparison amongst the different localities selected. These are:

i. High density planned areas
ii. High density unplanned areas
iii. Medium density planned areas
iv. Medium density unplanned areas
v. Low density planned areas
vi. Low density unplanned areas

The instrument of data collection is structured questionnaire and interview. The total estimated figure of the sampling area for this study as stated above is 2,828,861.Thus, the sample size is400, as explained by Krejcie and Morgan, (1970) and also research advisor 2006 who recommended that for populations sizes of between 2,500,000 and 300,000,000 million a sample size of 384 should be taken.

Multistage sampling procedure is used to select the sample size for the study. Njodi and Bwala (2004) explained that multi-stage sampling procedure is carried out in phases and usually involves more than one sampling method. Therefore, the stages for sampling selection for the study are as follows:

Stage I: Firstly, the local governments are stratified geographically, using the geographical stratification given by the National Population Commission (2006) viz: Tarauni, Fagge, Nassarawa, Gwale, Dala, Kano Municipal, Ungogo and Kumbotso.

Stage II: Simple random sampling was used to select three localities from each of the LGAs from each stratum. The procedure is as follows: the researcher used pieces of paper and wrote the names of all LGAs that made up the metropolitan Kano; the papers were folded, placed in a container mixed and shaken vigorously. The researcher asked one of the research assistants to pick three (3) of the folded papers one after another to represent three localities sampled from each stratum. The same procedure applied for the selection of the sampled localities of all the LGAs from the remaining seven (7) strata respectively.

Stage III: Simple random sampling was used also to select one Enumeration Area from each of the three localities, thus, three Enumeration Areas were selected from three localities of each LGAs within the Metropolis.

Stage IV: Proportional sampling technique here was used to determine the sample size to be taken from each of the LGAs population from the stratum by adopting Yamani's formula (1964) for calculation of sample size. For example, population of the study multiply by the estimated sample size for the study which is 400 divided by (2,828,861) the total population of study area.

Stage V: Purposive sampling technique is adopted to select the required respondents from each stratum for ease of administration and collection of the administered research instrument. The research questions were used to draft the questions in the instrument in order to keep the content and focus of the research in view. The research instrument designed for this study is subjected to both face and content validity.

Stage IV: Finally, the selected sampled localities from each local government within the metropolis were reclassified into clusters division based on population density and socioeconomic status as stated above for comparison amongst the study localities to see the differences in terms of the factors determining the adoption of cooking gas and the challenges of adoption of cooking gas.

TABLE 3.2: SELECTED L.G LOCALITIES AND THEIR ESTIMATED POPULATION OF KANO METROPOLIS BASED ON 2006 POPULATION CENSUS

S/N	LOCALITY	E.A CODE	ESTIMATED POPULATION OF E.A WITHIN THE LOCALITY	NUMBER OF SAMPLE QUESTIONNAIRES
		FAGGE L.G.A		
1.	FAGGE C.	0208	538	10
2.	RIJIYAR LEMO C/GARI	1244	466	9
3.	SABON GARI EAST	1840	481	9
			Total	**28**
		KANO MUNICIPAL L.G.A		
1.	SHARADA C/GARI	0156	496	17
2.	KURAWA	1648	496	17
3.	KOKI	2090	516	18
			Total	**52**
		GWALE L.G.A		
1.	SANI MAINAGGE	0366	412	15
2.	DORAYI KARAMA	1536	482	18
3.	GADON KAYA	1094	471	18
			Total	**51**
		DALA L.G.A		
1.	GWAMMAJA	0462	492	20
2.	AYAGI	1138	483	20
3.	YELWA	1450	480	19
			Total	**59**
		KUMBOTSO L.G.A		
1.	DANBARE	1704	432	14
2.	PANSHEKARA	1536	441	14
3.	DANLADI NASIDI	0360	416	14
			Total	**42**
		TARAUNI LG.A		
1.	KUNDILA	0208	378	9
2.	DAN MARKE	0666	462	10
3.	KARKASARA	1672	534	12
			Total	**31**
		UNGOGO LG.A		
1.	UNGOGO C/GARI	1200	496	18
2.	BACHIRAWA	1314	510	18
3.	RIJIYAR ZAKI	2266	455	17
			Total	**53**
		NASSARAWA LG.A		
1.	HOTORO AREWA	0312	405	25
2.	DAKATA	2862	468	29
3.	GAMA	4056	491	30
			Total	**84**

Source: Derived from National Population Commission, 2006 Census

3.6 DATA COLLECTION INSTRUMENTS

The instruments of the study are the questionnaire and interviews. The questionnaire is in appendix 1 which is meant to collect quantitative information while the interviews are meant to measure the qualitative data. The two instruments can supplement one another and can serve as triangulation method where errors and mistakes can be detected and corrected.

The instrument for data collection in this study is the researchers developed questionnaire named ‟ Determinants of Adoption of cooking gas as domestic fuel in Kano metropolis”. The questionnaire comprises of three(3) sections; section ‘‘A” contained items on demographic information of the respondents, section ‘‘B” contained items on determinants factors influencing adoption of LPG, while section ‘C’ contained items on the challenges of adoption of LPG as domestic fuel and measures to enable more households to shift away from solid fuels to LPG.

Moreover, interview would be conducted with the following categories of individuals that are directly or indirectly linked to liquefied petroleum gas (LPG):

- Gas sellers
- Commercial users (i.e. Restaurants, Gas meat sellers, etc)

3.7 METHOD OF DATA ANALYSIS

Simple frequency counts and percentage were used to describe and organize the personal information of the respondents and the demographic characteristics. Chi-square test was also chosen for the analysis as it tests for relationship between categorical data (field, 2009). The responses from the respondents in the questionnaires were tabulated, coded and processed by use of Microsoft Excel and exported to Computer Statistical Package for Social Sciences (SPSS V

20) for the analysis. The responses from the open-ended questions were listed to obtain proportions appropriately; the response was then reported by descriptive narrative.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter presents and discusses the results obtained from the field. The chapter contains four sections: the socio-economic characteristics of the respondents, factors determining the adoption of cooking gas, other energy sources and reasons for wood fuel preference over cleaner energy sources, challenges associated with the adoption of cooking gas and measures to increase adoption of cooking gas by households over solid fuels. It also presents the key findings of the research in accordance with the objectives and research questions.

4.2 SOCIO-ECONOMIC CHARACTERISTICS OF THE RESPONDENTS

This section presents the socio-demographic and economic characteristics of the respondents which include: Age distribution, level of education, gender, marital status, family size, level of income and occupation.

Table 4.1.: Age Distribution of the Respondents

Age	Frequency	Percentage %
21 – 40 years	247	62.7
41 – 60 years	125	31.7
61 and above years	22	5.6
Total	**394**	**100**

Source: field survey (2017)

Table 4.1 shows that the highest percentage of the respondents age category is between 21 – 40 years with (62.7 %) and responses of 247, then 41 – 60 years (31.7 %) with 125 respondents and finally 61 years and above which appears to be ageing has the lowest respondents with 22 respondents (5.6 %). This indicate that the decisions over which to adopt cooking gas as a source of domestic energy by the households are taken by adult under their active and productive years. This has an implication on the adoption of modern energy utilization due to the facts that they could change the trends of utilizing wood fuel and other sources of domestic fuel that are detrimental to environmental sustainability.

Table 4.2: Level of Education of the Respondents

Education Level	Frequency	Percentage
Informal school	23	5.8
Primary Education	6	1.5
Secondary Education	21	5.5
NCE/Diploma	75	19
Degree/HND	194	49.2
Higher Degrees	75	19
Total	**394**	**100**

Source: Field survey, 2017

Table 4.2 indicates that the majority of the respondents had their either first degree or HND. 49.2% have Degree/HND qualifications with 194 respondents. Higher degrees and NCE/Diploma qualifications had 19% each with 75 respondents each. Then the category with lowest respondent whom utilizes cooking gas as their main energy source for domestic cooking and heating are those with primary education, Secondary education and informal school with each having 1.5%, 5.3% and 5.8 % respectively. This shows that over 94 % of the respondents have average education and thus could have the knowledge of how to utilize cooking gas and its safety measures.

Table 4.3: Marital Status of the Respondents

Marital Status	Frequency	Percentage
Single	30	7.6
Married	355	90.1
Separated	3	0.8
Widowed	5	1.3
Divorced	1	0.3
Total	**394**	**100**

Source: Field survey, 2017

Table 4.3 reveals that 355 (90.1 %) of the respondents are married with spouse. 30 (7.6 %) of the respondent are single while 5 (1.3 %) of the respondent are widowed, 3 (0.8 %) are separated and 1 (0.3 %) are divorced. This shows that the majority of the respondents are matured and married.

According to table 4.4 below, the family size of 216 (54.8%) of the respondents fall within the range of 1 and 4 children. 94 (23.9 %) of the respondents family size fall within the range of 5 and 9. 23 (5.8 %) of the respondents had family size that fall within the range of 10 and 14 while 6 (1.5%) of the respondents had family size that is within the range of 15 and above. Lastly 55 (14%) have no children, probably they are newly married coupled or they are yet to get children.

The same table 4.4 also reveals that 89 (22.6 %) of the respondents falls within the income category of 20,000 and 40,000. 107 (27.2 %) of the respondents falls within the income category of 41,000 and 60,000. 53 (13.5 %) of the respondent are within the range of income 61,000 and 80,000 while 77 (19.5 %) and 68 (17.3 %) of the responses are those earnings income ranges between 81,000 – 100,000 and 101,000 and above respectively.

Table 4.4also indicates the occupation of the respondents. It shows that the respondents are mostly civil servants/ company workers, business, farmers and Artisans. 275 (69.8 %) of the respondents are civil servant, 64 (16.2 %) are farmers, 42 (10.7 %) are business/traders while 13

(3.3 %) of the respondents are artisans. Based on this, it indicates that the majority of the respondents whom utilizes cooking gas in the study area as their main domestic energy source are civil servant/ company workers with 69.8 %.

Table 4.4: Family size, Income and Occupation of the Respondents

Variables	Frequency	Percentage
House Hold Size		
0 – 4	216	54.8
5 – 9	94	23.9
10 – 14	23	5.8
15 – above	6	1.5
None	55	14
Total	**394**	**100**
Income		
20, 000 – 40, 000	89	22.6
41, 000 – 60, 000	107	27.2
61, 000 – 80, 000	53	13.5
81, 000 – 100, 000	77	19.5
101, 000 – above	68	17.3
Total	**394**	**100**
Occupation		
Farmer	64	16.2
Company Worker/ Civil Servant	275	69.8
Business	42	10.7
Artisan	13	3.3
Total	**394**	**100**

Source: Field survey, 2017

4.3: FACTORS DETERMINING THE ADOPTION OF COOKING GAS

The study observed that income and education level, family size and status, price of cooking gas (cheapness), efficiency of cooking gas, time savings for cooking and less pollutant source of domestic energy were amongst the factors influencing the populace to adopt cooking gas as domestic energy source for cooking and heating in the study area.

Table: 4.5
Determinants of the Adoption of Cooking Gas Household Domestic Fuel

Factors	No idea		Strongly Agree		Agree		Disagree		Strongly Disagree		Total	
	Frq	%	Frq	%	Frq	%	Frq.	%	Frq.	%	Frq.	%
Income and education level of household	5	1.3	107	27.2	220	55.8	55	14	7	1.8	**394**	**100**
Family size and status of the household	**-**	-	114	28.9	174	44.2	90	22.8	16	4.1	**394**	**100**
Cheaper source of domestic fuel for cooking and heating	11	2.8	136	34.5	204	51.8	40	10.2	3	0.8	**394**	**100**
Clean source of domestic energy	1	0.3	209	53	178	45.2	6	1.5	-	-	**394**	**100**
Efficiency in terms of cooking food faster	2	0.5	257	65.2	129	32.7	4	1.0	2	0.5	**394**	**100**
Time savings for cooking and heating	10	2.5	217	55.1	164	41.6	2	0.5	1	0.5	**394**	**100**
Less indoor air pollution and carbon emission	-	-	185	47	191	48.5	16	4.1	2	0.5	**394**	**100**

Source: Field Survey, 2017

According to table 4.5 above, shows that out of the total 394 questionnaire distributed to respondent, 107 respondents which is 27.2%, strongly agree that income and education level influences the adoption of Liquefied petroleum gas as domestic fuel. 220 responses (55.8%) agree, 55 respondents (7%) disagree, while 7 respondents (1.8%) strongly disagree and 5 (1.3%) were undecided about the decision. Therefore, this clearly shows that as the income of house hold increases, there is tendency of him to adopt cooking gas instead of wood fuel. These findings agree with Boukary (2006) who examines house hold energy preferences for urban Ouagadougou, Burkina Faso. He observed that wood fuel utilization decreases with increasing household income. He also discovered that house hold energy preferences are determined by income, household size, and high frequency of cooking certain meals. Also Okunade (2010) study on “Charcoal as an alternative energy source among urban households in Ogbomoso metropolis of Oyo State, Nigeria”. The study examined the type of energy sources available and the factors that determined their use. His findings coincided with this study where by the results reveals that level of education, household size; age and occupation are the significant factors determining household choice of energy use for cooking while income is insignificant.

Bello (2010) investigated the “Impact of wealth distribution on energy consumption in Nigeria: A case of selected households in Gombe State” also reveals that the choice of cooking energy amongst household was mainly determined by income, size of household and level of education.

On the contrary, my findings disagree with that of Adetunji *et al.,* (2007); he examined household energy consumption patterns in Osogbo L.G.A of Osun State. His findings indicated that Age, level of Education and Occupation of households are insignificant factors that determine household choice of energy consumption while income and household sizes are significant.

Also Shittu *et al.,* (2004) examined the demand for energy among households in Ijebu Division, Ogun State, Nigeria. He discovered that the influence of education and household size on household energy used were insignificant, while income and age of household revealed significant influence.

From the above table 4.5, it indicated that 28.9% of the respondents strongly agree that family size and status of the household influences the adoption of cooking gas as energy source for domestic cooking and heating., 44.2% agree, 22.8% disagree while 4.1% strongly disagree. It appears that the respondents collectively both those that agree and strongly agree have about 73.1% which shows that the number of children and the prestige of the household plays an important role whether the head utilizes cooking gas or other alternative sources of energy like wood fuel for daily routine cooking activities at home. For example, in most cases, smaller family sizes which ranges between 1 to 6 family members preferably and conveniently utilizes cooking gas for domestic cooking and heating. This is due to the cost and nature of food been cooked in comparison with the larger families whom in most cases happens to be traditional and conservatives in culture. For example, a family of more than 20 to 30 children in which the nature of food they cooked is cultural type of food and the size of the pot is larger than the usual burner attached to the cylinder unless if customized to fit the size of the pot. Likewise the status of the household also influences the adoption of cooking gas as domestic energy source.

Cleaner source of domestic energy is also one of the determinants of the adoption of cooking gas as domestic energy. As shown in table 4.5, 53%strongly agree that cooking gas been a cleaner source of domestic fuel influences the adoption of it as energy source for cooking at home, 45.2% agree, 1.5 disagree, 0.3% undecided about the decision. About 98% of the respondent are of the view that been cleaner source of energy, emits less smoke, it can be used indoors, while after coking the pot still remains clean. It also improves the health of the households.

Also from the table 4.5, 65.2% strongly agree that cooking gas is efficient especially in terms of cooking food faster. 32.7% agree, 1% disagree, 0.5% strongly disagree and finally 0.5 undecided about the decision to take.

Time savings is also another determinant of adoption of cooking gas by households as a domestic energy source. 55.1% strongly agree, 41.6% agree, 0.5% disagree,0.5% strongly disagrees while 2.5% undecided. Cooking gas saves time in cooking for women and rest time could be used for other productive activities at home. Probably that why most civil/company workers prefer it and adopt it. One of the respondent interviewed said that cooking gas saves a lot of time for him and his spouse for cooking and heating especially during cold season. Within short period of time his wife would prepare breakfast for him and his children whom usually go to school as early as 7:30 am in the morning.

About 47% strongly agree that less indoor air pollution and carbon emission determines the adoption of cooking gas as domestic energy source by the households, 48.5% agree, 4.1% disagree while 0.5% strongly disagree.

4.4 SOCIOECONOMIC FACTORS INFLUENCING CHOICE OF COOKING GAS IN RESIDENTIAL DENSITY CLUSTERS IN KANO METROPOLIS

This unit presents some of the socioeconomic factors influencing the choice of cooking gas energy. Crosstabs indicating the relationship between each of the socioeconomic variables and the adoption of cooking gas energy among the residential density clusters in Kano metropolis and also the Chi-square test results. Table 4.6 shows family size in relation to the choice of cooking gas among the various residential density clusters

Table 4.6 Family Size and the Choice of Cooking Gas among Residential Density Clusters In Kano Metropolis

Family Size	High Density Planned		High Density Unplanned		Medium Density Planned		Medium Density Unplanned		Low Density Planned		Low Density Unplanned		Total	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
1 – 4	48	52.2	110	63.2	27	40.9	10	71.4	9	52.9	12	38.7	216	54.8
5 – 9	25	27.2	33	19	23	34.8	1	7.1	5	29.4	7	22.6	94	23.9
10 – 14	5	5.4	7	4	8	12.1	2	14.3	-	-	1	3.2	23	5.8
15 and above	1	1.1	4	2.3	-	-	-	-	1	5.9	-	-	6	1.5
None	13	14.1	20	11.5	8	12.1	1	7.1	2	11.8	11	35.5	55	14
Total	**92**	**100**	**174**	**100**	**66**	**100**	**14**	**100**	**17**	**100**	**31**	**100**	**394**	**100**

Source: Field Survey, 2017

From table 4.6 indicate that small family size of 1-4 children adopt more cooking gas with the highest percentage compare to a large family with more than ten children and above. This attributable to the type of food they cooked and less burden of other household responsibilities. This result is in contrast with the findings of Kiyawa (2016) where he found that household size has little or no influence on the choice of energy whereas in the case of this study smaller family size in all the residential density zones utilizes more of cooking gas than other sources of energy. The findings of this work is in line with Lambu *et al.,(*2016) who discovered that smaller family start by smart, efficient and convenient source of energy such as cooking gas and kerosene, but as the size become larger, necessity forces many to adopt wood fuel as the energy source for domestic cooking. Therefore, this shows that family size determine the type of energy to be adopted for domestic usage.

Table 4.7 Educational Level and the Choice of Cooking Gas among Residential Density Zones in Kano Metropolis

Educational Level	High Density Planned		High Density Unplanned		Medium Density Planned		Medium Density Unplanned		Low Density Planned		Low Density Unplanned		Total	
	F	%	F	%	F	%	F	%	F	%	F	%	F	%
Informal School	2	2.2	10	5.7	8	12.1	2	14.3	-	-	1	3.2	23	5.8
Primary Education	2	2.2	3	1.7	-	-	-	-	-	-	1	3.2	6	1.5
Secondary School	3	3.3	10.	5.7	5	76	-	-	1	5.9	2	6.5	21	5.3
NCE/ Diploma	20	21.7	37	21.3	11	16.7	1	7.1	1	5.9	5	16.1	75	19
Degree / HND	45	48.9	91	52.3	27	40.9	6	42.9	9	52.9	16	51.6	194	49.2
Higher degree	20	21.7	23	13.2	15	22.7	5	35.7	6	35.3	6	19.4	75	19
Total	**92**	**100**	**174**	**100**	**66**	**100**	**14**	**100**	**17**	**100**	**31**	**100**	**394**	**100**

Source: Field Survey, 2017

From table 4.7 which present level of education of the respondents and the choice of cooking gas among the residential density clusters in the metropolitan Kano, indicate that the cumulative percentages of the respondents education level that utilizes cooking gas with higher percentage is those with post secondary education, Degrees and higher degree with each having 19%, 49.2% and 19% respectively among the various residential density zones compare to those that have less educational background. This finding coincided with that of Kiyawa (2016) who reveals that level of education of household influences the energy choice to be adopted as energy source. Those with primary education use more wood fuel than other forms of energy compared to those with tertiary education. As shown in the table above, those with primary and secondary education utilizes less cooking gas as their energy source for household consumption compare to respondents with post secondary and degrees. This could be linked to the facts that those with tertiary education secured jobs that opportune them to use gas. Likewise education enhances individual awareness of the detrimental effects of our decision on the environment.

Table 4.8 Occupation and the Choice of cooking Gas among Residential Density Clusters in Kano Metropolis

Occupation	High Density Planned		High Density Unplanned		Medium Density Planned		Medium Density Unplanned		Low Density Planned		Low Density Unplanned		Total	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	**Freq**	**%**
Farmer	14	15.2	34	19.5	9	13.6	1	7.1	2	11.8	4	12.9	**64**	**16.2**
Company/ Civil Servant	69	75	123	70.7	40	60.6	12	85.7	13	76.5	18	58.1	**275**	**69.8**
Business	7	7.6	13	7.5	13	19.7	-	-	-	-	9	29	**42**	**10.7**
Artisan	2	2.2	4	2.3	4	6.1	1	7.1	2	11.8	-	-	**13**	**3.3**
Total	**92**	**100**	**174**	**100**	**66**	**100**	**14**	**100**	**17**	**100**	**31**	**100**	**394**	**100**

Source: Field Survey, 2017

As shown in table 4.8, the cumulative percentage of farmers is 16.2% compare to company/civil servant with 69.8%, while business and artisans have 10.7% and 3.3% each. This indicates that the result of cross tabulation of occupation in relation to the adoption of cooking gas in the residential density clusters as shown in table 4.8 reveals that respondents whose primary occupation were farmers, artisan and business adopt less of gas as household energy source compare to civil/company workers whom have higher percentage of respondents utilizing cooking gas as domestic fuel. The chi-square test in table 4.9 indicates that the X^2 calculated value of 33.428 Significance at 0.05 level of significance. This indicates that there is variation between the occupation of respondent and the adoption of cooking gas among the residential density clusters. The finding of this study is in line with the work of Kiyawa(2016) who found that civil servant and private workers utilizes higher amount of kerosene and cooking gas in the planned areas of Birni, SabonGari compare to farmers, artisans whom utilizes more of wood fuel. It also corroborate with the findings of Firdausi(2008) who observed that cleaner sources of energy with low carbon emission are mostly associated with higher income earners, government workers and environmentally enlighten people.

Table 4.9 Relationship between socioeconomic factors and the adoption of cooking gas amongst the residential density clusters of metropolitan Kano

Socioeconomic factor	Value	Chi^2-P-value
Location	654.419 .	.000
Family Size	39.145	.006
Level of education	27.781	.318
Occupation	33.428	.005
Income	48.370	.005
Age	18.914	.041
Gender	4.960	.421

Source: Field survey, 2017

Table 4.10 Income and the Choice of Cooking Gas among Residential Density Clusters

Income	High Density Planned		High Density Unplanned		Medium Density Planned		Medium Density Unplanned		Low Density Planned		Low Density Unplanned		Total	
	F	%	F	%	F	%	F	%	F	%	F	%	**F**	**%**
20,000 40,000	29	31.5	33	19	11	16.7	3	21.4	3	17.6	10	32.2	**89**	**22.5**
41,000 60,000	18	19.6	65	37.4	15	22.7	-	-	3	17.6	6	19.4	**107**	**27.2**
61,000 80,000	12	13	21	12.1	6	9.1	5	35.7	5	29.4	4	12.9	**53**	**13.5**
81,000 100,000	20	21.7	27	15.5	19	28.8	3	21.4	3	17.6	5	16.1	**77**	**19.5**
101,000 Above	13	14.1	28	16.1	15	22.7	3	21.4	3	17.6	6	19.4	**68**	**17.3**
Total	**92**	**100**	**174**	**100**	**66**	**100**	**14**	**100**	**17**	**100**	**31**	**100**	**394**	**100**

Source: Field Survey, 2017

From the table 4.10 above shows individuals income in relation to the adoption of cooking gas in the residential density clusters of Kano metropolis. Contrary to the perception that higher income earner usually utilizes gas for cooking more than the middle income earners as their main energy source. From the table it indicated that 27.2% of income category between 41,000-60,000 has the highest percentage compare to 17.3% of income category between 101,000 and above. Contrary with the findings of Kiyawa(2016) who found that the low income earners between 18,000 and 68,000 utilizes more kerosene, wood fuel and charcoal than cooking gas where as high income earners 120,000 – 170,000 uses gas with higher percentage. The reasons attributable to my findings could be linked to the facts that cooking gas cylinders comes in various sizes ranging from 3kg, 5kg, 6kg, 8kg to 25kg and 50kg. While in terms of refilling of gas, all these sizes could be refilled by the retailers at customer's discretion. So, middle income earners could also afford it. Also the little awareness about the cleanliness, cheapness and less smoke emission from utilizing LPG also contributed. Result from the X^2 test indicate that income have a significant relationship with the adoption of cooking gas among the residential density clusters of Kano metropolis at (P<0.005). This finding is in line with the findings of Firdausi (2008) that income has a significant relationship with the choice of energy.

4.5 OTHER ENERGY SOURCES

The sources of domestic energy in Kano metropolis include wood fuel, kerosene, charcoal, electricity and cooking gas. The table 4.11 below shows that kerosene ranked first as the most preferred alternative cooking energy used in place of liquefied petroleum gas by households in the metropolitan Kano especially those households that usually adopt cooking gas as their domestic energy source. This result is expected given that the price of kerosene is relatively cheap as a result of government subsidy and little prestige it offers to households in urban areas than other energy sources such as wood fuels. Followed by charcoal, then wood fuel is ranked third and finally electricity.

Table 4.11 Other Energy Sources among Residential Density Clusters within Metropolitan Kano

Energy Sources	High Density Planned		High Density Unplanned		Medium Density Planned		Medium Density Unplanned		Low Density Planned		Low Density Unplanned		Total	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	**Freq**	**%**
Wood Fuel	3	3.3	8	4.6	3	4.5	1	7.1	-	-	4	12.9	**19**	**4.8**
Charcoal	16	17.4	41	23.6	13	19.7	5	35.7	5	29.4	3	9.7	**83**	**21.1**
Kerosene	65	70.7	110	63.2	43	65.2	6	42.9	7	41.2	14	45.2	**245**	**62.2**
Electricity	-	-	6	3.4	3	4.5	-	-	-	-	2	6.5	**11**	**2.8**
No response	8	8.7	9	5.2	4	6.1	2	14.3	5	29.4	8	25.8	**36**	**9.1**
Total	**92**	**100**	**174**	**100**	**66**	**100**	**14**	**100**	**17**	**100**	**31**	**100**	**394**	**100**

Source: Field Survey, 2017

The above table shows the cumulative percentage of the respondents that 62.2% depended on kerosene as an alternative to cooking gas with 245 respondents, 21.1% used charcoal with 83 respondents, 4.8% used wood fuel with 19 respondent while 2.8% (11 respondents) used electricity and lastly 9.1% with about 36 respondents were undecided or they only use gas, they do not have any other alternative other than cooking gas. As presented above, the results indicated that kerosene is the most preferred source of domestic energy for households that usually adopt cooking gas. Kerosene happens to be the most preferred other energy source for almost all the residential density clusters with each zone having higher percentages of it utilization. Kerosene ranks first, then charcoal, wood fuel comes third and electricity is ranked fourth from the table above.

Furthermore, this also indicated that most of the households that utilizes cooking gas hardly come down to the lowest energy ladder but rather shift a little to a much cleaner and less detrimental to the environment in the ladder such as kerosene, followed by charcoal then wood fuel. Though in the table above, electricity which is much cleaner than kerosene and charcoal in the energy ladder appears to be the least alternative domestic fuel to users of cooking gas in the study area. This is probably attributable to our dilapidated and unreliable power supply in the country at large. This study corroborate with Agwu *et al.,*(2015) who also reveals that kerosene ranked first as the most preferred cooking energy used in place of Liquefied petroleum gas by household’s in a study conducted on mitigating climate change and determinants of Access to LPG among urban household in Abia State, Nigeria.

Table 4.12 Reasons for Preference for Wood Fuel over Cleaner energy sources (L.P.G) For Domestic Cooking and Heating

Reasons	Frequency	Percentage
Cannot afford cooking gas	36	21.9
High cost of refilling cylinder	52	13.2
Explosion that could lead to fire outbreak	57	14.5
All of the above	193	49
Others	6	1.5
Total	**394**	**100**

Source: Field Survey, 2017

Table 4.12 above shows the various reasons for preferences for wood fuel over cleaner energy sources for domestic usage. 21.9% said that they cannot afford to buy cooking gas and its accessories but rather prefer use of wood fuel due to it cheapness compare to liquefied petroleum gas. 13.2% mention that high cost of refilling the cylinders also happens to be one the reasons for preference of wood fuel over cooking gas, while explosion could lead to fire outbreak is another reason why some house hold prefer wood fuel over cooking gas with 14.5% and this is attributable to easy to use and safety issues. 49% of the respondents are of the view that the above mentioned reasons thus, affordability, high cost of refilling and explosions were their reasons for the preference of wood fuel over cooking gas as a domestic energy source. And lastly 1.5% of the respondents mentioned different opinion as regards to the reasons why they prefer use of wood fuel over cleaner energy sources like cooking gas as others such as: readily available source of domestic energy, taste of food cooked with wood fuel better than that of cooking gas etc. These findings agrees with Agwu *et al.,* (2015) who found out that the predominant challenges to LPG utilization were product unavailability, psychological fear of explosion and high cost of starting up among others. In terms of starting up , these costs are linked to the cost in purchasing the burner, cylinder and filling and refilling gas when compared with other energy sources like kerosene, wood fuel and coal, intending household's may be discouraged. The study is also in line with Akuffo *et al.,* (2008) who reveal that safety problem and the associated perception have been described as likely barriers to the adoption of LPG

Table 4.13 Availability of cooking gas products and its accessories in the market

Variable		Freq.	%
	Undecided	3	0.8
Products availability of cooking gas in the market	High	113	28.7
	Moderate	255	64.7
	Low	23	5.8
Total		**394**	**100**

Source: Field Survey (2017)

From the table 4.13 above, 0.8% were undecided about whether there is availability of cooking gas products and its accessories in the market or not, 28.7% rated cooking gas products availability and accessories in the market as high, 64.7% rated it as moderate while 5.8% rated it as low. The above result coincided with prior expectation due to the facts that from the reconnaissance survey of the study Area it shows that almost all the major roads of the metropolitan Kano you find out that these accessories especially cylinders, burners are displayed in shops along the roads. If someone also goes to the market these accessories are also available, at filling stations such Oando gas cylinder, Total gas cylinder and refilling, Nigeria National Petroleum Cooperation gas cylinder e.tc. Therefore, cooking gas accessories is now a minor challenge to the adoption of liquefied petroleum gas as domestic fuel in the metropolitan Kano based on the above findings.

The table 4.14 below indicates that 74.1% said that they had knowledge about health and environmental benefit cooking gas offers to its users as a domestic energy source. While 25.6% said that they had no knowledge about the health and environmental benefit derived from adoption of cooking gas as domestic source of energy. The above result could be related to the level of education of the respondents in table 4.1.2 which shows that about 49.2% acquired Degree/Higher National Diploma qualifications and about 19% with Higher Degrees, collectively 68.2% had degrees and above qualifications.

Table 4.14 Knowledge about the health and environmental benefit derived from the adoption of cooking gas

Variable		Freq.	%
	Undecided	1	0.3
Knowledge about health and environmental benefit from adoption of cooking	Yes 292		74.1
	No	101	25.6
Total		**394**	**100**

Source: Field Survey (2017)

4.6 CHALLENGES ASSOCIATED WITH THE ADOPTION OF COOKING GAS

The study finds out that the major challenges confronting the users of cooking gas in the study area were amongst: leakages from the cylinder, fear of explosion, substandard accessories, poor literacy on it usage, finishes without notice, over refilling of the cylinder, taste and preference for other sources of energy (wood fuel), constraints for use especially for large family or for festivals etc.

From the 4.15table in page 66, about 43.9% of the respondents are of the view that leakages from the cylinder constitute a major challenge associated with the use of cooking gas as a domestic energy source for cooking and heating at home. One of the respondents whom also happen to be a gas seller narrated his ordeal from the leakages of the cylinder, said that a costumer came to him and reported that the 12.5 kg cylinder he bought from him evaporated all through the hose of the cylinder attributed to breakage of hose. 9.9 % of the respondents are of the opinion that poor literacy about the usage of cooking gas could bring about explosion, 6.1% of the respondent said that cooking gas finishes without showing any notice for the household to get prepared for buying another one. About 5.8% of the respondent challenges with the adoption of cooking gas as a domestic fuel is that cooking gas burns food especially if not properly handled with constant monitoring due to the facts that it very faster in cooking and heating.5.3% of the respondents mentioned that substandard accessories and poor technicians are the challenges they faced with. Other challenges included are that it shows no level of usage on the cylinder, over refilling of cylinder result to explosion if unawares, not readily available in some locations and not suitable for usage especially for larger family or for during festivals like Sallah break and new year with each having 1.5%,1%,1% and0.3% respectively.

Finally, adulteration of the products in terms of refilling has 0.5% of the respondents, 0.3% of the respondents challenges in the adoption of cooking gas is that it works or cooked food faster than other sources of domestic fuel. While 23.9% of the respondent expresses that fear of explosion poses a major challenge associated with the cooking gas as domestic fuel for household cooking

Table 4.15: Challenges associated with adoption of cooking gas as a domestic energy source in Kano metropolis (Residential density clusters)

Challenges	High Density Planned		High Density Unplanned		Medium Density Planned		Medium Density Unplanned		Low Density Planned		Low Density Unplanned		Total	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Substandard Equipment	6	6.5	12	6.9	1	1.5	1	7	-	-	1	3.2	**21**	**5.3**
Leakages from the cylinder	45	48.9	65	37.4	31	47	4	28.6	7	41.2	21	67.7	**173**	**43.9**
It burns food if not handle properly	2	2.2	14	8	2	3	1	7.1	2	11.8	2	6.5	**23**	**5.8**
It finishes without showing notice	5	5.4	11	6.3	2	3	2	14.3	-	-	4	12.9	**24**	**6.1**
It shows no level of usage	1	1.1	3	1.7	-	-	-	-	2	11.8	-	-	**6**	**1.5**
Poor literacy on it usage	5	5.4	21	12.1	8	12.1	2	14.3	1	5.9	2	6.5	**39**	**9.9**
Over refilling of cylinder	1	1.1	1	0.6	1	1.5	1	7.1	-	-	-	-	**4**	**1**
Not suitable for use in large family	-	-	1	0.6	-	-	-	-	2	11.8	-	-	**3**	**0.8**
It works faster than other energy source	-	-	-	-	1	1.5	-	-	-	-	-	-	**1**	**0.3**
Not readily available in some locations	-	-	3	1.7	-	-	1	7.1	-	-	-	-	**4**	**1**
Adulteration of the product a terms of refilling	-	-	2	1.1	-	-	-	-	-	-	-	-	**2**	**0.5**
fear of explosions	27	29.3	41	23.6	20	30.3	2	14.3	3	17.6	1	3.2	**94**	**23.9**
Total	**92**	**100**	**174**	**100**	**66**	**100**	**14**	**100**	**17**	**100**	**31**	**100**	**394**	**100**

Source: Field Survey, 2017

4.7 MEASURES TO INCREASE ADOPTION OF COOKING GAS BY HOUSEHOLDS OVER SOLID FUELS

In order to encourage more households to adopt cooking gas as their main energy source for domestic usage, a number of measures were mentioned by the respondents as indicated in the table 4.16 below. 92.6% out of the respondents which is about 365 out of 394 of the questionnaire distributed agree that when there is availability and the price is made affordable to middle income earners, there will be more households that will be willing to adopt it as their main energy source for cooking and heating. Another measure is that government should subsidize the price of cooking gas so that low income earners could afford it with about 91.1% of the respondents are having such view. Then awareness campaign on the benefit of cooking gas has about 90.1% of the respondents as a measure to encourage more household to adopt cooking gas over solid fuels. 87% of the respondents are of the view that raising public awareness about the impact of burning wood fuel for domestic cooking could also help to realize the adoption of liquefied petroleum gas as a domestic energy source for cooking and heating. And lastly 75.6% of the respondents are of the view that favorable government policy on cooking gas could also serve as measure to boast the utilization cooking by the Nigerian household as their main energy source for cooking and heating.

Table 4.16 Measures of Encouraging Households to Adopt Cooking Gas over Solid FUELS

Measures	Undecided Freq.	%	Yes Freq.	%	No Freq.	%	Total Freq.	%
Government subsidy on the price of cooking gas	-	-	359	91.1	35	8.9	**394**	**100**
Awareness campaign on the benefit of cooking gas	1	0.3	355	90.1	38	9.6	**394**	**100**
Favorable government policy on cooking gas	3	0.8	298	75.6	93	23.6	**394**	**100**
Availability and affordability of cooking gas products	-	-	365	92.6	29	7.4	**394**	**100**
Raising public awareness about the impact of burning wood fuel for domestic cooking	1	0.3	343	87.1	50	12.7	**394**	**100**

Source: field survey, 2017

Thus, from the above results presented, there is an urgent need from the government and nongovernmental organization (NGOs) to boast and crash the price of LPG at affordable price and made it available to the users. Also there should be enlightenmentcampaigns to make people aware about the benefit of using cooking gas and appreciate the importance of conservation of forests resources that is being used as wood fuel for the safety of our environment.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY

This study examines the determinants of cooking gas adoption as domestic fuel in Kano Metropolis, Nigeria. To achieve the purpose of the study, four research questions were raised. Related literatures were reviewed about the domestic energy choices and preferences and over view of LPG utilization in Nigeria.

Descriptive survey design was adopted for this study; the population of the study comprised all the households' users of cooking gas within the metropolitan Kano which has a population of 2,828, 861 based on 2006 population census, while the sample of four hundred (400) respondents was used. Data was collected using self-developed questionnaire named "determinant of adoption of cooking gas as domestic fuel in Kano metropolis". Out of the 400 questionnaires administered, 394 were returned and used for the analysis. the finding of the study revealed that the major determinant of the adoption of cooking gas were income and education level of household, family size and status, price of cooking gas, efficiency in terms of cooking food fast, time savings for cooking and less pollutants source of domestic energy were amongst the factors determining the adoption of cooking gas as domestic energy source for cooking and heating in the study area. The study also finds out that there is significant relationship between each of the socioeconomic variables such as family size, educational level, occupation, income, age and the adoption of cooking gas as energy source among the residential density clusters in Kano metropolis. Other sources of domestic energy in Kano metropolis include wood fuel, kerosene, charcoal, electricity and cooking gas. Kerosene was ranked first as the most preferred alternative cooking energy used in place of liquefied petroleum gas by household in the metropolitan Kano especially those households that usually adopt cooking gas as their domestic energy source.

The major challenges associated with the adoption of cooking gas as a domestic energy source were leakages from the cylinder, inadequate knowledge about how to utilize LPG and maintenance and fear of explosions among others. While the measures to be taken in order to increase the adoption of cooking gas by households over solid fuels usage is that there should be availability of the cooking gas products and the price should be made affordable to middle income earners. Government and private stakeholders should also intensify awareness campaign on the benefit of cooking gas adoption as domestic fuel and also raised public awareness about the impact of burning wood fuel for domestic cooking and to the environment.

5.2 CONCLUSION

It is observed from this study that family size, income and educational level of the household influences the adoption of cleaner energy sources such as cooking gas for domestic usage.

Kerosene was ranked first as the most preferred alternative household energy source for the users of cooking gas, and then followed by charcoal, wood fuel and electricity. This equally shows that energy switch by users of gas hardly utilizes wood fuel but rather kerosene and charcoal as their most preferred alternatives.

The findings of the study also reveals that leakage from the cylinder, poor literacy on how to operate and lack of awareness about benefit of LPG and fear of explosions were some of the major challenges for the adoption of LPG by the households as domestic energy source. Therefore, some of the measures identified to encourage more households to switch from solid fuels to gas reveals by this study were among others, there should be public enlightenment about safety measures and benefit of adopting cooking gas while also subsidizing the products and made it affordable and available to all regardless of social status, income, educational background so as to bring down the energy poverty level in Kano and Nigeria at large which will in turn improve the standard of living, health and the environment.

5.3 RECOMMENDATION

Based on the findings of this study the following recommendations were made to ensure that the provision of cleaner energy sources such as LPG are adopted as household energy for domestic purpose in the metropolitan area of Kano and beyond. And also to address the challenges that discourages household's utilizing cooking gas as domestic fuels.

1. There should be adequate enlightenment campaign on media to the public about the benefit of utilizing cooking gas to our health and to the environmental sustainability and also the safety measures on how to operate it at home should in case of explosion. Based on the finding of this study, poor literacy on how to operate the gas and fear of explosion happen to be one of the major challenges for the adopting of cooking gas which needs to be addressed. Therefore safety and public sensitization campaign should be organized to educate households on the use of LPG, the negative impact of using charcoal and wood fuel which will assist to ease the psychological barrier that discourages household adoption of LPG
2. Government needs to intervene through it agencies such as standard organization of Nigeria by checkmating on the substandard and expired accessories of cooking gas such as regulator, cylinders, pipes, hose so as to prevent leakages from the cylinder and the expired cylinder which usually leads to explosions.

3. Other renewable energy sources that are pollution free and environmentally friendly should be harnessed and exploit, Kano in particular and Nigeria at large is potentially endowed with various form of energy resources that are available like biogas, solar, which could substitute cooking gas. This could be realize by partnership with both local and foreign investors to manufactured bio-digester and solar panel at affordable prices which could equally be used as source of energy for domestic usage.
4. Public/Private partnership should provide incentives to low income earners by distributing medium size cylinders with gas (i.e. 3kg, 5kgs, 8kg) depending on the family size free from the first time. While when it comes to refilling, they should also subsidize the price of refilled gas to them, especially the conservatives amongst them as it usually done for mosquito net. This will likely reduce the cost by government in curbing some ailment associated with indoor air pollution as a result of using wood fuel.

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APPENDIX I

QUESTIONNAIRE

QUESTIONNAIRE ON THE DETERMINANTS OF ADOPTION OF COOKING GAS AS DOMESTIC FUEL IN KANO METROPOLIS, NIGERIA

Dear Respondent,

I am a postgraduate student of Geography Department, Bayero University Kano, conducting a research on "Determinants ofAdoption of Cooking Gas as Domestic Fuel in Kano Metropolis, Nigeria" for fulfilling the requirements for the award of M.Sc. Natural Resources Management and Climate Change by the Institution. Your kind cooperation is needed. All the information provided will be treated confidentially and will be used for Academic purpose. Thank you in anticipation of your cooperation.

SECTION A: No________

Demographic information of the respondent

INSTRUCTION: Please tick [√] the option that represents what you know and give reasons where necessary. **Date:**_____________

1. Age of the Household Head**: (a)** 21- 40yrs **[ ]** (b) 41- 60yrs **[ ]** (c) 61yrs above **[ ]**
2. Occupation: (a) farmer **[ ]** (b) company worker/civil servant **[ ]** (c) Business**[ ]** others (specify);____
3. Income of Household Head: (a) 20,000 – 40,000 [ ] (b) 41,000 – 60,000 [ ] (c) 61,000 – 80,000 [ ] (d) 81,000 – 100,000 [ ] (e) 101,000 - above
4. Gender of the Household Head (a) male **[ ]** (b) female **[ ]**
5. Marital Status: (a) Single [ ] (b) Married [ ] (c) Separated [ ] (d) Widowed [ ] (e) Divorced [ ]

6. Level of Education**:** (a) Qur'anic/informal school [ ] (b) Primary Education [ ]

(c) Secondary Education [ ] (d) NCE/Diploma [ ] (e) Degree/HND [ ] (f) Higher Degrees [ ]

7. Number of Children: (a) 1 to 4 family [ ] (b) 5 to 9 family [ ] (c) 10 to 14 [ ] (d) 15 and above [ ] (e) None [ ]

8. Local Government ………………………………………………………………………

9. Place of Residence/Location ……………………………………………………………….

SECTION B:

FACTORS DETERMINING THE ADOPTION OF LPG AS DOMESTIC HOUSEHOLD ENERGY

Kindly indicate by ticking (√) the appropriate response at the right of each statement using the formats below. SA = Strongly Agree; A = Agree, D = Disagree, SD = Strongly Disagree

S/N	**Statement**	SA	A	D	SD
10	LPG is an environmentally friendly source of domestic fuel due to the facts that it emits less CO_2 and reduces indoor air pollution				
11	LPG it is a clean source of domestic energy burns efficiently without producing smoke				
12	Cooking gas cook food faster than other sources of domestic fuel like wood fuel and kerosene				
13	It saves more time for women in cooking and heating				
14	It is cheaper source of domestic energy for cooking and heating				
15	Income and education level of Household head determines the adoption of LPG as domestic energy source				
16	Size of the family and Status of the Household head determines the adoption of LPG for domestic fuel utilization				

SECTION C:

CHALLENGES IN THE ADOPTION OF COOKING GAS AS DOMESTIC HOUSEHOLD ENERGY AND MEASURES TO ENABLE MORE HOUSEHOLDS TO SHIFT FROM SOLID FUELS TO LPG

17. Does fear of explosion from the cylinder discourages you to adopt LPG as domestic source of energy? Yes or No

18. Do high cost of starting up of utilizing LPG very high? Yes or No

19. If yes, what can you say about the cost of other sources of energy like wood fuel, charcoal and kerosene? (a) High [ ] (b) moderate [ ] (c) low [ ]

20. Were you informed about the health and environmental benefit derived from adopting LPG as domestic energy source? Yes or No

21. If yes, why do some household still use wood fuel as their main source of domestic energy? (a) Can't afford LPG appliances too expensive [ ] (b) Refilling cylinder too expensive [ ] (c) using LPG dangerous [ ] (d) All of the above [ ] (e) others, specify …………………………

……………………………………………………………………………………………………..

22. Are you aware of the danger of improper use and lack of maintenance of LPG cylinders could leads to accidents or explosions. Yes or No

23. What other challenges can you mention that you encounter when utilizing LPG as domestic source of energy? ……………………………………………………………………

24. Have you experience shortage of supply as regards to refilling of cylinders by the retailers? Yes or No

25. What other type of fuel do you adopt as an alternative? (a) Wood fuel [ ] (b) Charcoal [ ] (c) Kerosene [ ] (d) others (specify); ………………………………………………………………

26. What can you say about product availability of LPG and its accessories in the markets? (a) High [ ] (b) Moderate [ ] (c) Low [ ]

27. Subsidizing the price of LPG by the government as it did to kerosene and made it affordable to its citizens, will encourage household to shift from solid fuels to LPG? Yes or No

28. Awareness campaigns to the public on the environmental, economic and social benefit of adopting of LPG will motivate more households to switch from solid fuels to LPG. Yes or No

29. Do you consider favorable government policy on LPG utilization such as removal of kerosene subsidy, LPG VAT removal and granting of incentives to suppliers and retailers could encourage household in switching from solid fuels to LPG? Yes or No

30. If the LPG products are made available and the price is affordable would you adopt it as your preferred energy source? Yes or No

31. Raising Public awareness about the negative environmental and health impacts of burning wood fuel for cooking would increase the rate of adoption of cooking gas. Yes or No

Appendix II: Required Sample Size

Population Size	Confidence Margin of Error				Confidence Margin of Errors			
	5.0%	3.5%	2.5%	1.0%	5.0%	3.5%	2.5%	1.0%
10	10	10	10	10	10	10	10	10
20	19	20	20	20	19	20	20	20
30	28	29	29	30	29	29	30	30
50	44	47	48	50	47	48	49	50
75	63	69	72	74	67	71	73	75
100	80	89	94	99	87	93	96	99
150	108	126	137	148	122	135	142	149
200	132	160	177	196	154	174	186	198
250	152	190	215	244	182	211	229	246
300	169	217	251	291	207	246	270	295
400	196	265	318	384	250	309	348	391
500	217	306	377	475	285	365	421	485
600	234	340	432	565	315	416	490	579
700	248	370	481	653	341	462	554	672
800	260	396	526	739	363	503	615	763
1,000	278	440	606	906	399	575	727	943
1,200	291	474	674	1067	427	636	827	1119
1,500	306	515	759	1297	460	712	959	1376
2,000	322	563	869	1655	498	808	1141	1785
2,500	333	591	952	1984	524	879	1288	2173
3,500	346	641	1068	2565	558	977	1510	2890
5,000	357	678	1176	3288	586	1066	1734	3842
7,500	365	710	1275	9211	610	1147	1960	5165
10,000	370	727	1332	9899	622	1193	2098	6239
25,000	378	760	1448	6939	646	1285	2399	9972
50,000	381	772	1491	8056	655	1318	2520	12455
75,000	382	776	1505	8574	658	1330	2563	13583
100,000	383	778	1513	8762	659	1336	2585	14227
250,000	384	782	1527	9248	662	1347	2626	15555
500,000	384	783	1532	9423	663	1350	2640	16055
1,000,000	384	783	1534	9512	663	1352	2647	16317
2,500,000	384	784	1536	9567	663	1353	2651	16478
10,000,000	384	784	1536	9594	663	1354	2653	16560
100,000,000	384	784	1357	9603	663	1354	2654	16584
300,000,000	384	784	1357	9603	663	1354	2654	16586

Appendix III:

Distribution of Household by Residential Density Clusters

Localities	High Density Planned	High Density Unplanned	Medium Density Planned	Medium Density Unplanned	Low Density Planned	Low Density Unplanned	Freq	%
1. Fagge	19	9	0	0	0	0	28	7.1
2. KMC	17	34	0	0	0	0	51	12.9
3. Gwale	18	16	0	0	17	0	51	12.9
4. Dala	20	20	15	0	0	0	55	14
5. Kumbotso	0	0	15	14	0	13	42	10.7
6. Tarauni	0	0	31	0	0	0	31	7.9
7. Ungogo	12	18	5	0	0	18	53	13.5
8. Nassarawa	6	77	0	0	0	0	83	21.1
Total	**92**	**174**	**66**	**14**	**17**	**31**	**394**	**100**

Source: Field Survey, 2017

Appendix IV:

GENDER AND THE CHOICE OF COOKING GAS AMONG RESIDENTIAL DENSITY CLUSTERS

Gender	High Density Planned		High Density Unplanned		Medium Density Planned		Medium Density Unplanned		Low Density Planned		Low Density Unplanned		Cumulative data for the study size (N=394) Total	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Male	76	82.6	154	88.5	60	90.9	14	100	15	88.2	27	87.1	346	87.8
Female	16	17.4	20	11.5	6	9.1	-	-	2	11.8	4	12.9	48	12.2
Total	**92**	**100**	**174**	**100**	**66**	**100**	**14**	**100**	**17**	**100**	**31**	**100**	**394**	**100**

Source: Field Survey, 2017

Appendix V:

AGE AND THE CHOICE OF COOKING GAS AMONGST RESIDENTIAL DENSITY CLUSTERS

Age	High Density Planned		High Density Unplanned		Medium Density Planned		Medium Density Unplanned		Low Density Planned		Low Density Unplanned		Total	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
21 – 40	55	59.8	115	66.1	32	48.5	9	64.3	12	70.6	24	77.4	247	62.7
41 – 60	30	32.6	54	31	25	37.9	4	28.6	5	29.4	7	22.6	125	31.7
61 and above	7	7.6	5	2.9	9	13.6	1	7.1	-	-	-	-	22	5.6
Total	**92**	**100**	**174**	**100**	**66**	**100**	**14**	**100**	**17**	**100**	**31**	**100**	**394**	**100**

Source: Field Survey, 2017