HOUSEHOLD MOTIVATION TOWARD LIQUEFIED PETROLEUM GAS FOR COOKING PURPOSES

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Abstract

In Nigeria the population of households that use biomass and solid fuel for cooking is very high. These fuels have been described as 'dirty' because of their inefficient combustion. Unfortunately, the high dependence on these fuel types causes economic, social, and environmental problems. Therefore, there is a need to motivate the households using these fuels to adopt a cleaner fuel, Liquefied Petroleum Gas (LPG). This paper examined the factors that motivated current households using LPG in Lagos State to adopt LPG for cooking purposes. Online data were collected from 879 households in four Local Government Areas (LGAs) of the State - Lagos Mainland LGA, Agege LGA, Oshodi-Isolo LGA, and Surulere LGA. The data were analyzed using both descriptive and inferential statistics. The three hypotheses of the paper were tested with a multiple regression statistical method. Results indicated that LPG availability, household incomes, and household education level significantly motivated most of the households that have adopted LPG in the State. It was concluded that regular supply of LPG, growing household income, and high household education can motivate households in the State currently cooking with biomass and solid fuel to switch to LPG. The paper presented the practical implications of the findings.

Keywords: Adoption; Biomass; Clean cooking fuels; Liquefied Petroleum Gas; Household motivation.

1. Introduction

Historically, cooking is a major daily human routine around the world, which is used to to meet the nutritional needs of households. Ting et al. (2021) indicated that daily cooking is necessary for sustaining millions of people. Cooking is accomplished with energy of different forms, including traditional fuels (e.g. crop residues, animal lungs, coal, charcoal, and firewood) and modern fuels (e.g. kerosene, LPG, biogas, methanol, and electricity). Cooking energy constituted 80% of the total energy used in Nigeria; biomass, mostly firewood, accounted for a whopping 90% of cooking energy (International Energy Agency, IEA, 2015). This is a reflection of the biomass usage trends in developing countries. Biomass is the dominant cooking energy in many developing countries, particularly in Africa (Norad, 2020).

Between 2.5 billion and 3 billion people in developing countries use biomass for cooking purposes globally (Bonjour et al., 2013; IEA, 2006; Norad, 2020; WHO, 2014, 2016). Continued reliance on biomass and kerosene has negative effects on the people and the environment (World Liquefied Petroleum Gas Association, WLPGA, 2000). This is because inefficient and incomplete combustion of biomass emits large harmful pollutants such as respiratory particulates and carbon monoxide (Desai et al., 2004).

Exposure to these dangerous emissions constitutes health hazards and threatens the good health and well-being of the people. In particular, household air pollution (HAP) from cooking with dirty fuels causes more diseases and a high rate of premature deaths (Adane et al., 2021; WHO, 2015, 2020, 2024). Globally, HAP caused the death of an estimated 3.2 million people in 2020, including more than 237,000 children below 5 years. Various diseases contributed to these high premature deaths: 32% died of ischaemic heart disease; 23% died of stroke; 21% died of lower respiratory infection; 19% died of chronic obstructive pulmonary disease; and 6% died of lung cancer (WHO, 2024).

HAP from cooking with solid fuels was responsible for the death of over 128,000 people in Nigeria in 2019 (Murray et al., 2020). Similarly, cooking with traditional fuels also negatively affects both the environment and climate (Bruce et al., 2017; Watts, 2009; World Liquid Gas Association, WGLA, 2024) and economic activities (Heltberg, 2004; WGLA, 2024; WHO, 2016; World Energy Outlook, 2006). WGLA indicated that women and girls in developing countries spend a lot of time and effort gathering firewood and this prevents them from engaging in economic activities and earn income.

Access to clean cooking fuels can mitigate the adverse effects of cooking with traditional fuels. Consequently, policymakers, multilateral organizations, and environmentalists are encouraging households in developing countries to shift from traditional cooking fuels to modern, cleaner cooking fuels. This is in line with the Goal 7 of the Sustainable Development Goals (SDGs) – access to affordable, reliable, modern, and sustainable energy (UN General Assembly, 2015).

The shift to cleaner cooking fuels like LPG, biogas, ethanol, methanol, and electricity is due to their efficient burning (Quinn et al., 2018; Shen et al., 2018; WHO, 2015; 2024) and can potentially mitigate much of the high health affliction associated with ‘unclean’ fuels (Quinn et al., 2018). However, electricity costs are high and erratic in Sub-Saharan Africa (SSA) (Makonese et al., 2018) and it is impracticable to cook with it in developing

countries (Matthews & Reissign, 2015). In Nigeria, biogas and compressed biomass fuels are not yet developed, electricity supply is grossly limited and ever erratic, but LPG supply is increasing, according to Nnodim (2024). LPG remains the most popular alternative clean cooking fuel in terms of its affordability and reliability (WGLA, 2024).

Therefore, LPG is the only clean cooking fuel that is widely available, affordable, and reliable in Nigeria. Dombin (2017) noted that despite being a key producer of LPG in Africa, LPG adoption in Nigeria is low compared to other African countries. National Bureau of Statistics (NBS) (2020) affirmed that Nigeria made a little progress toward clean cooking from 2011 to 2018, with consumption increased from less than 5% to 10%. Consequently, the Federal Government, as a way of increasing access to clean cooking fuels in Nigeria, committed to the Paris Climate Change Agreement and set an ambitious target of making about 50% of households in the country to adopt LPG and 13% to adopt improved cookstoves by 2030.

The government planned to raise LPG supply to 5 million tons annually by 2030 to achieve this goal (Federal Ministry of Environment, 2024). It removed VAT from LPG and some energy products to reduce their prices and speed up the adoption of clean energy (Federal Ministry of Finance, 2024). It began free distribution of gas cylinders in Lagos State in August under the initiative to provide one million households to access to clean cooking energy (Jimoh, 2024).

Expectedly, Nigeria's LPG domestic consumption rose from over 400,000 tons in 2016 to 1.04 million tons in 2021 (Omuojine, 2021) and 1.4 million tons in 2023 (Hyde, 2023). Hyde noted that Nigeria's LPG consumption is still significantly lower than what is consumed in Morroco. Morroco, with a population of about 60 million people, consumes 5.5 million tons of LPG annually. Similarly, Nigeria's LPG per capita consumption increased from 1.8kg in 2015 to 5kg in 2021 (Omuojine, 2021).

In spite of the increasing popularity of LPG among households in Nigeria, there are a few extant studies that have investigated the household motivations for LPG adoption in Nigeria (Adeyemi & Adereleye, 2016; Baiyegunhi & Hassan, 2014; Bamiro & Ogunjobi, 2015; Lasisi, 2021; Ozor et al., 2018). These studies have used a small sample size and provided a limited amount of knowledge about motivations toward LPG adoption in the country. Besides, data for these studies were obtained via the traditional survey method and at a time when LPG was not widely adopted.

In contrast, the present study obtained large data through an online survey to reach a large number of diversified respondents across multiple local government areas in Lagos State, thus making the results more generalizable and filling a gap in the literature. In addition, the study is required to assess the response of the people in an urban city like Lagos State to various government interventions to promote LPG adoption in the country. WHO (2024) encouraged countries to formulate policies that will quickly increase access to clean fuels by 2030. Therefore, this paper examined consumer motivations toward LPG adoption in Lagos State and answered the following questions:

RQ1. *Does LPG availability significantly motivate households to adopt the fuel?*

RQ2. *Does households' income significantly motivate LPG adoption?*

RQ3. *Does households' education level significantly motivate LPG adoption?*

2. Literature Review

2.1 LPG and Motivation for Adoption

LPG is a mixture of propane and butane pressurized in cylinders for storage and transport (IEA, 2006), but may contain low concentrations of other hydrocarbons (Shen et al., 2018). It is a product of crude oil and natural gas production and petroleum refining (Bruce et al., 2017 Norad, 2020). It is also known as bottled gas or cooking gas (Norad, 2020) and it is produced with different compositions, which reflect different economics, regional norms, and climates (Shen et al., 2018). It is non-toxic, colorless, and odorless (Bruce et al., 2017). It is more popular as a clean fuel alternative (Gould & Urpelainen, 2018; Kojima et al., 2011; Norad, 2020). It has several applications (AssociationEuropéenne des Gaz dePétrole Liquéfés, AEGPL, 2019; WLPGA, 2017).

While LPG is mostly used in the domestic sector in Africa (87.6%), only 44% of it is consumed by households globally (WLPGA, 2016). In Nigeria, 85% to 95% of LPG is consumed by households for domestic purposes (Badmus & Bakri, 2021). The analysis of IEA data on access to clean cooking fuels in Nigeria by Dataphyte (2024) showed that 35.5 million people in Nigeria out of the estimated 211 million population in 2021 could access clean cooking fuels and technologies, representing 16.8% of the population. This suggests that about 175.9 used polluting fuels for cooking in 2021. Adoption of clean cooking fuels in Nigeria is taking longer than necessary (Oyeniran & Isola, 2023).

Adoption is defined as the decision-making activity of an individual through which a new product is accepted and used on a continuous basis (Kotler & Keller, 2015). It is buying and using a product for the first time and regularly purchasing it if it satisfies the needs of the consumer (Aminu, 2018). Adoption and diffusion of a new product is an important topic in marketing, helping marketers to understand how consumers learn about a new product, try, and subsequently adopt it (Aminu, 2018). Despite the high burning efficiency of LPG and its sustainability impacts, its adoption in developing countries is significantly low (Dombin, 2017; Jain et al., 2015; Norad, 2020).

However, some developing countries, especially in the Far East, Latin America, and to some extent North Africa and Sub-Saharan Africa (SSA) have witnessed increased use of LPG in the past 20 years (Norad, 2020). For example, Morroco had the highest LPG per capita consumption of 72kg/year in Africa in 2018; Egypt trailed Morroco behind with 43kg; this is followed by Ivory Coast and Ghana with 13kg each; Senegal and Angola had 9kg apiece; and South Africa, Cameron, Kenya, and Nigeria had 7kg, 4.5kg, 4.4kg, and 4kg respectively (Clean Cooking Alliance, 2022). Nigeria's LPG per capita consumption increased to 5kg in 2021 (Omuojine, 2021). The rate of adoption of clean cooking fuels in the country is unimpressive because of lack of access to clean fuels, low households income and low education (Oyeniran & Isola, 2023). The present paper examines the households' motivations for this positive trend.

2.1.1 LPG Supply (Availability) and LPG Adoption

In marketing, distribution is a crucial function responsible for making a product available in the market, where consumers can access and purchase it for the satisfaction of their needs (Aminu, 2022). Due to its importance, effective running of any economy depends on the efficient and sustainable supply of petroleum products (Aminu & Olawore, 2014). Market development, which includes the supply of fuels, is important to the adoption and use of energy by households (Puzzolo et al., 2016).

While the supply of LPG is in abundance globally, it is not evenly distributed across the globe, with North America, and the Middle East having the largest supply (Norad, 2020). Unlike solid fuels that are freely and widely available in developing countries, the acquisition of LPG is dependent on supply infrastructure, which is not within the control of households (Puzzolo et al., 2016). Inadequate supply and availability of LPG is one of the major barriers limiting the adoption of LPG in developing countries (Kojima et al., 2011).

In urban areas in Nigeria, LPG is widely available (Bruce et al., 2017). Despite this, there is still a high dependence on firewood, resulting in low per capita consumption of LPG in Nigeria, which Kalejaye (2014) estimated to be 1.8kg but increased to 5 Kg in 2021 (Omuojine, 2021). Efforts are required to make LPG more available and reduce its cost (Ihemtuge & Aimikhe, 2020). Access, availability, and reliability of LPG supply are important factors that affect usage (Kojima et al., 2011; WLGA, 2014). Provision and expansion of a more sophisticated supply infrastructure across the urban and rural areas in Ghana are crucial to motivating more households to switch to LPG (Dalaba et al., 2018). Consumers may be willing to buy LPG but not have access due to the unavailability of fuel in their neighborhoods (Chindarkar et al., 2021).

There is a plethora of empirical evidence on the availability of LPG and adoption of the clean fuel. Gupta and Kohlin (2006) conducted a study on the preferences for domestic fuel in Kolkata, India and found that the increased availability of LPG increased awareness of indoor air pollution and had a greater prospect for increased adoption in Kolkata, India. Lay et al. (2013) investigated solar home systems and lighting fuel choice in Kenya and their results indicated that access to renewable energy technology resulted in greater adoption of modern fuels by households in Kenya. Bisu et al. (2016) examined the urban household cooking energy choice in Bauchi metropolis, Nigeria and the findings showed that households' preference for cooking fuels is influenced by fuel availability in Bauchi State, Nigeria.

Karimu et al. (2016) undertook a study on who adopts LPG as the main cooking fuel in Ghana and why. They found that a reliable supply of LPG significantly affected the probability of adopting LPG in Ghana. Gould and Urpelainen (2018) carried out a research project on the adoption, use, and impact of LPG as a clean cooking fuel in rural India and found that LPG non-availability is a significant barrier to LPG adoption and sustained use in rural areas of India. Shupler et al. (2021), in their research on multilevel modeling of supply-side determinants of LPG consumption Sub-Saharan Africa, found that inconsistent supply of LPG constituted impediments to its adoption by households in peri-urban SSA countries.

In line with the foregoing, we hypothesize that:

H1: *LPG availability significantly motivates households to adopt LPG for cooking*.

2.1.2 Household Income and LPG Adoption

Prior studies have indicated that income (measured by per capita income) is a major factor determining a household mix, choice, and use of cooking fuels in developing countries (ENERGIA, 2012; IEA, 2006, 2015; Kojima, 2011; Lambe & Atteridge, 2012; Oyeniran & Isola, 2023). Due to the cost-prohibitive nature of LPG, households with low income may not be able to afford to regularly use LPG (Karimu et al., 2016). Low incomes households regularly avoid cooking with modern fuels (Ruiz-Mercado & Masera, 2015).

Income poverty is a major reason for the use of polluting fuels for cooking in Nigeria (Oyeniran & Isola, 2023). Though LPG has become more popular among the middle-income group in developing countries, it is more expensive than solid fuels (Debbi et al., 2014). Egypt trailed Morroco behind with 43kg; this is followed by Ivory Coast and Ghana with 13kg each; Senegal and Angola had 9kg apiece; and South Africa, Cameron, Kenya, and Nigeria had 7kg, 4.5kg, 4.4kg, and 4kg respectively (

Therefore, affordability has remained one of the major hindrances to the widespread adoption of LPG in developing countries (ENERGIA, 2012). This situation is improving in some countries, including Morroco, Egypt, Senegal, Ghana, Ivory Coast, South Africa, Cameron, Kenya, and so on (Clean Cooking Alliance, 2022), where an increasing number of low-income households are adopting LPG (ENERGIA, 2014). Studies have affirmed that the propensity of households in developing countries to shift to modern fuels such as LPG increases with the rise in income (Heltberg, 2004; Kojima et al., 2011; Zhang, 2010), while the use of solid fuels (SFs) decline especially in urban areas (Hetberg, 2004).

There is also a slew of empirical studies on household income and LPG adoption. Research by Kojima (2011) on the role of LPG in reducing energy poverty suggested that household income in 20 developing countries was one of the two major influences on the choice of LPG and the quantity consumed. Lambe and Atteridge (2012) investigated household energy decision-making in Haryana state, Northern India. Their findings indicated that low income deterred households in India from adopting LPG. Andadari et al. (2014) conducted a research project on energy poverty reduction through fuel switching in the rural, suburban, and urban areas of Indonesia. They found that rising households' incomes successfully motivated people to switch from kerosene to LPG in Indonesia.

Further more, in their research on who adopts LPG as the main cooking fuel in Ghana, Karimu et al. (2016) found that income was one of the key factors motivating households to choose LPG as the main cooking energy source in Ghana. Makonese et al. (2018) undertook a study on household cooking fuel use patterns and determinants across southern African countries and their results showed that income had a positive influence on the household type of cooking fuel used in the surveyed seven countries in the Southern region. Pooja and Shyamasree (2019) examined the factors that matter in household energy access in India. They found that states with higher incomes have greater access to LPG and electricity in India. In a choice experiment study on fuel preference of Kibera slum households in Kenya, Yonemitsu et al. (2015) found that fuel stacking was practiced more by households in Kenya with higher incomes.

Based on the foregoing analysis, we propose that:

H2: *Household income significantly motivates households to adopt LPG for cooking*.

2.1.3 Household Level of Education and LPG Adoption

Household level of education is another important determinant of LPG and modern fuels use in developing countries (Alem et al., 2015; Bamiro & Ogunjobi, 2013; Heltberg, 2005; Kojima, 2011). Education is key in fuel switching (Heltberg, 2005). A low level of education is a major hindrance to adoption of LPG (Shylag & Zuzarte, 2008). Households with more educated members are more likely to use cleaner and more efficient fuels as their main fuels (Bamiro & Ogunjobi, 2013; Mekonnen & Kohlin, 2008).

Households with lower education levels and private house ownership use fuels such as firewood and kerosene (Acharya & Marhold, 2019). Households with higher education levels are aware of the cost and other benefits of using clean fuels (Israel, 2002). They know about the time-saving benefits of using modern fuel (Reddy & Srinivas, 2009). Therefore, studies are unanimous that households with highly educated members understand the health and environmental risks that are associated with alternative fuels (Alem et al., 2015; Bamiro & Ogunjobi, 2015; Kojima, 2011).

There is also a plethora of evidence on the relationship between household education and LPG adoption. Heltberg (2005) carried out a research on the factors determining household fuel choice in Guatemala. Their findings indicated that there was a positive relationship between a higher level of education and adoption of LPG in the country. Kojima (2011) conducted a study on the role of LPG in reducing energy poverty and found that the more educated household members are, the higher the likelihood of the household using LPG for cooking in 20 developing countries. The results showed a larger effect for women than for men. Mekonnen and Kohlin's (2008) study on the determinants of household fuel choice in major cities of Ethiopia found that households with a member who had a post-secondary educational qualification in Ethiopia consumed more electricity and kerosene for cooking.

Similarly, the research by Alem et al. (2015) on the household cooking fuel choice in Ethiopia suggested that the higher the level of education, the higher the probability of using clean fuel sources and the smaller the chance of using biomass fuels in Ethiopia. Pooja and Shyamasree (2019) undertook a study on the factors that matter in household energy access in India. Their findings showed that households with a higher literacy rate have greater access to LPG and electricity in India. Gould and Urpelainen (2020) investigated the role of education and attitudes in cooking fuel choice in India and the results indicated that education greatly predicted LPG adoption in India. Finally, Ifegbesan and Makonese (2022) examined the energy preferences for household cooking in Burundi and found that household's highest level of education determined the cooking fuel used in Burundi.

From the foregoing, we hypothesize that:

H3: *Household level of education significantly motivates households to adopt LPG for cooking*.

2.2 Theoretical Framework

This research is anchored on the energy ladder theory and the fuel stacking theory. These two theories are apposite to explain households' behaviors toward cooking fuels in Nigeria.

2.2.1 The Energy Ladder Theory

The energy ladder theory has its foundation in the economic theory and regards a household energy transition as taking place in a hierarchical order, from the most traditional fuel (animal dung and crop residue) to the most modern and cleanest fuel (LPG and electricity) as the household socio-economic status increases (Hosier & Dowd, 1987). Households' increasing income motivates them to use fuels on the higher rungs of the ladders until they get to the zenith of the ladders (Goldemberg 2000).

LPG and electricity are in the last phase of a household fuel transition (Heltberg, 2004). The transition on the ladder is mainly determined by the household's rising income level and relative fuel prices (Barnes & Floor, 1996) and by fuel price, which reflects its levels of cleanliness and efficiency (Goldemberg 2000). The low income people are likely to cook with biomass fuel, while the wealthy populace will choose costly and clean burning fuels (Heltberg, 2005). As a household switches to a new fuel, it simultaneously abandons the previous fuel it was using (Heltberg, 2005).

2.2.2 The Fuel Stacking Theory

The fuel stacking theory, on the other hand, regards household fuel choice as involving multiple types (sources) (Dewees, 1989). According to Elias et al. (2005), households with increasing income adopted technologies that partially and not fully substitutes the traditional ones. Bruce et al. (2017) explained that households can quickly upscale to LPG because of lower initial costs of the required infrastructure and ease of transportation and storage. A number of studies have supported the fuel stacking hypothesis in developing countries.

Mekonnen and Kohlin's (2009) results supported the fuel stacking theory, which is more apt to depict fuel adoption behavior of households in developing countries. Yonemitsu et al. (2015) found that fuel stacking was practiced more by households with higher incomes in Kenya. The findings suggested that households increased the number of fuels they used as their income increased. Perros et al. (2023) also found that targeted fuel stacking interventions can reduce the use of polluting fuels in developing countries.

3. Methods

The study area was Lagos State, the commercial and economic city in Nigeria. Despite its commercial and economic significance, Lagos ranked as the fourth least livable city out of 173 global cities (EIU, 2024). The study used a cross-sectional design and obtained online data from respondents in four local government areas (LGAs) of Lagos State, determined by a voluntary response method of sampling. The four LGAs are: Lagos Mainland, Agege, Oshodi-Isolo, and Surulere.

A structured questionnaire, developed by the authors, was used to elicit the opinions of the respondents who participated in the study. The questionnaire has two parts, A and B. Part A covers the four research constructs (namely, LPG availability, household level of education, and household income (independent variables), and LPG adoption (dependent variable), while the second part deals with the demographic information and cooking fuel usage of the respondents. LPG availability is measured by five items; household education level is measured by four items; household income level is measured by four items; and LPG adoption is measured by three items.

Because all the variables in the questionnaire measure the respondents' attitudes, the questionnaire used a Likert Scale question type, with five points. Each of the statements in the scale was rated on a five-point scale, ranging from 1-5. 1 represents "Strongly Disagree" and 5 represents "Strongly Agree". Prior to the collection of the main data, a pilot study was conducted with a valid sample of 56 respondents at Ikorodu from 8th to 11th May, 2023. The study was used to pretest the questionnaire and make any adjustments to it. According to O'Sullivan et al. (2017), the pretesting of a survey instrument allows the

researcher to determine the adequacy and feasibility of data collection plans, train fieldworkers, and adjust the instrument, if necessary

The main online survey lasted for four months from May to September, 2023, and targeted a voluntary response sample of online respondents. Eight hundred and seventy-nine copies of the retrieved questionnaire were usable and analyzed. Cronbach Alpha was used to test the internal consistency of the research instrument. Multiple Regression analysis was used to test the three hypotheses of the paper.

4. Results and Discussion

4.1 Results

Table 1 provides information on respondents' demographics. Majority of the respondents, 67%, are female, who traditionally in the African culture, are responsible for cooking; 52% of respondents are 36 years and above, making them old and mature enough to understand the subject matter of LPG; a large population of respondents, 44%, are married; 63% possess at least a National Diploma certificate, which makes them to have good education to understand the importance of the research; 77% are self-employed or employed by private companies.

Table 1 − Respondents' Demographics

Variables	Frequency	%	Variables	Frequency	%
Gender			**Income**		
Male	326	37	N80,000-150,000/month	218	25
Female	553	63	N151,000-220,000/month	283	32
Age Category			N221,000-290,000/month	159	18
21-25 years	113	13	1N291,000-360,000/month	146	17
26-30 years	145	16	Above N360,000/month	73	08
31-35 years	164	19	**Local Government**		
36-40 years	268	30	Lagos Mainland	201	23
40 years and above	189	22	Agege	212	24
Marital Status			Oshodi/Isolo	349	40
Single	191	22	Surulere	117	13
Married	388	44	C**ombined 2 fuel types**		
Divorced/Separated	217	25	Yes	691	79
Widowed	83	09	No	188	21
Qualification			**Fuels Combined**		
O'Level	236	27	Kerosene and cooking gas	36	20
ND/HND/B.Sc	554	63	Kerosene and firewood	Nil	Nil
Post-graduate	89	10	Cooking gas and firewood	71	10
Occupation			Kerosene and charcoal	Nil	Nil
Private employee	281	32	Firewood and charcoal	Nil	Nil
Civil servant	206	23	Cooking gas and charcoal	175	25
Self-employed	392	45	Kerosene and electricity	Nil	Nil
			Cooking gas and electricity	309	45

Source: Authors' analysis

Further, 65% earn a minimum of N150,000/month, making LPG affordable for them; 40% are residents in the Oshodi/Isolo Local Government Area of Lagos State; and 79% acknowledged the fact that they were combining at least two cooking fuels; 45% of respondents stacking cooking fuels were combining cooking gas and electricity, 25% were using both cooking gas and charcoal, and 20% were cooking with cooking gas and kerosene.

Table 2 shows the construct reliability statistics based on Cronbach's Alpha and explains the internal consistency of the various items of each of the four constructs. The rule is that an Alpha value greater than .70 shows a high level of internal consistency (Cronbach, 1951). The table shows that LPG adoption has the least Alpha value of .848, while LPG availability has the highest Alpha value of .904. This suggests that our scale is reliable and can be replicated in future research.

Table 2 − Reliability Statistics for Items

Construct	Number of Items	Cronbach Alpha
LPG Availability	5	.904
Households' Income	4	.864
Households' Education Level	4	.848
LPG Adoption	3	.872

Source: Authors' analysis

The R in table 3 is the multiple correlation coefficients and determines the quality of dependent variable. A value of .684 in the table suggests a good level of prediction. The R^2 in the table is the coefficient of determination and is the amount of variance in the dependent variable that can be explained by all the independent variables. Therefore, the (R^2 = .468) indicates that 46.8% of the variance in LPG adoption is explained by the three independent variables of the paper. The remaining 53.2% is explained by other factors not covered in this research. This is depicted in the model as a stochastic error term.

Table 3 − Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.684	.468	.401	5.395

Predictors: (Constant). LPG availability, Household income, Household level of education.
Dependent Variable: LPG adoption.
Source: Authors' analysis

The F-ratio in Table 4 shows the extent to which the overall regression model is a good fit of the data. The table shows that at least one of the three independent variables statistically significantly predicts the dependent variable, LPG adoption, i.e. F(4,96) – 231.628. $p < .05$, and this indicates that the model is a good fit. This suggests a linear relationship among the variables and that there is a 96% chance that this relationship is not due to chance. The Sig. column in the coefficient table shows which and how many of these variables are significant.

Table 4 − ANOVA

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	64827.263	4	16206.263	231.628	.000[b]
Residual	74926.628	426	48.104		
Total	139753.891	1430			

a. Predictors: (Constant). LPG availability, Household income, Household level of education.
b. Dependent Variable: LPG adoption.

Table 5 − Regression Results for LPG Adoption

Constructs	Standardized Beta	t	Sig.
Constant	1.493	10.736	.000[b]
LPG Availability	.283	3.624	.000
Household Income	.362	4.246	.000
Household level of Education	.269	5.273	.002

a. Dependent Variable: LPG Adoption.

4.2 Hypothesis Testing

H_1: *LPG availability significantly motivates households to adopt LPG for cooking*.

The result of hypothesis 1 suggests that LPG availability is statistically significant and predicts LPG adoption for our dataset (B = .283, p<.05). Thus, hypothesis 1 is accepted, suggesting that LPG availability significantly motivates LPG adoption. LPG availability with Beta weight of .283 is the second-best motivator of LPG adoption for our sample.

H_2: *Household income level significantly motivates households to adopt LPG for cooking.*

The result of hypothesis 2 suggests that household income is statistically significant and predicts LPG adoption for our dataset (B = .362, p<.05). Thus, hypothesis 2 is supported, suggesting that household income significantly motivates LPG adoption. Table 5 shows that household income has the largest Beta weight of .362, indicating that it is the best motivator of LPG adoption.

H_3: *Household level of education significantly motivates households to adopt LPG for cooking.*

The result of hypothesis 3 suggests that household level of education is statistically significant and predicts LPG adoption for our dataset (B = .269, p<.05). Thus, hypothesis 3 is corroborated, implying that household level of education significantly predicts LPG adoption. From Table 5, household level of education has the least beta weight of .269.

4.3 Discussion

We ran a multiple regression analysis to understand the factors motivating households to adopt LPG in Lagos metropolis. The regression model suggests that the three constructs are significant in motivating households in Lagos metropolis to adopt a cleaner fuel, LPG,

for their cooking. LPG availability significantly motivates LPG adoption. The model was significant ($p<.05$), indicating that it is a good fit.

The model shows that household income is the best motivator of LPG adoption. The result suggests that households with high income use LPG regularly for their cooking. This finding is in line with the findings of earlier studies (Andadari et al., 2014; Karimu et al., 2016; Makonese et al., 2018; Pooja & Shyamasree, 2019; Yonemitsu et al., 2015). Currently, household incomes in Nigeria are very low and this finding means that as income of an average household increases, more and more households using dirty fuels will abandon them for LPG. This result is consistent with the energy ladder hypothesis (Hosier & Dowd, 1987). The energy ladder theory stated that a household energy transition takes place in a hierarchical order, from the most traditional fuel to the most modern and cleanest fuel as the household socio-economic status increases (Goldemberg 2000; Heltberg, 2004).

LPG availability is the next most important factor motivating households to cook with LPG in Lagos. This suggests that households place a premium on the access and availability of LPG in their neighborhood, suggesting that more households will switch to LPG if it is widely available like biomass and solid fuel. This result is corroborated by the results of extant studies (Bisu et al., 2016; Gould & Urpelainen, 2018; Karimu et al., 2016; Lay et al., 2013; Shupler et al., 2021). Like in many developing countries, LPG pipeline infrastructure is not yet developed in Nigeria.

Consequently, LPG is supplied through large or small LPG dispensing plants and mostly through mini LPG retail shops within the neighborhoods. As modern supply infrastructure, through gas pipelines, is developed and supplies gas directly into homes, more households are most likely to switch to LPG for their cooking. Dalaba et al. (2018) explained that the provision and expansion of a more sophisticated supply infrastructure across the urban and rural areas in Ghana are crucial to motivating more households to switch to LPG.

Finally, a household level of education also significantly motivates LPG adoption. This result is supported by the results of previous studies (Alem et al., 2015; Gould & Urpelainen, 2020; Heltberg, 2005; Ifegbesan & Makonese, 2022; Kojima, 2011; Mekonnen & Kohlin, 2008). This result suggests that the level of literacy is significantly related to the adoption of clean fuels like LPG.

This is because households with higher education levels are aware of the cost and other benefits of using clean fuels (Israel, 2002). They know about the time-saving benefits of using modern fuel (Reddy & Srinivas, 2009). The result reflects the increasing literacy rate in Nigeria. According to GlobalData (2024), as more people received better education in Nigeria, the country's literacy rate increased to 77.62% in 2021. If this trend continues, more households will switch to LPG in the future.

4.4 Contribution to Knowledge

The paper contributes by providing a fresh insight into the factors that motivated current households that have adopted LPG for cooking purposes and obtaining large-scale data through an online survey to reach a large number of diversified respondents across multiple local government areas in Lagos State, thus making the results more generalizable than similar studies.

5. Conclusion and Implications

5.1 Conclusion

Households across the world engage in daily cooking to obtain the necessary nutrition and live healthily and happily. While most households in industrialized and emerging countries rely on clean cooking fuels, several households in developing countries, especially in SSA, depend on dirty fuels for their cooking. In spite of many initiatives by the FGN to increase LPG adoption in Nigeria, the transition to LPG is still very low. Therefore, the paper investigated the factors that motivated households that have adopted LPG in Lagos metropolis.

The three constructs of the paper are found to be significant motivators for the households that have adopted LPG; household income is the most significant motivator. It can be concluded that growing household income, steady and regular supply of LPG, and rising household education can motivate households currently cooking with biomass and kerosene to adopt LPG.

5.2 Implications of Findings

The research findings have a number of practical implications. Hetberg (2005, p. 14) suggested that a "better understanding of the obstacles for the greater spread of clean cooking fuels would be of policy interest". For policymakers in Nigeria, the finding on LPG supply and availability implies that government interventions are continuously required to ensure steady and uninterrupted supply of LPG. KPMG (2020) indicated that government-led reforms have motivated the transition from kerosene stoves and firewood to LPG. In this regard, Nigeria Liquefied Natural Gas' (NLNG) decision to supply all its output to the local market is a welcomed development.

NLNG (2024) indicated that it committed its entire Butane and Propane production to the domestic market from 2023. Nnodim (2024) reported that NLNG has increased LPG production to 1.5 million tons and will sell the entire output to the local market. With the LPG consumption nearing 1.5 million tons, the government will need to augment local LPG output with imported LPG to guarantee steady supply of the cleaning fuel and keep more households motivated to adopt LPG. Shortage of the fuel might result in avoidable price increase and make it unaffordable to low income households intending to adopt it.

The significant motivating effect of income on LPG adoption implies that policymakers must formulate economic policies that will create massive employment opportunities and provide a real living wage for a large number of jobless and under-employed Nigerians. Higher incomes will empower millions of low-income earners and motivate them to switch to LPG. Increased adoption of LPG will present greater opportunities for marketers of LPG fuel, cylinders, and accessories.

A higher level of education among households will spur higher LPG demand and consumption of the fuel, creating more marketing job opportunities in Lagos State and across Nigeria, and contributing to unemployment reduction. Finally, with more households adopting LPG in Lagos metropolis, HAP will be mitigated, resulting in improved health of the people, especially women and girls, who have a responsibility for cooking. The clean burning of LPG will also mitigate the amount of GHG and other emissions in the metropolis, resulting in an improved environment.

5.3 Limitations and Suggestions for Further Studies

The research has a number of limitations. One, the findings of the paper are limited by the scope of the study - four LGAs in Lagos State. Future studies should consider covering more LGAs and in more States in Nigeria to make the findings more generalizable to the entire country. Two, the research was undertaken in the urban areas of Lagos and the results may not represent the situation in the rural areas of Lagos. Additional research is required to validate the variables of the research in the rural areas of the State.

Three, the voluntary sampling technique used to obtain our data is flawed with a self-selection bias and this limits the generalizability of the findings of the study. Future research should consider any of the probability sampling techniques to make the findings more generalizable. Finally, Lagos is a mega city with a population of about 20 million people. A sample size of less than 1,000 respondents may be limited to generalize the findings to the entire population. Future research should consider using a large sample size to provide more reliable data with smaller margins of error and standards of deviation.

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