WHY HOUSEHOLDS DELAY IN ADOPTING LIQUIDIFIED PETROLEUM GAS FUEL FOR COOKING USE?
A Case of Mbeya City, Tanzania

*Christopher Mgimba[1], Abbas Sanga[2] and Asheri Mwidege[2]
[1]Mbeya University of Science and Technology, Institute of Science and Technology
[2]Mbeya University of Science and Technology, School of Humanities and Business Studies
E-mail: cnngimba@yahoo.co.uk (*Corresponding Author*)

Abstract: This paper aimed at making assessment of the factors influencing adoption of LPG by households in Mbeya city. The sample size of 103 households was used in this study. The households were randomly selected from six wards. The study used cross-sectional research design where the data collected once from the identified sample of households. The collection of data based on questionnaire and interviews from key informants such as company supplier agents. The raw data were processed and analyzed through STATA version 11. The multi-collinearity problem was tested and variance inflationary factor (VIF) results showed that there was no multi-collinearity problem since VIF value was in the range of 0.09-0.55. The study revealed that adoption of LPG by households influenced by a number of factors among which include the prices of LPG and average usage of money to purchase LPG per month, family size, Institutional denial to the access to forest, and Decentralized LPG cooker production sites and markets, all are inversely associated with the household's willingness to switch to modern energy. Other variables such as Literacy level, availability of Government Institution closer to the users coupled with service provision positively associated with the households' willingness to adopt LPG.
Keywords: Liquidified Petroleum Gas (LPG), Household fuel, Mbeya city, Tanzania

1.0   Introduction

The level of energy consumption in households varies greatly among the types of energy sources available. Households in Tanzania generally use a mixture of energy sources for cooking, heating and lighting. Such energy sources categorised as traditional (such as dung, agricultural residues and fuel wood), intermediate (such as charcoal and kerosene) or modern (such as LPG, biogas, ethanol gel, plant oils, dimethyl ether (DME) and electricity) (Malla and Timilsina, 2014). The use of multiple energy sources in households provides a sense of energy security, since complete dependence on single energy source subject the households to the effects of price fluctuation and unreliable supply (WEO, 2006). However, the national energy balance is dominated by biomass-based fuels, particularly wood (charcoal and firewood) mainly for heating and cooking. According to the assessment made by ECS

(2015), wood (charcoal and firewood) accounts for 88% of the total energy consumption in both rural and urban areas, and the modern energy source such as oil, gas, electricity, and coal, as well as non-biomass renewable energy, account for the remaining 12%. The pattern of biomass consumption in Tanzania varies by locality; for example, firewood is the main source of energy in rural households whereas charcoal is more frequently used in urban households (Damian, 2009).

The over dependence of both urban and rural households in Tanzania on biomass fuels contribute to land degradation and deforestation/forest degradation and hence climate change. The extensive use of biomass fuel in cooking not only is a threat to the environmental quality but also have severe implications for human health. The World Health Organization (WHO) found that indoor air pollution associated with biomass use is directly responsible for more deaths than malaria, almost as many as tuberculosis and almost half as many as HIV/AIDS (WEO, 2006).

The energy sector in Tanzania is governed by the National Energy Policy (NEP, 2003) which was revised in 2014. The broad objective of the National Energy Policy is to ensure availability of reliable and affordable energy supplies and use them in a rational and sustainable manner to support national development goals. One of the specific objectives of the policy focuses at adequately taking into account of environmental considerations for all energy activities. Therefore, extensive consumption of modern energy sources like LPG complies with the policy's objective which promotes environmental sustainability.

Household energy consumption for modern energy sources like liquidified petroleum gas (LPG) is expected to increase proportionally with the growth in economy and rise in per capital income among the people. According to the energy ladder model, people tend to shift from traditional fuels such as firewood, charcoal and other biomass fuels to more modern and efficient fuel such as LPG, kerosene and electricity which have good health and environment implications, as a result of per income increase (Heltberg, 2005 and Toole, 2015). The household with low level income over depend on biomass, such as wood and dung, while the well-off households switch to cleaner and efficient energy sources like LPG and electricity (Thadeo, 2014). This trend of household energy consumption is contrary in many households in developing countries where they do not switch to modern energy sources, instead tend to consume both traditional (firewood, charcoal and dung) and modern fuels (kerosene, LPG and electricity) (Moses, 2006; Thadeo, 2014; Malla and Timilsina, 2014).

A study by Thadeo (2014) conducted in Arusha city in Tanzania, revealed that households are moving-up the energy ladder and their fuel choices are not only determined by their level of income but with addition of factors such as; higher education of household head, occupation of woman in the household, marital status, age of the household head, residence ownership, urbanization and insufficient availability and poor quality of traditional fuels in the market; tend to encourage adoption of modern fuels. Thus the authors found motivated to examine the factors influencing household cooking fuel choice in Mbeya city where its people have their own life background since variation in cultural background influence people's behaviuor, perception, knowledge, and choice (Kastanakis and Voyer, 2014).

2.0   Methodology

The study was carried out in Mbeya city in Tanzania. The city lies between latitude 8° $50'$- 8° $57'$ South of Equator and Longitude 33° $30'$-35° $35'$ East of Greenwich. According to URT (2012) National Census, Mbeya City Council had a total population of 385,279 in habitants, out of which 182,620 (47%) are male and 202,659 (53%) are female. The city population growth rate is 4% compared to the national average of 2.7%. It is situated at an elevated land along the slopes of Mount Mbeya ranges at an altitude rising from 1600 to 2400 meters above sea level. The city is characterized by moderate climate, with the mean annual rainfall of 1200 mm received between November–May which is accompanied with mean temperature ranging between 110C – 250C (MCC, 2015).

The sample size of 103 households was used in this study. The households were randomly selected from six wards namely Nsalaga, Iganzo, Ilomba, Sinde, Forest, and Ghana as shown in table 1. The wards were purposively chosen for they are adequately supplied with LPG shops. The study used cross-sectional research design where the data were collected once from the identified sample of households. This design was adopted because of its strength over other designs in providing useful data for simple statistic description and quantitative estimations (BMJ, 2014).The collection of data based on questionnaire and interviews from key informants such as company supplier agents. The collected raw data from the field were processed and analyzed through STATA version 11.

Table 1: The Household Sampled

Ward	Population size in each ward	Number of Households in each ward	Household sample size in each ward
Nsalaga	18993	4522	23
Iganzo	14414	3432	17
Ilomba	34021	8100	41
Sinde	7014	1670	8
Forest	6649	1583	8
Ghana	4885	1163	6
Total	**85976**	**20470**	**103**

Multiple linear regression analysis was used. The multi-collinearity problem was tested and variance inflationary factor (VIF) results showed that there was no multi-collinearity problem since VIF value was in the range of 0.09-0.55 which comply with the rule of thumb that if VIF is less than 5.3 then there is no multi-collinearity problem (Hair *et al.*, 2006).

2.1   Econometric model

Multiple linear regressions were used to determine the factors that affect LPG fuel use was implicitly specified as follows:

$$Y = f(x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + \ldots\ldots x_{14}) \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where:

$x_1 = $ Age

$x_2 = $ Marital status

$x_3 = $ Literacy level

$x_4 = $ Household size

$x_5 = $ Responsible person to purchase LPG stove in the household

$x_6 = $ Responsible person to purchase LPG in the household

$x_7 = $ Price of LPG

$x_8 = $ Average usage of money to purchase LPG per month

$x_9 = $ Nearby Government Institution (Through development agents, experts, health extension)

$x_{10} = $ Institutional denial the access to forest

$x_{11} = $ Services provision (awareness creation, quality control, price regulation)

$x_{12} = $ Support provision to households (Material, Technical, financial)

$x_{13} =$ Institutional influence on the availability and accessibility of LPG cooker

$x_{14} =$ Decentralized LPG cooker production sites (transportation cost)

3.0   Results and Discussion

Findings indicate a reasonably good prediction of household fuel choices in Mbeya city as found in table 2. Results show that age is inversely correlated with the use of LPG fuel and statistically significant at p<0.01, meaning that adoption of LPG fuel is less likely influenced by old age to make a household switch to the use of gas as an alternative to biomass energy sources such as firewood and charcoal. This study did not deep down to see the difference in attitude between youths and old people in the choice of energy sources. However, the choice of energy by older people might be influenced by the long experience they have on the application of biomass energy sources over the LPG which is a modern energy source. As some times the choice influenced by the cultural, social or taste preferences of the users (Farsi *et al*., 2006).

Findings show that household size is strongly and inversely associated with LPG at P<0.01 meaning that the bigger the family size the lesser likelihood to adopt and use LPG fuel in the household cooking. Such observation in this study is consistent with that of Mwaura *et al.,* (2014) which reported that the households with many members are unlikely to adopt cleaner energy due to more energy requirements and associated costs to fulfill household demand. This is also supported by the study by Bamiro and Ogunjobi (2015) which also shows that family size has negative effect on the choice of energy sources by households.

Moreover, service provision to households is positively correlated with the choice of LPG fuel and statistically significant at p<0.01. This implies that despite minimal use of LPG fuel in households there is insufficient material, technical and financial support from the service providers, this culminates many households to fail to use LPG fuel as they lack technical support which is very important in raising awareness among the current potential users.

Decentralized LPG cooker production sites and markets are inversely associated with the adoption of LPG and significant at p<0.01. This also implies that proximity of the markets for gas cooker and the gas to the users has an influence to the households in adopting the use of LPG. Households which are far away from markets for gas cooker and the LPG have less likelihood to adopt and use LPG than those with enhanced accessibility to such energy source. This observation is in line with that from a study by Suliman (2013) which found that

the proportion of rural households adopting biomass fuels is very high compared to their urban counterparts that is 79.3%, versus 36.7 %.

The findings in this study revealed that the formal education of households' members have, positive influence over the willingness of households in adopting LPG as their source of energy. Those who have acquired primary or secondary or tertiary education are expected to have better understanding about the advantages of using LPG over other sources of energy like biomass or kerosene in cooking. Thus the willingness to adopt LPG increases with the level of education of the head of household. Where the head of household is educated, there is likelihood for the family retreat from the use of biomass energy source for cooking and alternatively adopts LPG. The same observation was made in studies by (Suliman, 2013; Bamiro and Ogunjobi 2015 and Danlami *et al.,* 2015).

Service provision like price regulation and awareness creation has positive influence to the households in adopting LPG energy source. The association between the energy choice and the service provision is at $p<0.01$ significant level. The findings show that, some of households have not adopted LPG fuel for they lack correct information about the proper use of LPG stove and installation within the household. This matches with the findings by Farsi *et al*., 2006 which show that better education increases the awareness of households on the negative health impacts associated with the use of biomass and the advantages of modern fuel use, in terms of efficiency and convenience can be a motive among the households to switch to modern fuel sources.

Moreover, the results show that availability of institution or agents or experts for LPG closer to the households have positive correlation with the adoption of LPG at $p<0.05$ significant level, this means that availability of institutions which provide assistance to the households in terms of information and technical services might encourage more users to adopt LPG as their source of cooking energy.

Table 2: Regression Results of Ordered Linear Regression Model

Variables Label (Firewood, Kerosene, LPG)	Coef.	Std. Err.
Age	-0.0587467***	0.0033252
Marital status	0.1501158**	0.0708982
Literacy level	0.4069411***	0.0181045
Household size	-1.166679***	0.0625879
Responsible person to purchase LPG stove in the household	1.548163***	0.0669746
Responsible person to purchase LPG in the household	0.7074779***	0.0335003
Price of LPG	0.2205064***	0.027439
Average usage of money to purchase LPG per month	-0.7521402***	0.0403557
Nearby Government Institution (Through development agents, experts, health extension)	2.448598***	0.1036706
Institutional denial to the access to forest	-0.9676969***	0.0322215
Services provision (awareness creation, quality control, price regulation)	0.1965167***	0.0200126
Support provision to households (Material, Technical, financial)	-0.7879036***	0.0415602
Institutional influence on the availability and accessibility of LPG cooker	0.1829424**	0.0768702
Decentralized LPG cooker production sites and market	-0.826555***	0.046946
Cons	-0.184864	0.4401221

** Significant at 0.05; *** Significant at 0.01

Institutional denial to the access to forest, it is inversely associated with the choice of LPG statistically significant at $p<0.01$ implying that, if legislations denying the use of forest resources could be strict enforced, may influence people to switch away from the use of biomass and adopt the cleaner energy sources. The institutional denial becomes stronger if enforcement of legislations coupled with fiscal policies, where taxes for the forest products could be raised such that they discourage user. This suggests that more families are likely to adopt and use LPG fuel if there is an exorbitant charcoal price caused by government ban to use forest resources for cooking. However, price adjustment should also be made to LPG and the associated appliances to make the affordable to the users.

Expenditure in purchasing LPG stove or the gas itself is inversely associated with probabilities of a household choosing modern energy source at $p<0.01$ significant level. The findings show that, the households are responsive to the monthly expenditure in purchasing the LPG or the LPG stove. High expenditure hinders households from switching to the use of LPG in cooking as this has direct connection with the price of the LPG. High prices in LPG influences negative the choice by households. The response to the prices by the house

depends on the income levels of the households. Thus, switching to modern fuel can be influenced by the economic status of the households (Farsi *et al.,* 2006 and Thadeo, 2014).

4.0   Conclusion and Recommendation

The study has observed high dependency on biomass as cooking energy source among households in Mbeya city. The adoption of LPG by households in Mbeya city influenced by a number of factors positively or negatively. There is direct relationship between households' average usage of money to purchase LPG per month. Considering that the purchasing power of households depends on their level of income. Households were also observed to be sensitive to prices of LPG as it was inversely correlated to their willingness. Therefore responsible authorities could at least regulate prices of LPG to the extent affordable by many customers with low income to encourage them shift from biomass to LPG cooking energy. Institutional denial to the access to forest through application of fiscal policies can positively influence household in adopting LPG if prices are also considered.

References

[1] Bamiro, O.M and Ogunjobi, J.O (2015); Determinants of Household Energy Consumption in Nigeria: Evidence from Ogun State. The internationaljournal.org 4: 36-41.

[2] BMJ (2014); Cross sectional studies: advantages and disadvantages; 348:g2276

[3] Damian, C., (2009); Energy systems: Vulnerability- Adaptation- Resilience (VAR), Regional Focus Sub-Sahara Africa, Tanzania.

[4] Danlami, A.H; Rabiul Islam; Shri Dewi Applanaidu (2015); International Journal of Energy Economics and Policy 5 (1): 197-205

[5] Energy Charter Secretariat (2015); Tanzanian Energy Sector under the Universal Principles of the Energy Charter.

[6] Hair, J. F., Black, W.C., Babin, B.J., Anderson, R.E and Tatham, R.L (2006); Multivariate Data Analysis. Pearson Prentice hall.p889.

[7] Heltberg, R. (2005); "Factors Determining Household Fuel Choice in Guatemala," *Environment and* Development Economics 10: 337–61.

[8] Kastanakis, M. and Voyer, B. G. (2014); The effect of culture on perception and cognition: a conceptual framework. Journal of Business Research, 67 (4). pp. 425-433. ISSN 01482963

[9] Malla, S and Timilsina, R. G (2014); Household Cooking Fuel Choice and Adoption of Improved Cook stoves in Developing Countries.

[10] Mbeya City Council (2015); Mbeya City Council; City Health Department Annual Report.

[11] Mwaura,F; Okoboi, G and Ahaibwe, G (2014); Determinants Of Household's Choice Of Cooking Energy In Uganda; Research Series No. 114

[12] Suliman, M. K (2013); Factors Affecting the Choice of Households' primary Cooking Fuel in Sudan.

[13] Thadeo, M, S (2014); Economics of Urban Households' Cooking Fuel Consumption in Arusha City, Tanzania; Sokoine University of Agriculture. Morogoro, Tanzania.

[14] The United Republic of Tanzania (2012); Population and Housing Census, National Bureau of Statistics Ministry of Finance Dar es Salaam and Office of Chief Government Statistician President's Office, Finance, Economy and Development Planning Zanzibar

[15] Toole, R (2015); The Energy Ladder: A Valid Model for Household Fuel Transitions in Sub-Saharan Africa?

[16] World Energy Outlook (2006); Energy For Cooking In Developing Countries.