

Socio-Economic Factors Influencing Household Access to Liquefied Petroleum Gas in Dodoma City, Tanzania

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Abstract: This study sought to establish the influence of socio-economic characteristics on the household access to Liquefied Petroleum Gas (LPG) in Dodoma City, Tanzania, using the cross-sectional survey design. Yamane formula was used to determine the sample size of 100 respondents. The decided heads of households (respondents) were then selected from the population using a systematic random sampling procedure to fill a questionnaire. The IBM-Statistical Statistical Package for Social Science (SPSS) Version 20 was used to code and analyze the obtained data. Binary Logistic Regression model was used to establish the socio-economic factors that influenced households' decisions regarding access to LPG. The study concludes that socio-economic factors aside from sex and marital status have a substantial influence on the possibility of accessing LPG service in Dodoma City. Given these strong results, the researchers call for strategic investments in civic education programs focused at promoting eco-friendly alternative energy sources and supporting household economic stability to consistently increase the affordability of LPG pricing. The study also emphasizes how crucial it is for policymakers to be committed to tackling problems associated to poverty. The adoption of policies intended to enhance the general living standards of households in the area is advised as is the creation of a social security insurance program to lessen instances of poverty. These suggestions are essential steps to guaranteeing better access to LPG and improving the community's general standard of living in Dodoma City.

Keywords: Biomass Cooking Fuels; Cooking Energy; Liquefied Petroleum Gas.

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Introduction

International Energy Agency (IEA), 2017 estimates that 2.5 billion people use traditional solid biomass cooking fuels like animal dung, agricultural waste,

firewood and charcoal, which are inefficient and environmentally harmful (Malla & Timilsina, 2014), contributing to problems like indoor air pollution (IAP), health risks (Masera et al., 2000),

deforestation, poverty and gender inequality. Even though modern substitutes like electricity and Liquefied Petroleum Gas (LPG) are readily available, the reason why the majority of people in developing and low-income countries continue to use these fuels in spite of their known negative effects is still a hotly debated issue in both academic circles and policy discussions. The energy stacking and energy ladder theories, which influence household energy decisions, serve as the foundation for this study (Rajmohan & Weerahewa, 2007). The standard energy ladder model places a strong emphasis on income (affordability) as the only factor influencing a household's decision to adopt LPG (Masera et al., 2000). The energy stacking theory, a more modern viewpoint backed by actual data, provides a more thorough and realistic explanation in comparison (Kowsari, 2013). According to Masera et al. (2000) and Schlag and Zuzarte (2008), a household's choice to utilize LPG is influenced by a complex interplay of economic, social, cultural and environmental elements.

Over 700 million people in sub-Saharan Africa rely on traditional biomass cooking fuels such wood, charcoal, dung and agricultural waste (IEA, 2014). The environment and human well-being are both negatively impacted by reliance on these resources. Additionally, they hinder development because gathering and using these fuels is time- and labor-intensive. The Sustainable Development Goals (SDGs) set a goal in response to the heightened environmental threats facing the world today and the effects of climate change brought on by globalization and the quickening urbanization process. According to WALPG (2014), there will be 1 billion LPG users worldwide by 2030.

The United Nations High Commissioner for Refugees (UNHCR) provided LPG stoves to 150,000 refugee families in Tanzania in 2016. It was noted that among the beneficiaries in the Nyarugusu Camp, the need for firewood reduced by 70% (UNHCR, 2017). Notably, LPG emits much fewer greenhouse gases per unit of cooking energy compared to conventional stoves while being a fossil fuel. Additionally, it successfully tackles issues with indoor air pollution. According to reports from the United Republic of Tanzania (URT) in 2016, LPG was particularly desirable due to its mobility and simplicity of transportation, especially for urban-dwelling refugees who might have restricted access to firewood and charcoal.

Tanzania is home to a variety of energy sources, including electricity, geothermal energy, wood charcoal, natural gas, biogas, coal, solar and wind energy. More than 30% of the nation's GDP comes from these resources, which also provide employment opportunities for many rural and urban poor households (Kahyoza, 2013). However, these resources have not yet been properly used to provide clean and contemporary cooking fuels to replace the nation's reliance on polluting biomass fuels (URT, 2015). Several LPG market supplier businesses currently operate in Tanzania. These include Oryx Gas, Mihan Gas, Lake Gas, Manjis Gas, Cam Gas, State Gas and O. Gas. Nevertheless, despite the existence of these suppliers, Tanzania's LPG usage is still far lower than that of nations like Kenya, Uganda, Ghana, Nigeria, and Ethiopia (EWURA, 2016).

Numerous empirical studies have been conducted to establish factors that influence household access to LPG across a variety of continents. These studies provide numerous justifications for household LPG access. Sepp (2014) did one such study on "The Balancing of the Multiple Household Fuel Use between Firewood, Charcoal and LPG in East Asian Countries." The results indicated an interesting correlation: LPG usage decreased as household head age rose, a pattern that is common in developing countries. Similarly, the ages of families and the usage of biomass fuels were shown to be significantly correlated in Démurger and Fournier's (2011) study in rural northern China and Rahut et al.'s (2014) study in Bhutan, respectively.

In China, Hou, et al.'s study in 2022 found a strong correlation between greater levels of education and the adoption of cleaner cooking fuels like LPG. Similar findings were made by Shen, et al. (2015) in China, who discovered a link between families using clean fuel for cooking and public awareness, household characteristics, family size and age. A different study carried out in China by Ma, et al. (2018) found that socio-economic determinants had a favorable, significant impact on resident first-stage LPG and electricity choice.

Zhang and Koji (2017) found that LPG was preferred as a cooking fuel in homes in Northern China with per capita incomes over 4,000 RMB. On the other side, households with a per capita income below 4000 RMB preferred biogas if it was available; otherwise, they turned to conventional solid fuels like firewood and coal. In particular, low-income

households tended to utilize biogas, whereas higher-income households tended to select cleaner fuels like LPG. When household incomes rose, locals started looking for better energy sources. As a result, more affluent residents who previously used solid fuels for cooking and heating chose to switch from conventional fuels to biogas. This finding tells that household income is the key determinant to access certain types of cooking fuels.

A study was carried out in Tigray, Northern Ethiopia by Gebreegziabher et al. (2012) in an effort to identify the variables affecting urban energy transition and technological adoption. The focus of this study was on variables that affected prices and household characteristics. The study found that factors such as the household head's age, education level, family size and income/expenditure all had a positive and significant impact on whether new kitchen gadgets were adopted. It is interesting that the study indicated that the decision to adopt these technologies was not significantly influenced by the cost of fuel, including wood, charcoal and kerosene. Additionally, according to an analysis by Lewis and Pattanayak (2012), household size is a statistically significant factor that is positively correlated with the chance of utilizing upgraded cook stoves. Buba et al. (2017) investigated the socio-economic determinants influencing households' propensity for energy usage in Nigeria. The study's conclusions showed that social, economic, and public awareness factors all play a substantial role in determining how much energy is consumed by households.

A study by Ndunguru and Lema (2020) looked into the variables affecting the adoption of LPG in Kinondoni Municipality, Tanzania. The findings show that on a micro level, a variety of factors affect the adoption of LPG, with people's attitudes differing depending on their particular experiences. The amount of LPG that is offered for sale, household income, household size and level of awareness are some notable characteristics this study discovered. According to a research on the Sustainable Development of Oil and Gas in Tanzania by Yusuph and Alman (2020), institutional development, business growth and good governance are essential components in guaranteeing the sustainable development of oil and gas resources.

In a Tanzanian peri-urban area, Ishengoma and Igangula (2021) conducted a study to better establish factors that influence family decisions about the energy mix utilized for cooking. The

findings demonstrated that a number of important factors significantly influenced decisions. Particularly, households were more likely to choose an energy mix that contained a significant amount of LPG and subsequently used it for cooking as a result of their increased awareness of the harmful environmental and health effects associated with the use of fuelwood and their access to information about the LPG market. However, if families had a greater propensity to think that LPG is risky, this propensity reduced the likelihood that it would be used.

As was already mentioned, various studies have looked into Tanzania's access to cooking fuels. Despite the fact that these studies produced a variety of conclusions on what influences people's decisions about cooking fuel, it is clear that not all of them adequately examined how socio-economic factors affect people's access to LPG. By combining the ideas of the energy ladder and energy stacking theories, this study intended to close this gap and develop a thorough understanding of household energy options.

Methodology

Research Design

A cross-sectional survey design, a type of research methodology used in this study, is well known for its ability to shed light on phenomena in the context of the studied population. In a cross-sectional survey, information is gathered from participants at a single point in time, enabling researchers to look at how independent and dependent variables relate to one another at that particular time (Bhattacharjee, 2012; Saunders et al., 2012). Cross-sectional surveys have a number of benefits, including cost effectiveness, rapid data collecting and ability to take a moment to record the traits or behaviours of a community. When attempting to determine the prevalence of specific traits, behaviours or conditions within a group, researchers find this approach to be especially helpful. This study's design was helpful in determining how a complex interaction between economic, social, cultural and environmental factors affects household access to LPG.

Population and Sampling

The study concentrated on a total of 10,414 households in Dodoma City, the capital of Tanzania, located in the country's central region (2,402 from Kikuyu Wards and 8,012 from Kizota Ward). This city's selection is explained by its rapid growth and

plenty of LPG suppliers. The researchers used Yamane's (1967) formula, which is as follows, to get the sample size:

$$n = \frac{N}{1+N(e^2)}$$

Whereby n = sample size, N = Total number of households in two wards, e = Level of precision/Error of detection (10%), 1 = Constant. Therefore, $n = 104,14 / [1 + 104,14(0.1)^2] = 100$. Finally, systematic random sampling method was employed to select 100 respondents, specifically household heads, from the sample.

Data Collection Methods

Using a questionnaire, the socio-economic data was directly obtained from households. Most of the items in the questionnaire were in closed-ended binary choices designed to elicit precise response about various socio-economic variables. Such binary items were chosen to determine nature of such variables as age, household size, income, education

level, distance to the closest LPG merchant, marital status and price considerations. This strategy is in line with that recommended by Saunders et al. (2012), who noted that binary choices are frequently used to establish user or customer satisfaction across a variety of sectors.

Statistical Treatment of Data

Using IBM SPSS version 25, data was analyzed using the binary logistic regression to establish how socio-economic factors affect a household's access to LPG. The regression model shown below was used:

$$\text{Logit (Y)} = \ln [p / (1-p)] = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 \dots \dots \dots 1$$

Whereby; Y as a dependent variable

Where P is the probability of the event of interest, α is the Y intercepts, β_n are regression coefficients and X_1, X_2, X_3 and X_4 are a set of predictors. Furthermore, α and β_s are typically estimated by the maximum likelihood (ML) method.

Variable	Description
Y	LPG(1=Access LPG, 0=Otherwise)
X ₁	Age of the respondent (Years)
X ₂	Household size (Number of people in the household)
X ₃	Income (TSH)
X ₄	Education level of the respondent (1=Formal, 0=Informal)
X ₅	Distance to the selling point/centres (Km)
X ₆	Marital status of the respondent (1=Married, 0=otherwise)
X ₇	Price (TZS)

Validity and Reliability

It is important to take safety measures to keep the data's quality high in order to guarantee its scientific rigor. Therefore, a preliminary questionnaire was thoroughly reviewed by a subject-matter expert to confirm the validity. This expert consultation aimed to verify that the questionnaire was appropriate for gathering the desired data. As stressed by Kumar (2011) and Bhattacharjee (2012), validity relates to the extent to which the research instruments successfully measure what they are designed to assess. According to Bhattacharjee (2012) and Kothari (2009), dependability is concerned with the consistency of results. In addition to maintaining accuracy and repeatability, measurement quality is a component of reliability (Kumar, 2011). The authors in this study established the questionnaire's reliability using the Cronbach's α coefficients of above 0.7. The Cronbach's α value serves as an

indicator of the questionnaire's internal consistency, with a score exceeding 0.9 considered excellent, above 0.8 regarded as good, and above 0.7 accepted.

Ethical Considerations

To protect the study's integrity, the researchers gave ethical behavior top priority. They assured the respondents of the confidentiality of their shared information and gave them a clear and thorough explanation of the study's objectives. As a result, in any presentation of the research's conclusions, the participants' identities were kept a secret. All study participants' informed consent was meticulously sought prior to the collection of data. Additionally, in order to maintain the integrity of the study, correct attribution for all used sources was carefully upheld.

Results and Discussion

In this section, the researchers present results on socio-economic factors that may affect households' access to LPGs using a binary regression model. Table 1 shows that the logistic model adequately describes the data as indicated by Pseudo-R² (Cox and Snell= 0.574; Nagelkerke R²=0.632). Nagelkerke R². This indicates that 63.2% of the variance in the dependent variable was explained by the independent variables included in the model.

According to the analysis, six variables on socio-economic factors influenced households' LPG consumption as they were statistically significant at the 0.05 level. The age of the respondent (years), the size of the household (people in the household), the household income (TZS), the education level (1=Formal, 0=Informal), the distance to the selling point/centers (km) and the price (TZS) are among the relevant variables.

Table 1: Result Binary Logistic Regression on Influence for Socio-economic factors on Household access to LPG

Variable	β	S.E.	Wald	D.f	Sig.	Exp(β)
Age	-.508	.307	7.465	1	.047*	1.112
Sex	.436	.546	2.968	1	.071	1.615
Education level	.487	.675	6.571	2	.019*	1.878
Household size	-.335	.4567	8.567	1	.011*	1.697
Marital status	.471	.132	8.568	1	.063	1.952
Distance to the selling point/centres	-.417	.502	9.042	1	.014*	1.450
Household Income	.576	.178	6.567	1	.023*	1.345
Price	-.386	.056	473.66	1	.002*	.585
Constant	3.786	.767	45.542	1	.000	46.689

Note: * Significance

Chi-square: 128.493 at 9 df and P<0.05

Number of Observation = 100

Pseudo R²: Cox and Snell R square = 0.474 Nagelkerke R square = 0.63

Dependent variable (1= If access LPG, = Otherwise)

According to the results shown in Table 1, age is a significant predictor of a household's access to LPG (p = 0.047). The probability of having access to LPG decline by a factor of 1.112 for every unit older you get (= -0.508). The elderly people's decision to use LPG, a more contemporary energy source, may be affected by their extensive experience using biomass energy sources. Education level significantly affected households' access to LPG (p = 0.019). The probability of having access to LPG rises by a factor of 1.878 for every unit increase in education level (= 0.487). The results show that access to LPG as a source of energy is positively influenced by formal education of household members. Similar finding was made in a study by Hou et al. (2022) and Shen et al. (2015), who found a strong correlation between greater levels of education and the usage of cleaner cooking fuels, such as LPG.

Result further reveal that LPG access is significantly predicted by household size (p = 0.011). The likelihood of having access to LPG decreases by a factor of 1.697 when household size increases by

one unit (= -0.335). The results show that there is a decreasing possibility of using LPG fuel for cooking in households with larger family sizes. This study's findings are in line with those of Mwaura *et al.* (2014), who found that homes with more members are less likely to switch to cleaner energy due to higher energy needs and related expenditures to meet household demand. The study of Ndunguru and Lema (2020), which also demonstrated that family size has a detrimental impact on households' choice of energy sources, lends support to this.

Access to LPG is considerably influence by the distance to selling points or centers (p = 0.014). The probability of having access to LPG decline by a factor of 1.450 for every unit farther traveled (= -0.417). This implies that the farther a family is from a selling point or a center, the less likely it is for it to have access to LPG. Therefore, compared to households with better access to such an energy source, households who are far from gas cooker and LPG stores are less likely to embrace and utilize LPG. This finding is consistent with a study by Suliman (2013) which discovered that the market distance of

clean fuel causes a very low adoption rate of clean fuel in rural households compared to their urban counterparts. This suggests that families' adoption of LPG use is influenced by the availability of gas markets and gas stations close to consumers.

The availability of LPG is significantly influenced by household income ($p = 0.023$). The likelihood of having access to LPG increases by 1.345 times for every unit increase in income ($= 0.576$). The study's findings support Zhang and Koji (2017) conclusions that inhabitants of low-income households in the province of Northern China are likely to adopt biogas. Residents of high-income households may prefer to utilize LPG or other cleaner fuels instead of biogas. This is so since inhabitants can use cleaner fuels like LPG instead of biogas, which they would want to do given the rise in household income. This study indicates that household firewood consumption is negatively impacted by income growth and that abandoning traditional cooking methods will raise living standards and save the environment.

Household access to LPG is significantly impacted by price ($p = 0.002$). The probabilities of having access to LPG significantly reduce by a factor of 0.585 when the price rises by one unit ($= -0.386$). The results suggest that high LPG prices have a detrimental impact on households' decisions to use LPG. The responsiveness of the housing market to pricing is influenced by the household income levels. Once more, it was noted that sex has no statistically significant impact on how easily households may acquire LPG, according to the p-value of 0.071, which is higher than the standard significance level of 0.05. Additionally, marital status did not significantly affect a household's ability to get LPG ($p = 0.063$).

Overall, the results of the logistic regression analysis indicate that household access to LPG is significantly predicted by age, education level, family size, distance to selling locations and household income, whereas sex, marital status, and price are not statistically significant predictors. The odds ratios shed light on the nature and intensity of these associations.

Conclusions and Recommendations

The study concludes that socio-economic factors aside from sex and marital status have a substantial influence on the possibility of accessing LPG service in Dodoma City. Given these strong results, the researchers call for strategic investments in civic

education programs focused at promoting eco-friendly alternative energy sources and supporting household economic stability to consistently increase the affordability of LPG pricing. The study also emphasizes how crucial it is for policymakers to be committed to tackling problems associated to poverty. The adoption of policies intended to enhance the general living standards of households in the area is advised as is the creation of a social security insurance program to lessen instances of poverty. These suggestions are essential steps to guaranteeing better access to LPG and improving the community's general standard of living in Dodoma City.

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