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FACTORS THAT AFFECT THE USE OF FIREWOOD IN AWKA NORTH LOCAL GOVERNMENT AREA OF ANAMBRA STATE

Benedict Nnabuike Okoye and Nwabueze Ikennna Igu
Department of Geography and metrology, faculty of environmental science, Nnamdi Azikiwe University Awka, Anambra State, Nigeria.
Corresponding Author's Email: nnabuikeokoye19@gmail.com

Abstract

The persistent reliance on firewood as a primary source of household energy remains a pressing issue in many rural communities of Nigeria. Despite the availability of modern cooking alternatives, such as liquefied petroleum gas (LPG) and kerosene, a significant proportion of households continue to depend heavily on firewood due to affordability, accessibility, and cultural preferences. This dependence contributes not only to environmental challenges such as deforestation, biodiversity loss, and land degradation but also to health risks from indoor air pollution, which disproportionately affect women and children. This study adopted a mixed-method design, integrating qualitative and quantitative approaches to enhance validity and reliability. Data collection involved focus group discussions, key informant interviews, and household surveys across six rural communities in Awka North LGA, Anambra State. A sample size of 400 was derived using Taro Yamane's formula. The study area, characterized by tropical savanna climate, fertile plains, diverse relief, and rich vegetation, supports farming and small-scale industries. Instruments were validated by experts and reliability confirmed using Cronbach's Alpha. Data were analyzed with SPSS v20, employing Principal Component Analysis, ANOVA, and Kruskal-Wallis tests to explore firewood usage and its impacts. The study identified ten factors influencing firewood use in Awka North LGA, including socioeconomic status, household size, cultural practices, education, climate, and geographic location. Principal Component Analysis (PCA) reduced these into three major components explaining 91.25% of the variance. Component I (60.17%) highlighted socioeconomic conditions, education, climate, and household size as the strongest determinants. Component II reflected cultural practices, while Component III captured environmental awareness and geographic accessibility. Regression analysis confirmed that socioeconomic status, household size, and cultural practices significantly predicted firewood usage, with R^2 of 0.975. This demonstrates that firewood dependence is shaped by interconnected social, economic, and environmental factors. The study concludes that firewood dependence in the area is shaped by a complex interplay of economic, social, and environmental dimensions.

Keywords: Firewood use, socioeconomic factors, cultural practices, Awka North, sustainable energy.

Introduction

The rising world fuel prices, the growing demand for energy, and concerns about global warming are the key factors driving the use of renewable energy sources. Popp, Kot, Lakner and Oláh (2018) reported that energy consumption is still increasing rapidly, with approximately 570 EJ consumed at the primary energy level in 2014. The world gets about 19.2% of its energy from renewable sources, including about 8.9% from traditional

biomass and about 10.3% from modern renewable sources. The "traditional" share of biomass has been relatively stable for many years, while the "modern" share has grown since the late 1990s (Ślusarczyk, Baryń and Kot, 2016). Traditional solid biomass and hydroelectricity still dominate renewable energy consumption on a global scale. At present, some 76 EJ/year of renewable energy is consumed globally (Navickas, Vojtovic and Svazas, 2017).

In the past, biomass was primarily limited to woody feedstocks but today bioenergy resources range from residues, through by-products from the food industry to dedicated energy crops, post-consumer organic wastes and possibly to aquatic biomass (Popp, et al, 2018). In general, biofuels can be classified as solid, liquid, and gaseous biofuels. Solid biofuels are the most common and ancient type of fuels in human history. The main solid biofuels include Refuse-Derived Fuel (RDF), Briquettes, Pellets, and Wood (Skorek-Osikowska, Martín-Gamboa and Dufour, 2020). Liquid biofuels can be classified into Natural biochemical liquefaction biofuels and Synthetic oxygenated liquid fuels. The main liquid biofuels include Biodiesel, Bioethanol which can be used in internal combustion motors, as a neat fuel or in blends (Subramaniam, Masronand Azman, 2020). Gaseous Biofuels on the other hand are the least used biofuels. Gaseous biofuels are produced through the biomass gasification process, which is a thermal or microbial degradation of biomass substances (Moore, Thornhill, Weinzierl, Sauer, D'Ascoli, Kim, Lichtenstern, Scheibe, Beaton, Beyersdorf and Barrick, 2017).

Biofuels occupy a noticeable position in the international research agenda, given the crucial role they are attributed to play in fulfilling the future world energy demand and reducing its carbon intensity (Demirbas, 2007; Filimonau, Mika, and Pawlusiński, 2018). While existing research on biofuels shows its truly global penetration, it also pinpoints the limited number of subject categories from the perspective of which the topic of biofuel technology has targeted firewood. Firewood is an important energy source, especially in developing countries, because 2 billion people in developing countries depend on firewood for energy (FAO, 2010). In 2011, firewood consumption was approximately 42 million m^3 (FAO, 2011) and is expected to increase to 55 million m^3 by 2030 (UN-REDD, 2017). Thus, the sustainable production and utilization of firewood for satisfying future demand has received considerable attention.

One possible factor related to the ease of firewood collection is forest degradation. Living trees are important firewood resources, especially when collected trees are converted to charcoal (Bensch and Peters, 2013). Thus, evaluation of the use and implications of firewood consumption is especially important. Previous studies on the relationship between firewood collection and forest degradation have focused on the implications of biofuel on forest degradation and have shown that firewood collection is a major cause of forest degradation (Baland et al., 2010; Démurger and Fournier, 2011). Despite the importance of firewood in the daily lives of people in Awka North Local Government Area, very limited empirical studies of firewood consumption as well as official data on forests (Ojomah, Ibe, Ezenwenyi, Chukwu and Adum, 2020; and Onuegbu, 2021)

and other woody vegetation are lacking. Furthermore, no attempts have been made to quantify the association between firewood consumption and factors that influence it. This study was carried out to gain an understanding of the use and implications of firewood consumption and the factors influencing it. This understanding is crucial for sustainable management of energy sources not only in the South-Eastern Nigeria but also in other regions of the world with a similar historical background or biophysical conditions.

Deforestation is on the increase due to the continuous anthropogenic activities and the use of tree biomass for firewood, charcoal, and timber. Burning of woods subsequently leads to the release of greenhouse gases, which has resulted in temperature rise both during the day and at night, and obstructing the balance between oxygen and carbon dioxide (Werner et al., 2010). This has resulted in the loss of vegetation, all due to the overexploitation of wood plant resources for many domestic and industrial purposes. Nigeria has the highest rate of firewood harvesting in the world, according to the Food and Agriculture Organization of the UN (FAO, 2011; Okereke et al., 2023). The volume of firewood harvesting and its economic and environmental implications are no doubt huge. The major problems are those of pollution and environmental quality reduction.

The use of inefficient traditional cooking systems also has social implications, including higher physical burdens and opportunity costs, since more time is spent collecting firewood. This is especially important as it limits women and children from improving their education or spending time on income-generating activities (Akintan, Jewitt, and Clifford, 2018). Another concern about the use of firewood is that the smoke produced creates high levels of indoor air pollution. Dry cough, phlegm production, breathing difficulties, cardiovascular disease, cancer, blindness, and low birth rates have also been linked to indoor air pollution (Jung and Huxham, 2018). Each year, indoor air pollution contributes to around 4 million premature deaths globally (Raju, Siddharthan, and McCormack, 2020). In addition to their adverse health impacts, suspended particulate matter and CO emitted contribute to accelerating anthropogenic climate change.

Given its land-intensive nature, firewood consumption can have profound environmental and socioeconomic impacts, especially in the poor agrarian contexts of Awka North Local Government Area of Anambra State. The resultant changes in the flow of such ecosystem services can have substantial effects on human well-being, especially in the poor rural areas in Africa, where local communities depend highly on ecosystem services for their livelihoods. Loss of forest leads to loss or diminution of the services it provides. Awka North Local Government Area has suffered from deforestation and forest degradation for decades, and firewood collection constitutes an important pathway for forest degradation. This is because wood is still a crucial biofuel for many households in Awka North Local Government Area, which use firewood daily. Most villages that make up Awka North Local Government Area have experienced decreases in wood volume over the years. Besides, they have also experienced wind storms, soil erosion, leaching, loss of biodiversity as well as land use conflicts.

Understanding the factors affecting firewood consumption patterns is important for sustainable firewood utilization, as variation in firewood consumption patterns can depend on several factors, such as activities using firewood (San et al., 2012), firewood prices (Danlami, 2019), elevation (Khuman et al., 2011), and household size (Win et al., 2018). Evidence relating to the factors that affect the consumption rate of firewood is especially important for policymakers. While previous studies have examined biofuel consumption and its impact on forest degradation, there is a lack of specific research focusing on the Awka North Local Government Area. This geographical specificity is crucial because different regions may have unique characteristics and challenges related to biofuel use. Understanding the local implications is crucial for ensuring that biofuel initiatives align with the goals and needs of the community. It can help identify potential benefits, such as job creation and rural development, as well as any adverse effects on local ecosystems or livelihoods.

1.1 Research Objectives

Identify the factors that causes the use of firewood in Awka North Local Government Area

1.2 Research Questions

What factors influence the use of firewood in Awka North Local Government Area?

1.3 Research hypotheses

There is no significant relationship between socio-economic factors and the use of firewood in Awka North Local Government Area.

2. Theoretical framework

The study was anchored on Energy ladder theory. The energy ladder hypothesis is one of the most popular methods for examining the patterns of the usage of biofuels is (Rajmohan and Weerahewa, 2005). According to the energy ladder theory, households with higher incomes often switch from traditional to modern fuels as their income rises, whereas households with lower incomes typically use traditional fuels as their primary source of energy (Nicolai and Fiona, 2008). as applied by many researchers studying biofuel (Chaudhuri, 2021), the energy demand study's findings showed that the level of biofuel consumption is influenced by factors such as household characteristics, intra-household income distribution, fuel availability, proximity to distribution networks, cultural preferences, demographic distribution, and physical environment.

These studies provide evidence that urban dwellers consume more kerosene, LPG, and electricity. Moreover, they contend that family income level has less of an impact on urban fuel consumption patterns than price- and quantity-based government regulations. The idea of the "energy ladder hypothesis" is demonstrated to be loosely founded on the economic theory of consumer behavior (Meried, 2021). This partially explains the theory by demonstrating that as income rises, households not only consume more of the same thing, but also move up the socioeconomic ladder to more modern, higher-quality goods. For example, as a household rises in socioeconomic status, it moves up the energy ladder to cleaner, more efficient sources of energy. Moreover, it makes the assumption that cleaner fuels are standard economic commodities whereas conventional fuels are subpar products.

The percentage of income spent on energy increases with family income; impoverished households spend between 30 and 50% of their income on energy, whereas higher-income families spend less than 10%. The "interior living environment" of the home influences energy usage to some extent. For instance, since they lack bathrooms, the rural poor tend to take fewer baths and consequently use less energy than the urban poor to heat water.

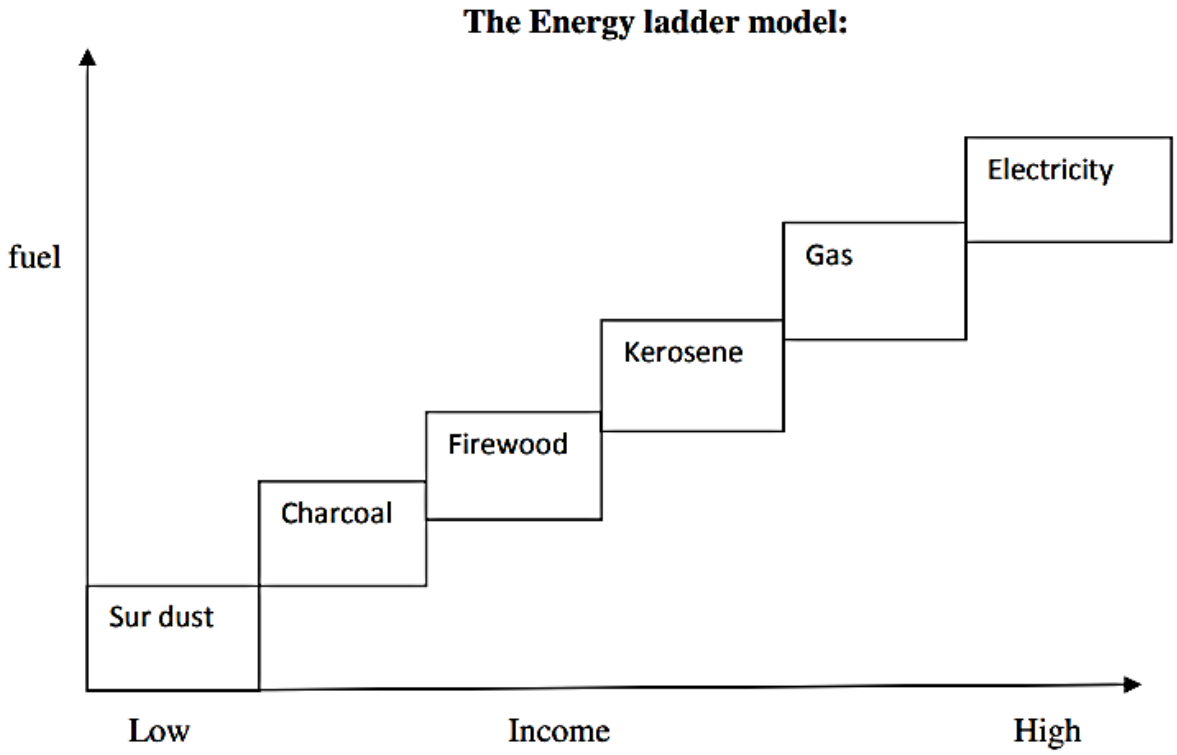

Figure 1: The Energy ladder model (Rajmohan and Weerahewa, 2005).

The shift from conventional fuels to contemporary fuels and appliances inside of homes is explained theoretically by the energy ladder. The ladder lays out a progressive ladder where users move away from less efficient and unclean fuels and toward more efficient and clean fuels. The bottom rung of the ladder represents inefficient traditional fuels (such as sawdust, firewood, and charcoal) while the top rung represents efficient modern fuels (such as electricity). The energy ladder model explains how households, society and schools transition from traditional to modern energy sources as economic capacity improves. In homes, prosperity encourages a shift from firewood or kerosene to cleaner fuels like LPG, electricity, and renewables. Similarly, schools with better funding and management progress from basic energy sources to advanced systems that support ICT-driven learning and safer environments (Ohamobi & Ezeaku, 2016; Manafa, Ohamobi & Osegbue, 2022).

Rooted in the economic theory of the consumer, the model emphasizes movement from lower- to higher-quality goods as wealth grows. Just as effective school leadership enhances teacher productivity and institutional performance (Onyekazi et al., 2024; Osegbue, Ohamobi & Manafa, 2018), structured energy management ensures sustainable transitions. This demonstrates that prosperity, administrative efficiency, and policy

frameworks (Ohamobi, Manafa & Osegbue, 2020; Osegbue, Ohamobi & Alordiah, 2025; Ohamobi & Manafa, 2021) are vital in advancing energy choices in both homes and schools.

3. Method

3.1 Design of the study

A mixed (qualitative and quantitative) research design was used in this study, which combined both qualitative and quantitative research approaches in the data collection and analysis. A composite research approach is considered appropriate for this study because of its numerous advantages. The advantages of such a holistic research design is well documented by Bryman (2016). First, a composite research approach allows the researcher to draw from the strengths of both approaches for a robust and detailed study. Also, the systematic application of both qualitative and quantitative methods enhances complementarities in the study. Integrating both qualitative and quantitative research methods ensure the researcher explores the issues from multiple perspectives of a deeper understanding of the issues regarding the exploitation, uses, and effects of households' wood fuel. Furthermore, the triangulation of data sources is equally achieved, which enhances data quality and validity of the research. Considering these advantages, the researcher chose a mixed-method design that combined focus group discussions (FGDs), key informant interviews and a household survey for collecting and analysing the data. These methods were systematically applied to enhance data validity and reliability

3.2 Study Area

The area of the study is Awka North Local Government Area of Anambra State. Awka North is a Local Government Area in Anambra State, south-central Nigeria. Awka North local government area is domiciled in Anambra state, Southeast zone of Nigeria as shown in Fig 3.2. The area is home to the Igbo ethnic group and comprises a number of towns and villages which include Awba-Ofemili, Ugbene, Ebenebe, Amansea, Ugbenu, and Mgbakwu as shown in Fig. 3.2. The headquarters of the LGA is situated in the town of Achalla and has Christianity as the widely practiced religion. Awka North is one of the local government areas that make up Anambra North Senatorial District. It is bordered by other local government areas within Anambra State, including Ayamelum to the north, Anambra West to the west, Anaocha to the south, and Dunukofia to the east. Awka North Local Government Area covers a geographical area that includes several towns and communities, with Achalla as the administrative headquarters. The local government area is accessible via various road networks, including major highways such as the Enugu-Onitsha Expressway and the Awka-Enugu Road. Geographically, Awka North is situated within the Anambra Basin, a sedimentary basin known for its undulating terrain and fertile plains along the banks of the Niger River. Awka North LGA is home to a colourful festivals such as the Iwa-Ji and Imoka festivals are held periodically within the area.

3.2.2. Climate

The climate of Awka North Local Government Area in Anambra State can be classified as tropical savanna climate with distinct wet and dry seasons. Awka North experiences warm to hot temperatures throughout the year. The average annual

temperature ranges between 26°C to 30°C (79°F to 86°F). The hottest months are typically between February and April, with temperatures occasionally reaching above 35°C (95°F). The area has a bimodal rainfall pattern, characterized by two distinct rainy seasons. The first rainy season occurs from March to July, with peak rainfall in June. The second rainy season is shorter and occurs from September to October. The annual rainfall in Awka North averages around 1,500 to 2,000 millimeters (59 to 79 inches) (Ugwu et al., 2021).

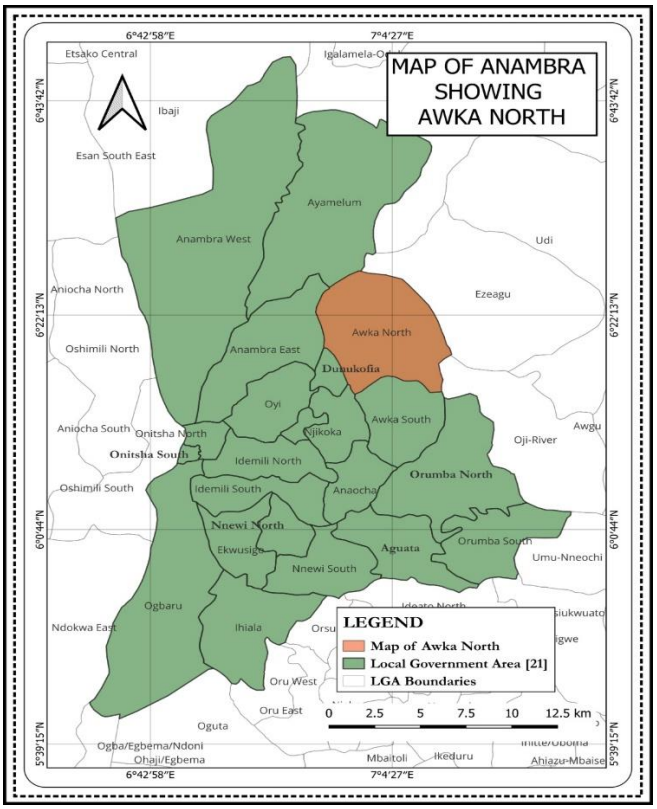

Figure 3.1: Map of Anambra Showing Location of Awka North Local Government Area Within Its Axis

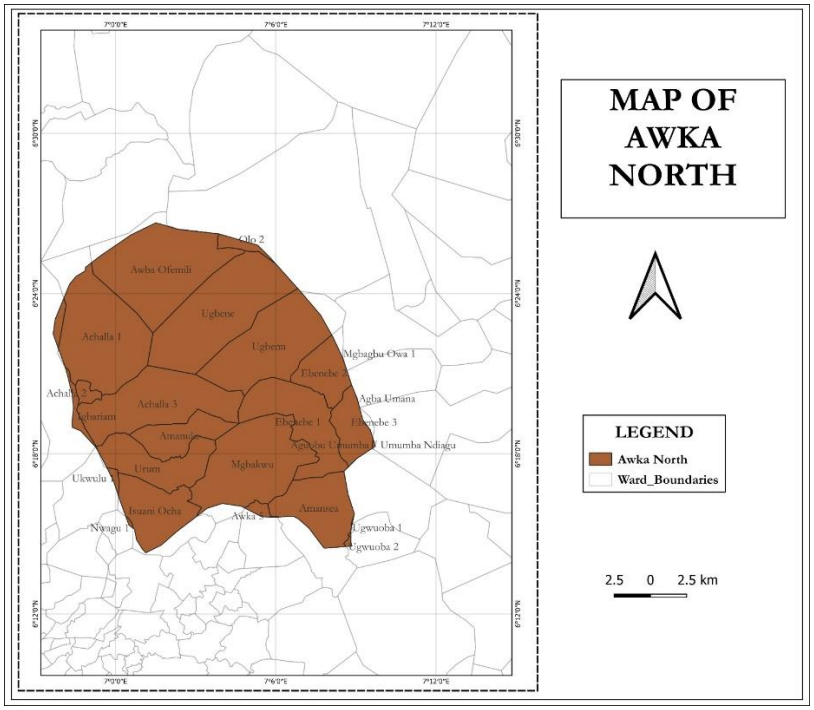

Figure 3.2: Map of Awka North Local Government Area showing various communities.

The dry season in Awka North usually extends from November to February. During this period, rainfall is minimal, and the weather is generally drier and cooler. Harmattan winds, characterized by dry and dusty conditions, can occur from December to January, leading to reduced visibility and cooler temperatures. The area experiences relatively high humidity levels throughout the year, particularly during the rainy season. Humidity levels can range from 70% to 90% during this period, contributing to a humid and tropical environment. The climate of Awka North supports lush vegetation, including savanna grasslands and scattered trees. The region benefits from the ample rainfall, which fosters the growth of vegetation and supports agricultural activities (Anarado et al, 2019).

Like other regions in Nigeria, Awka North can also experience climate variability and occasional extreme weather events such as heavy rainfall, thunderstorms, and flooding, particularly during the peak rainy season. Overall, Awka North Local Government Area experiences a distinct wet and dry seasons. Understanding the local climate is important for various sectors, including agriculture, infrastructure planning, and overall preparedness for weather-related events.

3.2.3. Relief and Geology

Awka North Local Government Area is characterized by diverse relief and geological features. It exhibits a varied relief pattern that includes both lowland areas and upland regions. The local government area is part of the Anambra Basin, which is known for its undulating terrain. It is primarily located within the Anambra-Imo sedimentary basin and is bordered by the Niger River to the east. The lowland areas are found along the banks of the Niger River, characterized by relatively flat and gently sloping landscapes. These areas are often fertile and suitable for agricultural activities (Onyenweife, 2023). In contrast, the upland regions feature more rugged terrain with rolling hills and occasional plateaus.

The geology of Awka North is primarily characterized by sedimentary rock formations. The area is underlain by sedimentary deposits that have accumulated over millions of years. These sedimentary rocks consist of layers of sandstones, shales, and mudstones, which were formed through the deposition of eroded materials carried by rivers and other geological processes. The Anambra Basin, in which Awka North is located, is known for its abundant coal deposits. The coal-bearing strata found in the area have been a significant resource for energy production and have contributed to the economic development of the region.In summary, Awka North Local Government Area exhibits a diverse relief pattern, including lowland and upland areas. Its geology is predominantly characterized by sedimentary rock formations, including coal-bearing strata, influenced by its location within the Anambra Basin.

The topography of Awka North Local Government Area in Anambra State is characterized by a combination of hilly and flat terrain. Awka North has several hills and ridges scattered throughout the area. These landforms contribute to the undulating nature of the landscape and add visual interest to the region. There are also plateaus in Awka North, which are elevated flat areas with steep slopes. Plateaus are typically found in the higher regions of the local government area and provide panoramic views of the surrounding areas. In contrast to the hills and plateaus, Awka North also has valleys. Valleys are low-lying areas between hills or mountains, often characterized by the presence of streams or rivers. These valleys contribute to the overall drainage patterns in the local government area. Along the banks of the Niger River, Awka North features plains that are relatively flat and fertile. These plains provide suitable conditions for agricultural activities, and farming is prevalent in these areas (Obiadi, Ajaegwu, Meniru, Nzeakor and Ejike, 2022). The topography of Awka North exhibits some erosional features, including gullies and ravines. Erosion is a natural process that can be accelerated by human activities, such as improper land use and deforestation. Efforts are made to mitigate erosion and preserve the topographic integrity of the area. Overall, the topography of Awka North is a mix of hills, plateaus, valleys, and plains. The diverse terrain contributes to the natural beauty of the area and offers various opportunities for activities such as agriculture, tourism, and outdoor recreation.

3.2.4. Hydrology

Awka North Local Government Area is situated within the Anambra Basin and is influenced by the hydrological features of the region. It is also traversed by several smaller rivers and streams. These watercourses contribute to the overall hydrological system in the local government area and provide additional water resources for the surrounding communities. The rivers and streams serve as potential sources for water treatment and distribution to meet the domestic and agricultural water needs of the communities. The hydrological resources in Awka North support agricultural activities, particularly irrigation farming (Obiadi, Ajaegwu, Meniru, Nzeakor and Ejike, 2022). Farmers in the area utilize water from the rivers and streams for irrigating their crops, enabling agricultural productivity and food security. Awka North is susceptible to flooding, especially during

periods of heavy rainfall. Flooding occurs in low-lying areas, causing temporary disruptions and potentially impacting the livelihoods of the local communities.

3.2.5. Vegetation

Awka North is part of the southern forest zone of Nigeria, and it exhibits characteristics of the tropical rainforest biome. The area is covered by dense vegetation consisting of tall trees, shrubs, and a variety of plant species. The rainforest vegetation provides habitat for numerous wildlife species. In addition to the rainforest, Awka North also features savanna woodlands. These areas are characterized by scattered trees, grasses, and shrubs. The savanna woodlands are typically found in the transitional zones between the rainforest and the grassland regions. These grassland are mostly found in the extensive plains and lower-lying regions (Nse-Nelson, Osondu, Oke and Chux, 2017). They are characterized by a mix of grass species and some scattered trees and provide grazing areas for livestock and other agricultural purposes. Awka North is known for its agricultural activities, and a significant portion of the land is utilized for farming. Various crops, including yam, cassava, maize, vegetables, and fruits, are cultivated in the local government area.

3.2.6. Urban Development

Awka North Local Government Area, located in Anambra State, has witnessed significant urban development in recent years. Urban development in Awka North has led to the improvement and expansion of infrastructure. This includes the construction and upgrading of roads, bridges, and drainage systems to enhance transportation and connectivity within the area. The population growth and urbanization in Awka North have resulted in the development of new residential areas and housing estates. These areas provide accommodation for the growing population and cater to various income groups. Urban development has led to the establishment of commercial centers and markets in Awka North. These centers provide spaces for economic activities, such as trading, retail businesses, and services, contributing to the local economy. Awka North has witnessed the establishment and expansion of educational institutions to meet the growing demand for education. This includes primary and secondary schools, as well as tertiary institutions, providing opportunities for academic and skill development. Urban development has also brought improvements in healthcare infrastructure (Onuoha, 2020).

3.2.8. Economics Activities

Awka North Local Government Area in Anambra State, Nigeria, is characterized by a range of economic activities that contribute to the local economy. Agriculture is a significant economic activity in Awka North. The fertile plains along the Niger River and its tributaries support the cultivation of crops such as yam, cassava, maize, vegetables, fruits, and palm produce. Farmers engage in both subsistence and commercial farming, contributing to food production and the local agricultural value chain. Awka North is home to various markets and trading centers that serve as hubs for commercial activities. These markets facilitate the exchange of goods and services, including agricultural produce,

handicrafts, household items, and clothing. Awka North hosts small-scale industries that engage in activities such as agro-processing, woodwork, carpentry, block-making, and metalwork. These industries provide employment opportunities and contribute to the local economy through the production of goods and services.

3.2.9. Population

According to National Population Commission (2006), Awka North Local Government Area of Anambra State had a population of 60,728 in 1991 and 112,192 in 2006. The UN-HABITAT study for Awka and satellite towns done in 2009 puts the 2006 population of Awka North LGA at 112,608. Similarly, the projected population of Awka North for 2010 by NBS (2011) is 125,488. Using a population growth rate of 5.34 (UN-HABITAT, 2009), the population of Awka North was projected for 2024 using a growth rate of 4.2, determined using the growth rate formular given below:

$$growth\ rate\ (r) = \left(\frac{Pn}{Po}\right)^{1/n} - 1$$

where, P_n = present population (2006), P_o = past population (1991), n = number years interval. However, the population projection for 2024 for the study area is presented in tabular form as:

Table 3.1: Projected Population of Awka North LGA

Year	Population	Source
1991	60,728	NBS (2011)
2006	112,192	NBS (2011)
2024	236,060	Projected

Table 3.2: Population Distribution of Awka North LGA

Towns	1991	2024
Awba-Ofemili	6064	23572
Ugbene	2504	9734
Ebenebe	9759	37935
Amansea	2965	11525
Ugbenu	4239	16478
Mgbakwu	6999	27206
Isuaniocha	4597	17869
Urum	4599	17877
Amanuke	5162	20066
Achalla	13840	53799

The population of Awka North LGA in 2024 is put at 236,060 inhabitants with the Igbo spoken extensively within the area

3.3 Sample and sampling techniques

The study is focused on six communities in Awka North LGA based on their level of accessibility and rural nature of these communities. These six communities are given in table … and have a combined population of 126,450. The sample size was 400 residents of Awka North Local Government Area of Anambra State which was calculated using 'Taro Yamene' technique as follows:

$$n = \frac{N}{1 + Ne^2} = \frac{126450}{1 + 126450\ (0.05)^2} = 400$$

where, n = the sample size, N = population (See section 3.2.4), e = level of significance (0.05) I = unity (a constant)

Furthermore, the sample distribution of the respondents across the six selected communities is shown in Table 3.3.

3.4 Instrument for data collection

A household survey was conducted as part of the study design. The survey was conducted among four hundred (400) sampled household respondents across all the sampled communities. The instrument is a structured questionnaire, administered by three (3) trained enumerators. The survey questions were structured along with the major research questions, with available response options. Responses were recorded in the hard copies using pencils. All responses were later coded with numeric codes into the Statistical Package for Social Scientist (SPSS) for further analysis.

Table 3.3: Proportion of sample distribution

Towns	**1991**	**2024**	**Proportion**	**Sample size**
Awba-Ofemili	6064	23572	0.19	75
Ugbene	2504	9734	0.08	31
Ebenebe	9759	37935	0.30	120
Amansea	2965	11525	0.09	36
Ugbenu	4239	16478	0.13	52
Mgbakwu	6999	27206	0.22	86
Total		**126,450**	**1**	**400**

3.5 Validation of the Instrument

The face and content validity of the questionnaire was ensured. The researcher conducted this by consulting three experts specialized in measurement and evaluation in the Department of Educational Psychology to examine and make necessary corrections and remark. These experts were given the purpose of the study and the research questions alongside with the questionnaire to examine and make necessary corrections and remarks. The suggested corrections such as appropriateness of the items and appropriates of language used was done before the final draft.

3.6 Reliability of the Instrument

The instruments were trial tested in Awka South Local Government Area of Anambra State which is outside the study area so as to ascertain its true consistency and dependability. The researcher will administer copies of the instruments to the residents of

Awka South Local Government Area of Anambra State. The data obtained were used for the calculation of the reliability indices. Cronbach's Alpha (α) was used in the calculation of the reliability indices of the instrument.

3.7 Method of Data Collection

The researcher adopted direct delivery and retrieval method in administering the instruments. The researcher briefed ten research assistants who was instructed on the relevance of the study and method of administering the instruments. The materials to be used in facilitating the sessions was given to the research assistants more than 3 weeks before the briefing and they was required to read through the materials before attending the session. During each of the briefing session, the researcher discussed the materials with them and supply answers to any question asked. This information made available to research assistants enabled them in understanding every step to be followed in carrying out the study. The research assistants were informed to strictly follow the laid-down procedure in the process of carrying out the study. The researcher used the medium to familiarize self with the research assistants and address any issue or question that were raised concerning the research process. The reason for adopting this method is to help ensure a high return rate of the instruments.

3.8 Method of Data Analysis

The data analysis process for this study incorporated both qualitative and quantitative data analytical techniques. For the qualitative analysis, the researcher used tables and graphs to describe the data collected.

3.8.1 Principal Component Analysis

To achieve the objective of this study, the outcomes of the questionnaire distribution were tabulated and analysed. The data generated were subjected to Principal Component Analysis (PCA). Before PCA analysis, the data generated were structured as strata, with data generated on the factors causing the use of firwood linked to the communities from which they were generated in the study area. The principal component analysis (PCA) is a statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. This transformation is defined in such a way that the first principal component has the largest variance, and each succeeding component in turn has the highest variance possible under the constraint that it is orthogonal to the preceding components. The resulting vectors are an uncorrelated orthogonal basis set. PCA is sensitive to the relative scaling of the original variables.

4. Results

4.1 Biodata of the Respondents

The respondents' demographic data sampled in Awka North LGA are presented below. The presentation of the demographic information of the respondents was to show clearly the characteristics of the people interviewed, the gender distribution, the ages of the respondents, and their educational qualifications. This reveals to the reader the respondents' ability to understand the contents of the questionnaire. The gender

distribution of the respondents, administered the questionnaire is shown in Table 4.1. The recorded responses showed that 52.3% of the respondents were males and 47.6% were females.

Table 4.1: Gender distribution of respondents

Gender	**Frequency**	**Percentage**
Male	208	52.1
Female	192	47.9
Total	400	100
Gender distribution of respondents based on communities		
Towns	**Male**	**Female**
Awba-Ofemili	39	36
Ugbene	16	15
Ebenebe	63	57
Amansea	19	17
Ugbenu	27	25
Mgbakwu	45	41
Total	**208**	**192**

The age distribution of the respondents living in the study area is shown in table 4.2.

4.2: Age distribution of the respondents

Age bracket	**Frequency**	**Percentage age distribution**
18 – 28	40	10%
29 – 39	128	32%
40 – 50	148	37%
Others	84	21%
Total	**400**	**100%**

Out of 400 respondents, 10% of the respondents were between 18 and 29 years of age; 32% of the respondents were between the ages of 29 and 39 years; 37% were ages ranging from 40 to 50, while 21% of the respondents were in the age group of Others. Based on the age distribution, it is obvious that most of the respondents are within the productive age group, ranging from 18 to 60 years. The age distribution of the respondents showed that over 65% are above 30 years of age and believed to understand the content of the questionnaire.

The educational qualifications of the respondents shed light on their understanding of the subject matter of the questionnaire upon explanation. Figure 2 shows the level of education of respondents. About 13% had a primary school education as their highest education. Also 27% of

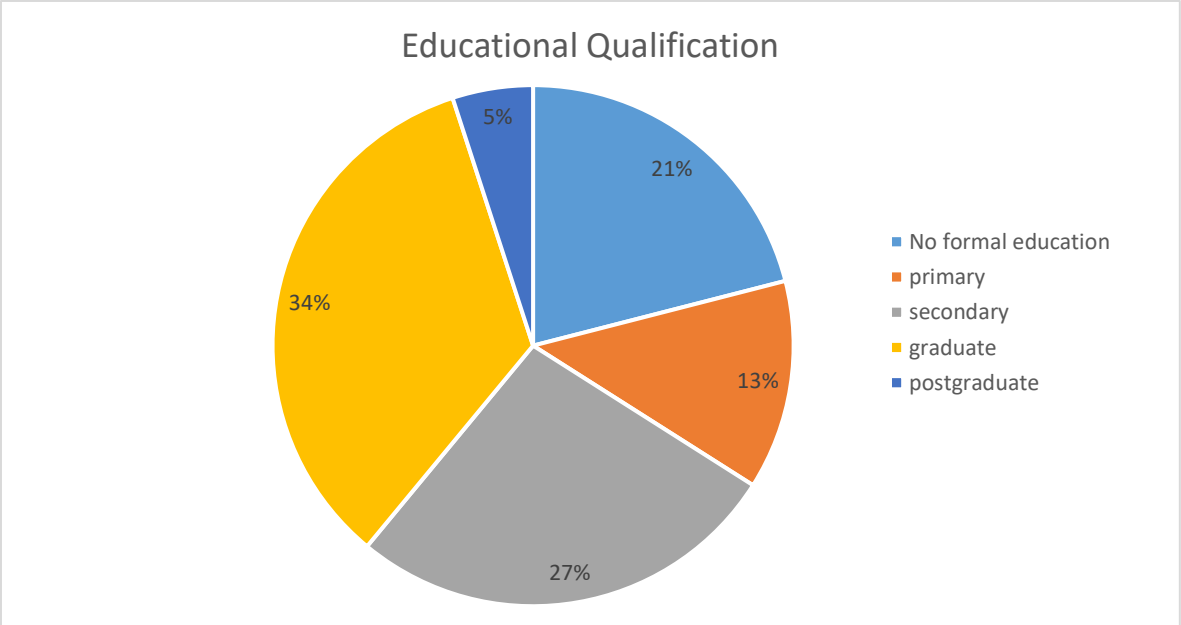

Figure 2: Educational qualification of the respondents

The respondents attest that they had secondary education as their highest level of formal education while 34% of the respondents identified as university graduates in various fields. It also reveals that 5% of the respondents identified as having postgraduate degrees, while 21% of the respondents have no form of formal education. The educational characteristics of most of the respondents showed a good understanding of the subject of the questionnaire upon explanation.

4.2 Responses to the Questionnaire Items and Research Questions

4.2.1 Factors that affect the use of firewood in Awka North Local Government Area

The perception of the respondents on factors influencing the use of firewood was sought using the questionnaire designed for this study. This effort was backed by the need to explain the first objective of this study. Ten factors were presented in the questionnaire to enable the respondents to make decisions on how they perceive their contributions. The data obtained from the responses collected from the respondents are shown in Table 4.3.

Table 4.3: Factors influencing the use of firewood in Awka North LGA

S/N	Factors	YES	NO	NO RESPONSE
X1	Geographic location affects accessibility and availability of firewood in Awka North.	193	123	84
X2	Socioeconomic status determines reliance on firewood for cooking and heating.	346	33	21
X3	Cultural practices influence the traditional use of firewood for ceremonies.	390	10	0
X4	Population density impacts the demand for firewood in the area.	354	39	7

X5	Environmental awareness affects attitudes towards sustainable firewood harvesting practices.	307	54	39
X6	Education levels determine the knowledge of alternative energy sources beyond firewood.	400	0	0
X7	Government policies on forestry management influence firewood availability and usage.	233	100	67
X8	Climate conditions dictate the need for firewood for warmth or cooking.	309	41	50
X9	Household size and composition determine firewood consumption rates.	367	32	1
X10	Traditional cooking methods in households influence firewood usage patterns.	369	22	9

These responses obtained from the respondents across the study area were further separated to clearly highlight the distribution of the responses across the study area. This is shown in table 4.4.

Table 4.4: Respondents' perceived responses on the factors influencing the use of firewood in Awka North LGA

Selected Towns in Awka North	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
Awba-Ofemili	36	21	28	36	64	73	66	32	28	36
Ugbene	52	30	40	15	27	30	27	46	40	52
Ebenebe	86	50	66	58	104	117	106	76	66	86
Amansea	57	24	92	28	40	66	58	24	93	28
Ugbenu	73	66	57	75	43	117	106	92	120	70
Mgbakwu	30	27	24	31	18	36	32	28	36	21

The data presented provides the responses obtained through the distributed questionnaire. To derive meaning from the data generated, statistical techniques were employed to analyze and identify the major factors influencing firewood usage in Awka North. To achieve this, principal component analysis (PCA) was used. This statistical process sorts the raw data by reducing the cases-by-variables data table to its essential features, called principal components (Greenacre et al., 2022). The first step was to define and parameterize the variables as presented in Table 4.5.

Table 4.5: Coding and Labelling of the Variables

Variable code	Name of Variable	Variable label
X1	Geographic location affects the accessibility and availability of firewood in Awka North.	GELOC
X2	Socioeconomic status determines reliance on firewood for cooking	SOCEC
X3	Cultural practices influence the traditional use of firewood such as using firewood to cook public food during ceremonies.	CULTURE
X4	Firewood use increases with population density in the area.	USAGE
X5	Environmental awareness affects attitudes towards sustainable firewood harvesting practices.	ENAWAR
X6	Education levels determine the knowledge of alternative energy sources beyond firewood.	EDULE
X7	Government policies on forestry management influence firewood availability and usage.	POLICY
X8	Climate conditions dictate the need for firewood for warmth or cooking.	CLIMATE
X9	Household size and composition determine firewood consumption rates.	HOSIZE
X10	Traditional cooking methods in households influence firewood usage patterns.	TRADIT

Part of the PCA analysis requires that interrelations among a set of variables be conducted to establish the level of correlations among the variables before using an orthogonal transformation to convert the set of correlated variables to a set of

uncorrelated variables. The correlation analysis conducted on the set of variables is shown in Table 4.7. However, the existence of multicollinearity as typified by X4 having multiple high correlations with X2, X7, X8, and X9, justifies the applicability of orthogonal transformation by the PCA technique employed here.

Table 4.7: Correlation of perceived factors influencing firewood usage in Awka North LGA

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
X1	**1.000**	.144	.412	.565	.602	.364	.636	.504	.230	.047
X2	.144	**1.000**	.232	.768	-.094	.885	.781	.812	.974	.701
X3	.412	.232	**1.000**	.662	-.084	.216	.418	.263	.176	.722
X4	.565	.768	.662	**1.000**	.050	.653	.791	.893	.800	.660
X5	.602	-.094	-.084	.050	**1.000**	.239	.442	.186	.043	-.200
X6	.364	.885	.216	.653	.239	**1.000**	.927	.676	.848	.662
X7	.636	.781	.418	.791	.442	.927	**1.000**	.764	.795	.631
X8	.504	.812	.263	.893	.186	.676	.764	**1.000**	.907	.391
X9	.230	.974	.176	.800	.043	.848	.795	.907	**1.000**	.587
X10	.047	.701	.722	.660	-.200	.662	.631	.391	.587	**1.000**

Varimax rotation was employed in transforming the 10 factors into three significant and orthogonal components that explained the observed data obtained from the respondents (Table 4.7). The result of the varimax rotation showed that each of the three components had eigenvalues greater than 1 and explained 91.25% of the variance. Table 4.7 shows that four of the factors load highly on component I. These factors are X2, X6, X8, and X9; only one factor, X3, loaded high on component II; while two factors, X1 and X5 were highly loaded on component III. These components and the factors that loaded highly on them were extracted and shown in tables while the implications of this outcome were further explored. The screen plot of these components is shown in Figure 3.

Table 4.7: Varimax Rotated Component Matrix of the factors influencing firewood usage in Awka North LGA.

		Components			h^2
		I	II	III	
X1	Geographic location affects accessibility and availability of firewood in Awka North.	0.187	0.327	0.874	0.905
X2	Socioeconomic status determines reliance on firewood for cooking and heating.	0.977	0.175	-0.118	0.999
X3	Cultural practices influence the traditional use of firewood for ceremonies.	0.076	**0.989****	0.108	0.995
X4	Firewood use increases with population density in the area.	0.713	0.587	0.231	0.907
X5	Environmental awareness affects attitudes towards sustainable firewood harvesting practices.	0.056	-0.209	**0.892****	0.841

X6	Education levels determine the knowledge of alternative energy sources beyond firewood.	0.895	0.139	0.188	0.856
X7	Government policies on forestry management influence firewood availability and usage.	0.796	0.314	0.466	0.95
X8	Climate conditions dictate the need for firewood for warmth or cooking.	0.844	0.164	0.290	0.822
X9	Household size and composition determine firewood consumption rates.	**0.986****	0.094	0.019	0.982
X10	Traditional cooking methods in households influence firewood usage patterns.	0.564	0.704	-0.236	0.869
Eigen values		**6.017**	**1.781**	**1.326**	
% of variance		**60.173**	**17.814**	**13.264**	
Cumulative %		**60.173**	**77.987**	**91.251**	

*Significant loadings ±0.80 and **component defining variables (CDVs) above.*

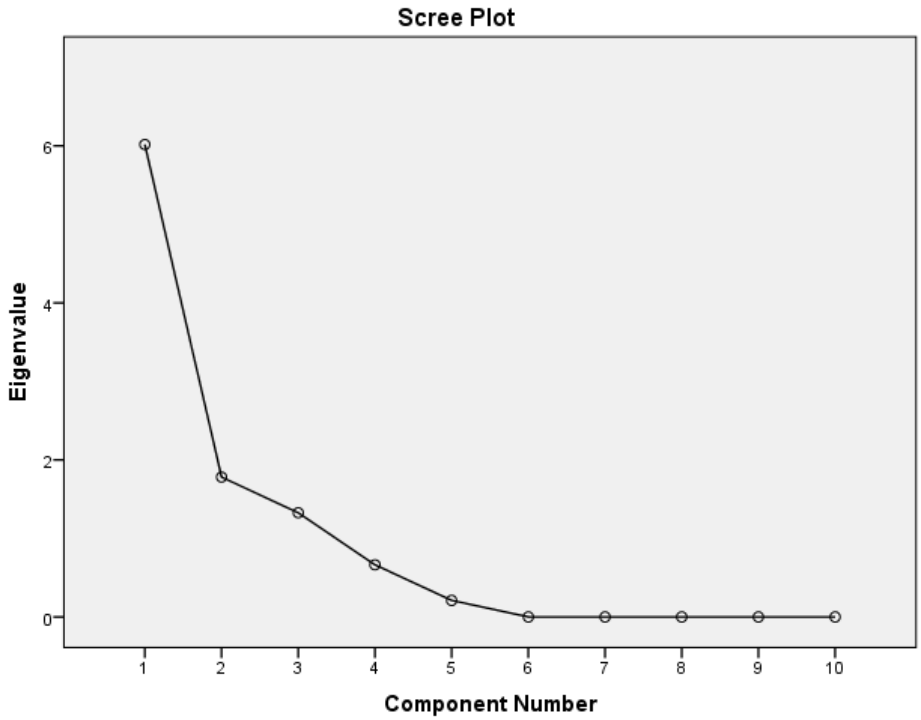

Figure 3: Screen plot

The first component (Table 4.8), with three factors loading high and given the connections between the factors, is an indication that socio-economic condition and size of the household is a critical factor that determines the usage of firewood as a primary energy source in the studied locations within Awka North LGA. This component has been shown to explain 60.17% of the variations observed in the responses obtained from the

respondents. This points clearly to the importance of the economic situation of the people in choosing what they perceived as a cheaper source of energy which is depicted by this component as a critical factor.

Table 4.8: Variables loading highly on Component I

Variables	Variable name	Loadings
X9	Household size and composition determine firewood consumption rates.	0.986
X2	Socioeconomic status determines reliance on firewood for cooking and heating.	0.977
X6	Education levels determine the knowledge of alternative energy sources beyond firewood.	0.895
X8	Climate conditions dictate the need for firewood for warmth or cooking.	0.844

In Table 4.9, only one factor loads high on component II, and this depicts that the cultural practices of the people in the study area strongly influence the use of firewood as a source of energy for the occupants of the communities studied in Awka North LGA. These communities are known to be mostly rural, possessing the features of the rural environment, and characterized by low-income populations who seek cheaper energy sources. Thus, the majority of this demographic group is heavily dependent on firewood for cooking.

Table 4.9: Variables with high loadings on Component II

Variables	Variable name	Loadings
X3	Cultural practices influence the traditional use of firewood for ceremonies.	0.989

For component III, variables X1 and X5 loaded highly. In Table 4.10, seeing that the two variables, "environmental awareness affects attitudes towards sustainable firewood harvesting" and "geographic location affect accessibility and availability of firewood usage" load highly on component 3, it is clear that the awareness by the respondents of available forest resources in their locality defines this component. This implies that knowledge of available forest resources in their locality is a factor that motivates and influences the use of firewood in the study area.

Table 4.10: **Variables with high loadings on Component III**

Variables	Variable name	Loadings
X5	Environmental awareness affects attitudes towards sustainable firewood harvesting practices.	0.892
X1	Geographic location affects the accessibility and availability of firewood in Awka North.	0.874

The three components, influencing firewood use in Awka North LGA, explained 91.25% of the variance. Further, the sum of the squared loadings (h^2) of all components was determined. This is known as communality, and it explains the proportion of the variance

of each variable that is accounted for by all the extracted components. Thus, the uniformly high values of the communalities (Table 4.7) are explained by the fact that the three components explained almost all the variance (91.25%) in the study area.

4.2.1.1 Component Scores

The component scores of the isolated components that now define the dominant factors that influence firewood usage were calculated and shown in Table 4.11. Evaluation of these component scores revealed their magnitude and direction, as positive signs indicate high dominance, while negative sign indicates areas where the said component has its lowest influence. These are regarded as degrees of association.

Table 4.11: Component scores of factors influencing firewood usage

Towns	I	II	III
Awba-Ofemili	-3.25779	-2.29391	-0.53066
Ugbene	-4.23599	-1.99822	-2.07417
Ebenebe	5.899409	3.294495	4.005151
Amansea	-1.98253	0.466861	-0.31694
Ugbenu	7.765784	3.548624	1.915768
Mgbakwu	-5.32663	-3.29128	-2.99915

For component I, socio-economic conditions and size of household (Table 4.13) exhibit its influence in Ugbenu, followed by Ebenebe, given their high scores of 7.7658 and 5.8994, respectively. Mgbakwu, Ugbene, and Awba-Ofemili showed very low values of influence from this component. Thus, while socio-economic conditions and the size of households greatly influence firewood consumption in Ugbenu and Ebenebe, this factor does not significantly influence the need to use firewood in Mgbakwu, Ugbene, and Awba-Ofemili. It also has little impact in Amansea. Component II, which describes the cultural practices of the people, showed that the scores of this component displayed their highest presence in the responses pieced together from Ugbenu and Ebenebe parts of Awka North LGA, with a slight contribution in determining firewood consumption in Amansea, given their scores of 3.5486, 3.2945, and 0.4669, respectively. The component has its lowest presence in Mgbakwu, Awba-Ofemili, and Ugbene in this order of importance. For component III, knowledge of available forest resources in their locality (Table 4.13) has its highest occurrence in Ebenebe (4.0051) and lowest in Mgbakwu and Ugbenu, given their score values of -2.9991 and -2.0742, respectively.

4.3.1 Hypothesis 1

Multivariate regression was used on the component-defining variables (CDVs) from each of the components. The standard linear regression model assumes, the value of Y has a linear form with the set of predictor variables (X1, X2, X3…, Xn) as follows:

$$Y = f(X_1, X_2 \ldots., X_n) = \beta_o + \beta_1 X_1 + \beta_2 X_2 \ldots. + \beta_n X_n$$

Principal Component Regression (PCR) was employed to extract the underlying effects of the explanatory variable and to use these to predict the dependent values. The dependent variable (Y, which is the firewood use), increases with population density with a loading of 0.713 in component I and is used here as a surrogate measure of firewood usage. Using the

PCR ensures that only independent effects are used with the certainty of excluding local variance noise to improve the quality of the least regression model. From Table 4.7, the highest loadings from each component, known as the Component Defining Variable (CDVs), were isolated. The CDVs were used as explanatory variables, which have now replaced the original variables. The original variables of these isolated variables cannot be used because of their multicollinearity, which will expectably distort the result. The PCR equation expressing the closest possible relationship between the firewood usage and the three specified variables is

$$Y(X_4) = 7.091 + 0.474(X_5) + 0.759(X_9) - 0.753(X_3)$$

The contributions of individual variables to the explanation of the variation are given by the R^2 change, and the level of variation is the amount of firewood being used that can be explained by the linear dependence upon the independent variables operating together, as seen in the equation.

Table 4.12: Result of PCR Analysis Statistics

Statistics	**Result**
Multiple Correlation (R)	0.987
Coefficient of Multiple Determination (R2)	0.975
Standard Error of Estimates (mm)	5.4636

The combined strength of the relationship between these three variables and the firewood usage was assessed by the Multiple Regression Coefficient (R) and coefficient of multiple determination (R^2), which gave 97.5%. The significance of this regression equation showing the relationship between factors influencing firewood consumption and firewood usage in Awka North LGA was tested using the Analysis of Variance (ANOVA) test. This tests the first null hypothesis (H_o1), which states that "*there is no significant relationship between socio-economic factors and the use of firewood in Awka North Local Government Area*". At a 0.05 level of confidence, the critical value of F from the F-Snedecor table is 19.16. Given that F of 26.045 is greater than 19.16, the Ho 1 is rejected. In other words, there is a significant linear relationship between firewood usage and the three isolated factors influencing the use of firewood in Awka North LGA.

Table 4.13: ANOVA for testing the significance of the regression

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2332.379	3	777.460	26.045	.037[b]
	Residual	59.702	2	29.851		
	Total	2392.081	5			

5. Discussion and Conclusion

The findings on factors influencing firewood usage in Awka North Local Government Area reveal complex interactions between socioeconomic, cultural, environmental, and demographic variables. Socioeconomic status, household size, and

education emerged as the strongest determinants, collectively explaining over 60% of the variation in firewood use. This aligns with French et al. (2019), who found that household income and family composition strongly dictate dependence on biomass fuels in rural Nigeria. In contrast, a study by Seglah et al (2022) in Ghana reported that education had a stronger moderating effect, as higher literacy levels encouraged transitions to liquefied petroleum gas (LPG). Cultural practices also significantly influenced firewood use in Awka North, particularly for communal ceremonies and traditional cooking. This finding agreed with Safieddin-Ardebili et al. (2022), who emphasized that cultural norms perpetuate firewood use in West African communities despite the availability of alternatives. In a related study, Sufiyan et al. (2021) demonstrated that while cultural attachment sustains firewood use in Northern Nigeria, urbanizing areas gradually shift to modern fuels, underscoring contextual differences.

Environmental awareness and geographic location formed another critical dimension. Respondents in forest-adjacent areas relied more on firewood, while awareness of sustainable harvesting influenced consumption patterns. This finding contrasts with Ifegbesan et al. (2016), who argued that environmental awareness alone is insufficient without policy enforcement to restrict unsustainable harvesting. However, Ogbu et al (2022) agreed that geographic access remains decisive, as proximity to forests reduces energy costs for households. Climate conditions and population density also shaped firewood reliance. Higher demand was observed in densely populated areas, echoing the findings of Bulama et al. (2022), who reported that population pressures increase fuelwood demand, aggravating deforestation. Yet, unlike their study where climate had minimal effect, the Awka North context showed that seasonal cold spells reinforced dependence on firewood for heating.

The principal component analysis revealed three dominant components: socioeconomic and household characteristics, cultural practices, and environmental-geographic awareness. Together, these explained 91.25% of the variance in firewood use, demonstrating that reliance on firewood is not merely a matter of preference but the outcome of interwoven economic, social, and environmental factors.

The study revealed that dependence on this traditional energy source is the outcome of interrelated socioeconomic, cultural, and environmental influences. Socioeconomic status, household size, and education were found to be the most significant determinants, while cultural practices and geographic accessibility further reinforced reliance on firewood. The findings highlight that firewood use is not merely a matter of choice but a necessity shaped by affordability, availability, and deeply rooted traditions. The results also underscore the environmental and health implications of continuous dependence on firewood, including deforestation and indoor air pollution. Addressing these challenges requires more than simply promoting alternative fuels; interventions must be socially acceptable, economically feasible, and contextually relevant. Policies aimed at expanding access to affordable modern energy, improving rural livelihoods, and raising environmental awareness will be crucial in reducing firewood

dependence. Firewood use in Awka North is influenced by complex and multidimensional factors. A coordinated effort involving government, community leaders, and development partners is essential to foster sustainable energy transitions while safeguarding both the environment and the well-being of rural households.

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