Knowledge, Attitude and Practices of energy utilisation behaviours: A study of residential building occupants

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Abstract:

Purpose:

This study aims to assess residential energy consumption knowledge, attitudes, and practices in Abuja Municipality, providing insights for effective conservation strategies, reducing costs and mitigating environmental impact.

Design and Methodology: Data for this study was collected through a cross-sectional survey conducted among a representative sample of the Nigerian population between February and April 2021. A total of 462 questionnaire responses were collected and subsequently analysed using SPSS. Descriptive statistics, including frequency count, percentages, mean, and standard deviation, were calculated. Additionally, inferential statistics were performed using Chi Square analysis, with significant level set at $P \leq 0.05$ to draw meaningful conclusions from the data.

Results:

The study results indicate that out of the total respondents, 244 individuals (67.4%) demonstrated a profound knowledge of and good practice in energy utilisation. In comparison, 118 individuals (32.6%) exhibited poor knowledge and practice in energy saving. Moreover, the findings reveal a significant association between the socio-demographic factors of the respondents, building type, and their overall practice in energy utilisation. Statistical analysis shows significant $\chi 2$ values for each case: 8.563 (P=0.003), 66.736 (P=0.000), 60.866 (P=0.000), 23.487 (P=0.000), 37.877 (P=0.000), and 92.334 (P=0.000), respectively, where $P<0.05$. These results highlight the importance of considering socio-demographic profiles and building characteristics when assessing general energy utilisation practices.

Originality: The research offers valuable insights into Nigerian energy usage behaviours and attitudes towards energy saving in residential buildings, contributing significantly to the knowledge base.

KEYWORDS: knowledge, attitude, practices, energy utilisation behaviour

Introduction

1.1 Key concept and study background

The substantial energy consumption in buildings poses significant environmental challenges, contributing to climate change, air pollution, and thermal pollution, all of which have profound implications for humanity's survival (Pham *et al*., 2020). Over the last few decades, the building sector has experienced a substantial increase in energy demand due to factors such as population growth, rapid urbanisation, and heightened social needs (Amasyali and El-gohary, 2018). The building sector is crucial in shaping our environmental footprint, accounting for approximately 30% of global energy consumption and emitting around 40% of all carbon dioxide (CO_2) emissions (Mardiana and Riffat, 2015; Laasri *et al*., 2023; Han *et al*., 2022). Remarkably, more than 80% of building energy is consumed during the operational stage of the building life cycle (Kazemi and Udall, 2023). Buildings must be energy-efficient and sustainable to mitigate climate change impacts, and analysing energy consumption patterns is crucial for informed decision-making and conservation (Olu-Ajayi *et al*., 2022). Li *et al*. (2019) emphasise that households' knowledge, attitude, and behaviour significantly influence energy consumption patterns, particularly in residential buildings. Abuja, Nigeria's fastest-growing city, requires investigating energy consumption in residential buildings to tackle urban expansion challenges (Obia, 2016). Thus, understanding energy consumption in residential buildings is crucial for identifying and resolving issues arising from urban expansion.

A substantial body of literature documents research on the patterns and trends of energy usage across various countries. Bishoge *et al*. (2021) conducted a review to investigate the

impact of behavioural change on households on the energy efficiency of buildings. A study by Ahamad and Ariffin (2018) in Selangor, Malaysia, discovered a significant correlation between knowledge, attitudes, and practices in addressing sustainable energy consumption challenges. Martiskainen (2008) highlights the growing concern of household energy consumption in the United Kingdom, highlighting the importance of a reliable feedback mechanism in influencing energy consumption behaviour. Emmanuel and Ajide (2015) found that 75% of people in Lagos, Nigeria, are aware of renewable energy, 65% are willing to use it, and more are willing to invest more in it. Kazemi and Udall (2023) identified behavioural barriers to renewable and energy-efficient technology use in Iran, including traditional education and online feedback, as major challenges.

In a similar study conducted by Gârdan *et al*. (2023) on Romanian consumers' attitudes towards renewable energy during the crisis, the authors suggested strategies such as social marketing campaigns and government support to address social pressure and perceived utility. This shows that individuals may be influenced by societal norms, attitudes and perceptions. A study by Paço and Lavrador (2017) in Covilhã, Portugal investigated the relationship between environmental knowledge, attitudes, and behaviours among university students. The findings revealed that while there was no significant relationship, certain demographics, such as male, older, and Engineering and Social and Human Sciences students, exhibited higher environmental knowledge. Meanwhile, female students showed greater awareness. Therefore, it stands to reason that energy consumption and management could be influenced by users' awareness of the need to utilise energy (IEA, 2022), while people's behaviour could significantly impact their energy use (Shaw and Ozaki, 2013).

This study focuses on residential buildings in Abuja with the intention of providing a comprehensive understanding of energy usage, given their higher population density and diverse demographics. While extant literature offers insights into general energy consumption trends in residential buildings, a research gap exists regarding the specific impact of occupants' activity patterns on energy usage within Abuja's varied dwelling types (Ubani *et al*., 2024). Furthermore, comparative studies on nuanced energy consumption

between diverse residential structures and more uniformly used office buildings are scarce (Trepci *et al*., 2020), indicating an area primed for investigation. Consequently, this study's aim is to explore the influence of socioeconomic factors on energy utilisation among residential occupants in Abuja, with a specific focus on differences in knowledge, attitudes, and practices.

1.2 Study Implications

This study offers valuable insights for Abuja Municipality authorities, urban planners, and stakeholders, highlighting the need for targeted policy and urban design focused on energy hotspots in residential areas. By adopting energy efficiency standards and environmental guidelines, specific challenges identified in the research can be addressed. It emphasises the significance of community engagement and educational efforts to foster an energy aware culture, advocating for infrastructure improvements and the promotion of sustainable technology use to enhance energy efficiency in living environments.

In the aspect of theoretical implications, this study contributes to the advancement of existing frameworks in the field of sustainable energy behaviour. In particular, by placing the Knowledge, Attitude, and Practices (KAP) models (Liao *et al*., 2022; Bhuwandeep, 2021) inside the particular dynamics of energy use in residential settings, the empirical evidence acquired improves the KAP models. Incorporating socioeconomic variables, such as cultural dimensions and income levels, enhances theoretical foundations by investigating their influence on energy consumption patterns. Additionally, the study contributes to broader discussions on the relevance of findings in varied situations by providing insights into cross-cultural viewpoints on sustainability. Creating a baseline for present energy use patterns lays the groundwork for upcoming longitudinal studies, which will theoretically shed light on the temporal dynamics of locals' behaviours, attitudes, and knowledge regarding sustainable energy use.

The paper's structure comprises six sections: an introduction outlining research gaps, a literature review on energy consumption behaviours, a detailed description of the research

methodology, presentation of questionnaire findings, a discussion of insights gained, and recommendations for future research and policy implications.

2. Literature Review

Energy consumption patterns constitute a critical component of modern urban life, with profound implications for environmental sustainability, economic efficiency, and social development (Pham *et al*., 2020). As urban centres expand, particularly in developing countries, understanding the interplay between residents' knowledge, attitudes, and practices (KAP) toward energy use becomes increasingly significant. This literature review systematically synthesises existing research on the determinants and characteristics of energy consumption patterns, behaviours, attitudes and perceptions, and knowledge and attitudes towards energy savings among urban households.

2.1 Energy Consumption Patterns

Energy consumption patterns are intricately linked to the broader framework of energy culture, which encompasses societal attitudes, norms, and behaviour regarding energy use (Burger *et al*., 2015). The Energy Culture Framework offers a perspective that enables analysing and comprehending the underlying forces influencing our energy consumption behaviours (Kimutai *et al*., 2019). Numerous factors influencing consumption patterns, including weather conditions, building characteristics, equipment usage, and occupant behaviour, have been subjected to extensive research (Zhao *et al*., 2019).

Building energy consumption patterns are crucial for sustainability and urban development, especially in residential structures. Factors like space heating, cooling, appliances, lighting, and water heating influence sustainability (Chen *et al*., 2020). Efficient energy practices reduce utility costs and contribute to long-term economic sustainability. Combining renewable technologies with energy-efficient practices can reduce environmental impact (Chel and Kaushik, 2018). Government incentives and regulations influence energy performance (Lee *et al*., 2015). Optimising domestic energy consumption patterns is crucial for financial savings and environmental sustainability. This includes integrating energy-efficient technologies, renewable energy sources, and consumer behaviour changes (Zhao *et al.*, 2019). Residential energy consumption patterns

significantly impact building energy use, environmental impact, resource efficiency, and economic considerations (Chel and Kaushik, 2018). Efficient energy practices reduce utility costs and contribute to long-term economic sustainability.

Cao *et al*. (2021) studied energy consumption patterns in rural households, highlighting the impact of agricultural income on cooking energy hierarchy. They suggest augmenting agricultural earnings to encourage the adoption of cleaner energy and implementing energy transition policies. Esmaeil *et al*. (2019) analysed energy consumption patterns in Saudi Arabian residential buildings, specifically villas and flats, considering consumption per dwelling, per population, and unit area. The study also explored energy efficiency techniques, proposing opportunities for savings through implementing insulation standards and optimising air conditioning temperature settings. The emphasis lies on the importance of research on residential energy consumption to raise awareness and offer valuable insights for energy efficiency and conservation initiatives.

Yousefi *et al*. (2017) found that occupant lifestyles significantly impact energy usage in residential buildings in Iran, potentially altering the building's thermal characteristics by up to 90%, highlighting the need for accurate energy consumption simulations. Ma *et al*. (2014) study used a Gaussian mixture model to analyse energy consumption patterns in district heating systems. Findings showed time did not accurately capture energy consumption patterns, but classifying buildings based on functions was effective. The aforementioned research is highly noteworthy, yet there may be room for improvement. A more thorough investigation of the socio-cultural elements influencing the adoption of clean energy will benefit Cao *et al*. (2021) examination of energy use in rural households. A closer look at socioeconomic issues could complement Esmaeil *et al*. (2019) focus on the technical aspects of energy efficiency in Saudi Arabian residential buildings. Concrete suggestions for creating energy-efficient buildings and a more thorough examination of regional factors would benefit Yousefi *et al*. (2017) study on the relationships between occupant lifestyle and energy usage in Iranian residential structures.

Ma *et al*. (2014) conducted a quantitative analysis on district heating energy usage, indicating the need for a deeper exploration of influencing variables. The rationale behind

this study is to address the need to understand the patterns of energy use in residential buildings in the Abuja Municipality. Understanding residential occupants' knowledge, attitudes, and behaviours is crucial for shaping targeted policies, urban planning strategies, and community engagement activities in this rapidly rising metropolitan centre confronting increasing energy demands.

2.2 Energy Consumption Behaviours

Understanding and managing energy consumption behaviours is a critical aspect of energy management, influenced by various factors. Research into the determinants of individual energy consumption behaviour is challenging due to its interdisciplinary nature (Burger *et al*., 2015). A study emphasised the impact of human behaviour on energy utilisation, highlighting that user attitudes significantly affect energy consumption reduction (Mahgoub and Khalil, 2012). Income level and knowledge emerged as pivotal factors in determining household energy utilisation and behaviour changes (Kimutai *et al*., 2019). This underscores the importance of knowledge, attitude, and practices in achieving maximum energy efficiency and management (Thondhlana, 2016). However, for effective strategies to reduce household energy consumption, it is crucial to consider both the environmental impact and ongoing efforts towards achieving net-zero emissions. In certain developing nations, like Nigeria, accurate energy metering and billing pose challenges due to issues in electricity infrastructure (Schützeichel, 2022). Improper energy metering is a significant issue, resulting in unfair energy rates for residential consumers (Adekitan *et al*., 2018). Additionally, variations in electrical equipment, monthly power expenditure, and alternative energy sources complicate the assessment of energy utilisation and management on a household level (Ibitoye, 2013).

Previous research on residential energy consumption examines factors like building design, technology, socioeconomic variables, individual actions, renewable energy use, policy implications, and environmental effects, focusing on appliances, HVAC systems, lighting, and renewable energy sources (Cao *et al*., 2021; Chen *et al*., 2020; Chel and Kaushik, 2018; Lee *et al*., 2015). Nonetheless, the literature on behavioural differences in residential communities is limited, and further research is needed to determine the effectiveness of

energy-saving behaviours and their sustainability, considering policy changes, cultural transformations, and technological advancements.

2.3 Attitude and Perception of Energy Saving

Initiating behavioural change and reducing energy consumption and greenhouse gas emissions hinges on consumers' accurate perceptions of energy use and savings. According to (Lesic *et al*., 2018), consumers with precise perceptions are better equipped to identify activities that yield the most energy savings. Attari *et al*. (2010) study revealed a significant discrepancy between actual energy use and savings, with individuals underestimating the impact of 15 activities, with overestimations for low-energy activities and underestimations for high-energy activities by a factor of 2.8. In a different scenario, using a 3W LED flashlight bulb as a reference for judging energy use (Frederick *et al*., 2011) shows respondents underestimated energy consumption by a staggering factor of 18.3. Similarly, when a 100W incandescent light bulb was used, respondents underestimated consumption by a factor of 2.5, aligning with the findings of Attari *et al*. (2010). Accurate energy usage perceptions are prevalent among households, necessitating a nuanced understanding of their impact on decision-making and planning across diverse populations. Chen *et al*. (2015) study found a large discrepancy between household estimations and actual usage, with 75% overestimating lighting and 29% underestimating plug-load use. The study analysed appliance-level power consumption collected from 124 flats over a 24-month period. Through three cognitive accessibility studies, participants estimated annual percentages of total individual and household energy consumption for various purposes. Despite focusing on national rather than personal energy use, the studies consistently found overestimation for low-consumption categories and underestimation for high-consumption categories, aligning with the findings of Attari *et al*. (2010).

Finally, Nazarahari *et al*. (2021) study on daily energy use and related expenses of 447 college students found a correlation between energy cost awareness and usage, with those monitoring bills showing increased awareness. Contrary to broader studies, this research

focuses on material culture, knowledge, and energy utilisation practices among Abuja's residential occupants.

2.4 Knowledge and Attitude towards Energy Savings

Understanding users' knowledge and attitudes toward energy conservation is pivotal for effective energy efficiency and management. Pothitou *et al*. (2016) observed that knowledge potently influences behaviours, attitudes, and habits leading to household energy-saving activities. Statistical evidence further supports the direct impact of environmental knowledge on behavioural changes within households Żywiołek *et al*. (2021). Kazemi and Udall's (2023) study highlights the significance of closing information gaps for energy efficiency since 83% of respondents admit that user awareness strongly influences their attitude toward energy saving. Consequently, awareness emerges as a pivotal driver for cognitive, attitudinal, and behavioural changes, contributing to significant shifts towards energy-saving practices (Zhao *et al*., 2019). These findings highlight the importance of knowledge in energy saving and management.

Item Response Theory (IRT) was utilised in Belaïd and Joumni's (2020) study on energy conservation in residential structures to examine household environmental attitudes. The study found that energy-saving behaviour fluctuated over time. Additionally, according to Żywiołek *et al.* (2021), economic considerations impact energy conservation practices and help shape a society conscious of sustainable development and focused on resource management.

While most studies in this domain are conducted in European, South, and North American countries, there is a notable dearth of data in sub-Saharan Africa. This study, therefore, chose to focus on sub-Saharan Africa, particularly Abuja, Nigeria, acknowledging the research gap as a significant factor in shaping the questionnaire variables to generate pertinent data. This approach seeks to contribute valuable insights to understanding knowledge and attitudes about energy conservation in a region with limited research.

To bridge cultural disparities, the study investigates energy attitudes, behaviours, and knowledge in Abuja's residential buildings. It contributes to urban sustainability discourse by enhancing understanding of residential energy practices. The questionnaire development involved an extensive literature review, expert consultations, and pilot studies to refine key factors influencing energy consumption. Identified variables comprehensively capture energy-related knowledge, attitudes, and practices. Addressing a research gap, the study delves into awareness levels, cultural influences, and knowledge discrepancies in Abuja's residential communities. Highlighting the significance of attitudes in influencing energy-saving activities directs stakeholders and policymakers to promote sustainable behaviours and energy efficiency. Positive attitudes are linked to environmental awareness, responsibility, and cost savings, while negative attitudes may stem from a lack of awareness or perceived inconvenience. Understanding these attitudes is essential for designing effective interventions, such as educational campaigns.

3. Research Method

This study conducted a descriptive, cross-sectional survey among households within the Abuja Municipal Area Council of Nigeria to assess the knowledge, attitudes, and behaviours regarding energy utilisation in residential buildings. The choice of a cross-sectional survey design, as noted by (Wang and Cheng 2020), was due to its flexibility and functionality it facilitates single point-in-time data collection, evaluates the prevalence and distribution of variables across various demographic groups, and enables the examination of energy-related behaviours in diverse socio-economic, housing, and cultural contexts. The cross-sectional design is also resource-efficient, logistically feasible, and supports the systematic collection of both quantitative and qualitative data (Spector, 2019).

The survey was conducted between February to April 2021 and formed part of ongoing research. The rationale for selecting this area resulted from high domestic energy consumption from their suppliers (Dahiru *et al*., 2019). Thus, the target population was households with access to electricity in Abuja's municipal area, registered with a pre-paid meter. Participants who were involved in an earlier research study were recruited through the energy supplier's database, although the researcher only considered samples who had

given third-party permission to access their data. Participants were selected using stratified random sampling to minimise error and bias (Stratton, 2021) and ensure representativeness. The study ensures representation across socioeconomic backgrounds, housing types, and cultural contexts. This approach improves the findings' accuracy and generalizability and offers a thorough grasp of energy usage patterns among various demographic groups. The survey includes questions about religion and tribe to understand cultural and sociodemographic factors influencing energy consumption in residential buildings. This information is crucial for designing culturally sensitive interventions, fostering community engagement, and understanding demographic variability.

A single pilot test was carried out on the instrument's reliability using about 45 residents in Abuja. Reliability refers to the extent to which quantifiable variables yield consistent results if the data collection process is replicated (Anderson and Kelley, 2022). The Cronbach Alpha coefficient is widely recognised as the main indicator of internal consistency (Yañez-Figueroa *et al*., 2022), and a value above 0.7 is generally considered acceptable. Thus, the Cronbach Alpha coefficient was employed to assess the internal consistency of the items, and a score of 0.71 was obtained. The questionnaire underwent content validity testing to ensure its intended measurement and subsequent adjustments were made after the validity test. Respondents were contacted via WhatsApp, invited to participate in a study, and sent questionnaires. Reminders were sent at different intervals to increase response rates. The sampling frame consisted of 1000 paper questionnaires and web-link invitations, and about 700 expressed an interest in participating in the study. Thus, participation was voluntary, and responses were both anonymous and confidential. A total of 519 responses were collected, but only 462 were complete and valid for analysis.

3.1 ***Questionnaire*** **Design/Data Collection**

Designing the questionnaire involved consulting several vital texts regarding structure (Callegaro *et al*., 2015). Moreover, Bernard (2017) raised issues with forms of bias and

Presser and Krosnick (2010) recommended re-wording questions to align with the energy culture framework (Stephenson *et al*., 2010, Stephenson *et al*., 2015).

The questionnaire utilised closed and open-ended questions with Likert-style ratings to evaluate attitudes and behaviours on a five-point scale. With 52 questions, the questionnaire assessed Abuja's municipal households' attitudes, behaviours, and opinions regarding energy utilisation.

1. **Socio-demographic variables**: This section contained 13 questions relating to respondents' demographic information, including gender, age bracket, religion, tribe, marital status, employment status, type of property, energy used for cooking, cooking gas expenses, type of meter, electricity bill expenses, method of paying energy bills, and awareness of energy-efficient appliances.
2. **Material culture and energy utilisation**: This section contained 11 statements on which respondents were asked to rate their agreement or disagreement using a Likert scale with four options: Strongly Agree (SA), Agree (A), Strongly Disagree (SD), and Disagree (D). The statements focused on respondents' attitudes and practices regarding energy utilisation and household habits.
3. **Cognitive norms associated with energy use**: This section consisted of 15 statements where respondents were asked to rate their agreement or disagreement with different cognitive norms related to energy usage. The responses were collected using the same Likert scale as that used for material culture and energy utilisation.
4. **Energy practices and energy utilisation**: This section contained 13 statements related to respondents' energy utilisation practices. Again, respondents were asked to rate their agreement or disagreement using the same Likert scale.

A questionnaire was distributed via WhatsApp and hardcopies to Nigerian nationals aged 18 and above, requiring voluntary completion and consent via a web link. Participants were guided to complete a brief self-report questionnaire, which took 10 -15 minutes to acknowledge their voluntary participation.

3.2 Statistical Data Analysis

The retrieved questionnaires were checked, compiled, recorded, and documented in a prepared form (using Listwise deletion) to reduce the risk of missing data due to incomplete questionnaires. The data were analysed using descriptive analysis (frequency count, percentages, mean, and standard deviation), and inferential statistics were conducted using Chi-Square, with inferences made at $P \leq 0.05$.

4. Findings

The analysis of socio-demographic characteristics using variables like gender, age, tribe, marital status, and occupation revealed that male participation was higher than female participation, with over 62.2% to 37.8%. The study revealed a predominant age group of 41–55, constituting over 47% of the participants, with 82% of the respondents being married. This diverse sample suggests richness in outcomes. Data analysis indicates that 31.2% of respondents spend 10,000-15,000 naira on monthly electricity bills. However, many energy users know about energy-efficient appliances and are considering changing their building type to reduce consumption, indicating a sustainable energy efficiency and management approach.

Over two-thirds of respondents favoured good energy usage, as shown in Table 1, while 69% considered relying on national grid electricity to be more viable than independent generation. Approximately 83% of respondents acknowledge that using greener energy is necessary for energy efficiency; nevertheless, some respondents are concerned about how the atmosphere may affect their decision to use greener energy sources. However, about 30% of respondents indicated a ‘carefree’ attitude towards energy, while 23.5% strongly agreed, which indicated that most respondents were neutral on efficient energy use.

Likewise, some Participants advocated for sustainable building design, showing good energy use practices and value addition, as presented in Figure 1. Cognitive norms significantly influenced attitudes and behaviours towards energy utilisation.

Table 1: Cognitive norms associated with energy used

The Table 1 shows that 31.2% of Nigerians don't know their energy usage, despite a gradual shift towards energy-efficient appliances since the 2000s (Adedayo *et al*., 2021). About 77.6% of parents believe their children are taught about it. Furthermore, Nigeria's energy practices are impacted by the availability of energy-efficient appliances, the unreliability of grid power, the development of energy infrastructure, and difficulties with energy consumption reduction for most families. Results in Table 2 show that cognitive norms significantly influence energy usage, indicating a shift in attitudes towards energy efficiency. Conversely, Table 1 shows that 37.0% strongly agree that solar panels should be integrated into new properties, while 51.4% strongly disagree.

Table 2: Impact of Socio-demographic Variables on Cognitive Norms and Their Influence on Energy Usage and Utilisation Practices

The study examined the connections between socio-demographics, cognitive norms, and energy consumption. The findings revealed that 32.6 per cent of respondents used energy poorly, compared to 67.4% who used it well. Energy consumption was positively correlated with cognitive norms: 53.0% of respondents reported having high norms, 34.0% had moderate norms, and 13.0% had low norms. The data points to a contradictory outcome as more individuals become aware of the significance of energy conservation despite perceptions of energy abundance. The data analysis examined the correlation between socio-demographics and energy usage practices, revealing respondents' demographics, including gender, age, tribe, marital status, occupation, and building type. these show significant associations with general practice on energy utilisation at ($\square^2$=8.563, P=0.003), ($\square^2$=66.736, P=0.000), ($\square^2$=60.866, P=0.000), ($\square^2$=23.487, P=0.000), ($\square^2$=37.877, P=0.000) and ($\square^2$=92.334, P=0.000) respectively with P<0.05 for each case. The study reveals a significant correlation between socio-demographic factors, cognitive norms, and energy use, highlighting the importance of considering these factors in energy efficiency and management strategies at ($\square^2$=10.234, P=0.006), ($\square^2$=73.758, P=0.000), ($\square^2$=193.899, P=0.000), ($\square^2$=28.020, P=0.000), ($\square^2$=46.626, P=0.000) and ($\square^2$=113.790, P=0.000) respectively whereby P<0.05 for each case.

Employment status significantly influences energy utilisation at 46.7%, with cognitive norms also having a significant impact. Marital status also significantly influences energy usage behaviours, suggesting increased responsibility may improve practices. Table 2 provides data on gender, age, tribe, and property type to enhance data quality and analysis of energy utilisation.

Figure 1: Association between socio-demographic variable and Cognitive norms associated and its Impact on energy usage and utilisation practices.

Figure 2: Linear regression analysis on cognitive norms associated with energy-saving behaviour and practice of the respondents on energy utilisation.

In Figure 2, the linear regression analysis on cognitive norms associated with energy-saving behaviours and practices shows a significant association with cognitive norms at mean ±SD of (2.89±0.999) at $p<0.05$. This suggests a close association between the cognitive norms of energy-saving behaviour and practice.

5. Discussion

Energy is vital to economic and social development and improving the quality of life in all countries (Kaya *et al*., 2019). It is important to note that energy conservation in homes has been cited as a significant problem. Still, researchers, energy experts, and politicians argue this issue has great potential for change (Kraft, 2021). Households seem to be becoming more conscious of the need to select sustainable energy choices (Gârdan *et al*., 2023). Nevertheless, despite awareness of climate change and increased energy prices, many consumers fail to take significant steps to improve energy efficiency and conservation at home.

The findings from this study show that more than two-thirds of respondents live in a flat and use gas and electricity as their primary energy source. Most respondents have formal education and are conversant with the study topic. Targeted awareness campaigns can effectively encourage individuals to adopt energy-efficient technologies and behavioural

leveraging practical interventions for this purpose. Regarding energy-efficient building development, 46.4% pay monthly, while 31.2% use instalment payment. This echoes the findings of (Nnodu *et al*., 2017) on sustainable energy-efficient strategies for retrofitting building developments in Abuja, Nigeria, which found that most households belonged to the medium and high-income group, as most respondents were from the federal capital territory. Furthermore, residents of the study area were shown to have moderately efficient practices and a reasonable understanding of energy utilisation. Hence, the attitude towards energy savings and utilisation is high due to a significant level of awareness and understanding of its economic and environmental impacts.

This study offers significant insights on the prevailing energy consumption patterns and attitudes of individuals in residential settings. Policymakers can utilise this information to formulate precise and effective policies that foster the adoption of sustainable energy practices, considering the populace's distinct requirements and attributes. Furthermore, it is estimated that households account for the largest share of consumption at about 78% (Nigerian Energy Support Programme, 2015). In this study, most respondents were aware of energy-efficient appliances, as noted in their responses to energy consumption practices. It was also observed that most respondents responded positively about how individuals change household energy, control heating efficiently at home, and check the energy rating of appliances before buying. These findings align with those of Zhang *et al*. (2021), who reported a willingness to reduce residential energy consumption. Their study reported that 88% of participants accepted more than a 5% cost increase for more energy-efficient appliances. Furthermore, nearly 80% of respondents (suggesting a concern for energy-efficient household products) pay attention to energy efficiency parameters/indicators when purchasing.

The most prevalent type of energy is electricity, which is produced from several sources and used as a secondary fuel (Jewell, 2011). Furthermore, electricity is utilised in many places, including homes, companies, and industries (Babatunde and Shuaibu, 2009). Since it cannot be easily replaced by other forms of energy and is necessary for fundamental household tasks like lighting, cooling food, and the use of appliances, access to electricity is essential for human growth. Despite the importance of household energy in most

developing nations, there are few rigorous empirical studies on the factors influencing household preferences and choice of domestic energy services. In this study, more than two-thirds of the respondents indicated good attitudes/cognitive norms concerning energy use, as most understood the energy pattern used in each household. Most respondents indicated they generate their energy to do their house chores, such as kerosene or charcoal in combination with electricity to ensure optimum energy.

Additionally, most households understand the importance of self-generated energy, such as the use of solar panels. However, some agreed while others disagreed that solar panels should be built into all new properties, which could be due to significant price increases in their installation cost in Nigeria. Nevertheless, in developed countries like the USA, households are known to generate energy for their personal use (Wellinghoff and Weissman, 2015).

A similar study by (Meried, 2021) reported that attitudes towards adopting solar energy are promising and becoming more favourable, although the supply is scant, especially in developing countries such as Nigeria. About 63% of respondents stated they have adopted non-depletable energy sources, including solar energy. When asked whether they had enough training on the use of renewable energy sources and if they had heard anything on the radio or television about how children are now taught to utilise energy, the vast majority of study participants responded negatively. This highlights the lack of sensitisation and awareness of energy utilisation by the government and other responsible stakeholders which could enhance residents' use through good practice (IEA, 2022; Zhao *et al*., 2019; Lee *et al*., 2015).

Overall, respondents' practices and cognitive norms show a significant association with their employment status. A large proportion of those employed had good practice with higher cognitive norms associated with using energy compared to other respondents. However, the Pearson correlation between cognitive norms and energy utilisation shows a negative significant association with energy utilisation practice. This implies that respondents' status directly impacts the cognitive norms associated with energy utilisation. This finding corroborates that of (Zhao *et al*., 2019; Lee *et al*., 2015), who reported basic

information, energy-saving knowledge, energy-saving education, energy-saving attitudes, and energy-saving behaviours positively correlate with energy-saving awareness. Nonetheless, the respondents' energy utilisation pattern based on the apartment type was high ($p>0.05$). One limitation of this study is that the data was collected quantitatively. Thus, future research could explore energy utilisation in the same study area using mixed methods to obtain a deeper view.

6. Conclusions

More than two-thirds of those surveyed indicated favourable behaviours and attitudes toward cognitive standards related to energy consumption. This study found that the majority of households in Abuja belong to the average or high-income group. Furthermore, amongst most households, there is an awareness of the appliances required for efficient energy utilisation and a need to pay attention to energy-efficient parameters and indicators. While many respondents have a positive attitude and good cognitive norms on energy utilisation, most consider alternative energy sources that are not environmentally friendly and do not align with the net zero strategies. It was also observed that practices and cognitive norms demonstrate a significant association with participants' employment status. Thus, the government should reconsider the structure and content of energy-saving publicity and education to target people with poorer energy consumption habits. Comprehensive and appropriate education and publicity should be used when creating an energy-saving policy.

Furthermore, the government should intensify its external efforts as situational factors have a significant moderating effect. To promote social ethics such as conservation, the government could also engage in more teaching and counselling; for example, it is crucial to emphasise energy-saving education and public relations advice in order to persuade university students to adopt energy-efficient practices. Hence, the study has demonstrated that knowledge, attitude and practice significantly impact energy-saving behaviours and cognitive norms, which also impact behavioural change. The study has further shown the effect of cognitive norms and demographic factors such as age, employment, tribes and gender on energy utilisation.

Online forums for energy users can be useful in altering the 'having', 'thinking', and 'doing' aspects of behaviour. Discussions between users, how-to videos, and interactive tools such as energy-use calculators may impact people's thinking. Creating and disseminating knowledge and expertise about purchasing and using energy-efficient tools and devices may impact the 'having' variable.

This study can help researchers identify knowledge gaps in energy utilisation and practice. This could guide the development of educational programs and campaigns to improve energy literacy among the general public. It could further help to identify the barriers and drivers to adopting energy-efficient behaviours. This is essential in the design of effective communications and intervention strategies for more sustainable energy use. Furthermore, the information from this research could be used to advocate for more equitable energy resources that could benefit all segments of society and help to achieve the United Nations Sustainable Development Goals. Against this background, future studies could apply mixed-method research approaches to better understand energy saving and use in residential buildings. Furthermore, to better understand this area, studies could consider the critical drivers and impediments that influence energy-saving behaviours, which are not adequately captured in this study.

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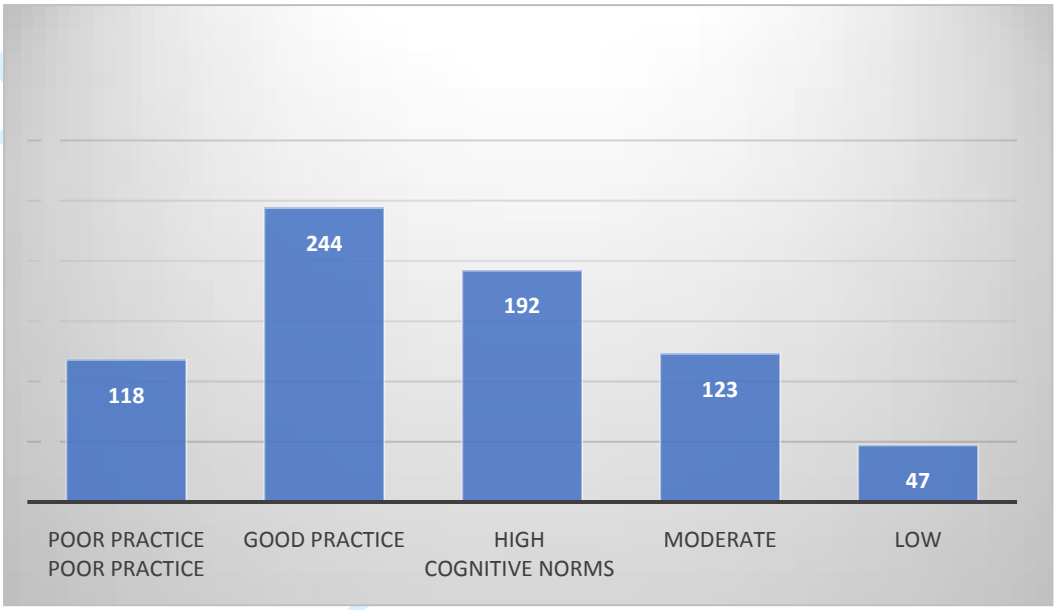

Figure 1: Association between socio-demographic variable and Cognitive norms associated and its Impact on energy usage and utilisation practices (Figure by authors).

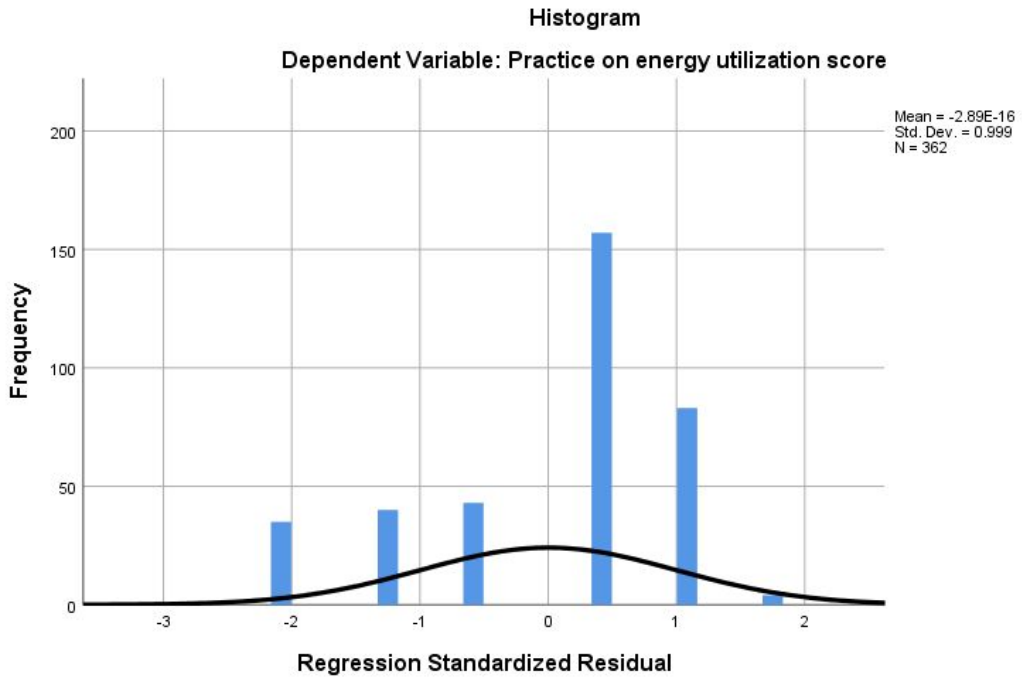

Figure 2: Linear regression analysis on cognitive norms associated with energy saving behaviour and practice of the respondents on energy utilisation (Figure by authors).

LIST OF TABLES

Table 1: Cognitive norms associated with energy used (Table by authors)

Variable	Strongly Agree	Agree	Strongly Disagree	Disagree
I don't know how much heating I use	113(31.2)	125(34.5)	42(11.6)	82(22.7)
Parents should ensure that their kids are taught how to be energy efficient at home	281(77.6)	12(3.3)	29(8.0)	40(11.0)
I don't like there to be more environmentally friendly sources of energy	233(64.4)	73(20.2)	38(10.5)	18(5.0)
I want my energy use to be greener	303(83.7)	20(5.5)	23(6.4)	16(4.4)
I am concerned about the effect of energy use on the atmosphere	253(69.9)	59(16.3)	38(10.5)	12(3.3)
I don't like to generate my own energy	250(69.1)	45(12.4)	41(11.3)	26(7.2)
I try and reduce my energy use to save money	200(55.2)	47(13.0)	50(13.8)	65(18.0)
The government is not doing enough about improving energy use	263(72.7)	74(20.4)	14(3.9)	11(3.0)
We are not using sunlight or wind effectively as a nation	133(36.7)	116(32.0)	55(15.2)	58(16.0)
I switch energy tariffs regularly to get the best deal	61(16.9)	151(41.7)	67(18.5)	83(22.9)
Protecting the environment is important to me	272(75.1)	41(11.3)	26(7.2)	23(6.4)
I never really think about my household energy use	85(23.5)	109(30.1)	85(23.5)	83(22.9)
I think solar panels should be built into all new properties	134(37.0)	42(11.6)	65(18.0)	121(33.4)
As a society, we should be self-sufficient with our energy	216(59.7)	110(30.4)	20(5.5	16(4.4)
Modern technology, such as Plasma TVs are less energy efficient than LED-lit LCD TVs	186(51.4)	150(41.4)	20(5.5)	6(1.7)

Table 2: Impact of Socio-demographic Variables on Cognitive Norms and Their Influence on Energy Usage and Utilisations Practices (Table by authors)

Variable	Categories	Practice on energy utilisation score	Statistics	Cognitive norms	Statistics
Gender	Female	105(29.0%)	χ^2=8.563	67(18.5%)	χ^2=10.234
	Male	139(38.4%)	df=1,P=0.003	125(34.5%)	df=1,P=0.006
Age	18-25 years	6(1.7%)	χ^2=66.736	3(0.8%)	χ^2=73.758
	26-40 years	100(27.6%)	df=2	75(20.7%)	df=4
	41-55 years	138(38.1%)	P=0.000	114(31.5%)	P=0.000
Tribe	Hausa	50(13.8%)	χ^2=60.866	5(1.4%)	χ^2=193.899

	Igbo	40(11.0%)	df=3	24(6.6%)	df=6
	Others	39(10.8%)	P=0.000	61(16.9%)	P=0.000
	Yoruba	115(31.8%)		102(28.2%)	
Marital status	Married	223(61.6%)	χ^2=23.487	181(50.0%)	χ^2=28.020
	Single	21(5.8%)	df=1, P=0.000	11(3.0%)	df=2, P=0.000
Occupants employment status	Employed	169(46.7%)	χ^2=37.877	124(34.3%)	χ^2=46.626
	Others	41(11.3%)	df=2	41(11.3%)	df=4
	Unemployed	34(9.4%)	P=0.000	27(7.5%)	P=0.000
Type of Property Storey building	Apartment/flat	119(32.9%)	χ^2=92.334	122(33.7%)	χ^2=113.790
	Bungalow-detached	44(12.2%)	df=3	27(7.5%)	df=6
	Bungalow-semi	41(11.3%)	P=0.000	41(11.3%)	P=0.000
	others	40(11.0%)		2(0.6%)	