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Exploring Cooking Energy Choices in Maiduguri's Restaurants: Implications for Environmental Sustainability, Health Safety, and Achieving SDG7.

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Abstract
This research work examined cooking energy preferences in Maiduguri's restaurants, focusing on environmental sustainability, health safety, and alignment with SDG 7 using primary data sourced from the structured questionnaire. The study utilized descriptive statistics to present the results. The results revealed that 38% of restaurants predominantly use charcoal and fuelwood due to their affordability, with 19% citing cost as the primary factor. While 55% view their energy choices as environmentally positive, 11% neglect regular safety inspections. Surprisingly, 36% aren't considering transitioning to cleaner energy sources. Major barriers to this transition include regulatory uncertainties (17%), perceived costs (16%), supply issues (13%), and a lack of awareness (12%). The study underscores the need for improved health and safety standards in Maiduguri's restaurants. Recommendations emphasize the role of stakeholders in promoting cleaner energy alternatives like LPG, supported by awareness initiatives, financial incentives, and collaborative efforts to enhance safety and infrastructure.

Keywords: Cooking Energy Choices, Restaurants, Environmental Sustainability, Health Safety, SDG 7.

Introduction

Access to affordable and reliable energy is a linchpin for economic development. It fuels industries, powers businesses, and drives innovation. The Sustainable Development Goal (SDG 7) recognizes that sustainable economic growth and job creation are intrinsically tied to energy access and efficiency. The global energy demand data shows that there is over-dependence on traditional biomass fuels, often used by those without access to modern energy sources, which results in indoor air pollution, leading to serious health issues, these include energy utilisation even in restaurants. Global cooking energy demand in restaurants is a significant aspect of the broader energy landscape. The culinary industry faces a growing need for sustainable and energy-efficient practices (Wilkes et al., 2017). Restaurants worldwide are increasingly recognizing the importance of adopting cleaner and more environmentally friendly cooking energy sources (Gallego-Schmid et al., 2020). This shift aligns with global efforts to combat climate change, reduce deforestation, and improve air quality, making energy choices in restaurants a matter of international concern (IPCC, 2019). Across the African continent, restaurants serve as cultural ambassadors, where local dishes are transformed into exquisite culinary experiences Bakunda, and Otengei, (2013). In cities like Cairo, Cape Town, and Dakar, restaurants are hubs of cultural exchange, offering a taste of tradition and innovation on every plate (Touahri, 2019). These establishments, rich in flavours and ambience, are also dynamic economic contributors, offering livelihoods to countless individuals and contributing significantly to local economies (Frayne et al., 2018).

The culinary landscape of Nigeria celebrated globally for its rich and diverse gastronomy, is a vibrant fusion of flavours and culinary traditions that reflect the nation's multicultural tapestry. From the spicy jollof rice of the southwestern region to the aromatic suya skewers of the northern savannas, Nigerian cuisine is a testament to the country's diverse cultural heritage. This culinary diversity is not only an intrinsic part of the nation's identity but also a source of pride and a unifying thread that connects communities from Lagos to Maiduguri (Ajayi, 2015). However, while the world celebrates the global richness of African cuisines including Nigeria's and the vibrant restaurant cultures that bring them to life, there exists an often-overlooked challenge "energy". The preparation of these beloved dishes, served with pride in restaurants relies heavily on various energy sources (Kammen & Lew, 2005). From

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traditional biomass fuels like firewood and charcoal to modern energy forms like natural gas and electricity, the choice of cooking energy in African and Nigerian restaurants is a multifaceted and critical decision (IEA, 2019). Nigeria, as Africa's most populous nation, encapsulates both the promise and challenges of the continent (NPC, 2017). Nigerian restaurants, from street vendors to upscale eateries, play a pivotal role in celebrating the nation's culinary heritage (Adesina & Djido, 2016). Yet, just like the household sector they face energy-related challenges reflective of the broader Nigerian context unreliable power supply, environmental concerns stemming from the use of traditional biomass fuels, and economic considerations surrounding energy costs (Arowosoge et al., 2018). In this multifaceted context, Maiduguri, the capital city of Borno State, serves as a microcosm of the intricate interplay between culinary excellence and energy sustainability (Fasona et al., 2014). While the city's restaurants contribute to its vibrant culinary culture, they also grapple with the complexities of energy choices that have implications not only for the quality of cuisine but also for the environment, health, and local economic development (Ige & Adetayo, 2019). SDG 7 seeks to improve the health and well-being of the populace by advancing clean cooking technologies and reducing reliance on traditional fuels. Thus, necessitates significant innovation in energy technology, infrastructure, and policy. This innovation not only transforms the energy sector but also catalyzes progress in other sectors, making it a linchpin for achieving multiple Sustainable Development Goals. Against this backdrop, this research embarks on a journey to explore the various energy sources used for cooking in restaurants in Maiduguri, to analyze their energy patterns, to identify the reasons behind the fuel choices for cooking energy in restaurants, including economic, environmental, cultural, and regulatory factors, to assess the environmental and health sustainability of different cooking energy choices in Maiduguri's restaurants. Thus, it aims to shed light on the dimensions of these preferences, thereby contributing to a deeper understanding of the nuanced relationship between energy utilisation environment sustainability and health safety.

Aim and objectives of the study

The primary aim of this research is to explore the cooking energy choices utilized by restaurants in Maiduguri, examining their implications for environmental sustainability, health safety, and the achievement of Sustainable Development Goal (SDG) 7.

Methodology

The study employs descriptive statistics to summarize and analyze the data collected. This is because descriptive statistics provide a foundational understanding of the key characteristics of the dataset, enabling the identification of trends, patterns, and relationships between variables. The study was conducted in the Maiduguri urban area of Borno which comprises the Metropolitan council and some part of Jere. It is located between Longitudes: 13°3'E and 13°12'E and Latitudes: 11°46'30"N and 11°55'30"N. The study area is made up of fifteen electoral wards, these are Bolori, Gwange, Maisandari, Shehuri North, Yerwa, Old Maiduguri, Galtimari and Khaddamari(Waziri, 2009). There are over 300 restaurants and eateries in Maiduguri, these include food stalls and street food vendors. This number is based on the number of businesses that are listed on Google Maps, and it is possible that there are even more restaurants and eateries in Maiduguri that are not listed on Google. Additionally, the number of restaurants and eateries in Maiduguri fluctuates over time, as new businesses open and old businesses close (Google Map 2023).

The study utilized primary data collected through direct surveys using structured questionnaires, which were distributed to participants with the help of trained field workers in Maiduguri. These questionnaires included a mix of open-ended and multiple-choice questions, gathering detailed information on the types of cooking fuels used by local restaurants, as well as the economic, environmental, cultural, and regulatory factors influencing their choices of cooking energy. The study employed the judgmental or purposive sampling method to select restaurants that use energy for cooking as its important criteria for selection. Firstly, the list of areas with many restaurants and eateries was collected from Google Maps. These include **the University of Maiduguri (UNIMAID), Maiduguri Town Centre,** Kofar Mata Area, GRA (Government Reserved Area and Wulari Area. The high number of residents characterises the areas; thus, they serve a variety of cuisines, including Nigerian traditional/local dishes such as tuwon shinkafa, Egusi soup, and pounded yam, to a variety of low budgets and tasty food such as snacks and meals (grilled beef), Akara (fried bean fritters), and masa (fermented rice cake) to those serving other African, Asian, and European cuisines. After identifying these areas, stratified sampling was employed to ensure that various types of restaurants (those serving local, low-budget meals and those offering African, Asian, and European cuisines) were included. A total sample size of 180 was determined based on the number of restaurants in each location. This was further distributed across the locations as; 50 restaurants from the University of Maiduguri, and 30 restaurants each from the

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other four areas (Maiduguri Town Centre, Kofar Mata, GRA, and Wulari). Thus, the sampling process ensures that the selection is representative of the variety of restaurant types across Maiduguri, based on both their geographical distribution and the types of cuisines they offer. Descriptive Statistics were used to describe the characteristics of the data set. These include frequencies, bar charts, and pie to present the findings of the study pattern, frequency, and reasons for fuel choices among the restaurants and eateries owners in Maiduguri.

Results

Table 1: Restaurant Information

S/n	Type of Restaurant	Frequency	Percentage (%)
1.	Fast Food	63	35
2.	Modern Restaurants	49	27
3.	Traditional	68	38
	Total	**180**	**100.0**

Source: Field Survey, 2023

Table 1 presents the distribution of different types of restaurants considered for this study in Maiduguri, Borno State, based on the data collected during the field survey in 2023. Traditional restaurants are the most prevalent type in Maiduguri, making up the largest share (38%) of the restaurant market. Fast-food restaurants are the second most common type, constituting 35% of the market. Modern restaurants represent the smallest segment, with 27% of the market share.

The Pattern of Energy Sources

The study examined the pattern of fuel choices in the restaurants in the study area and presented the results in Figure 1.

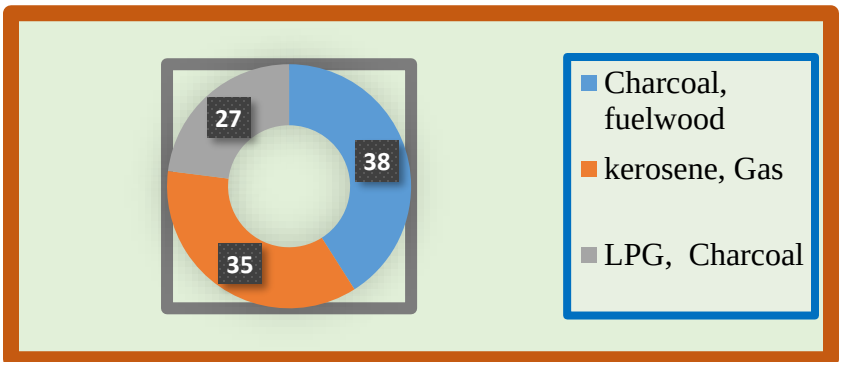

Figure 1: Energy sources currently used for cooking in restaurants.

Figure 1 provides information on the energy sources currently used for cooking in restaurants, presented in terms of percentages. The frequency of restaurants and eateries utilizing charcoal and fuelwood constitutes the highest with 38%. The reasons for such a result could be due to the availability and affordability of the energy sources. This finding agrees with that of Smith and Sagar (2014) which highlighted that the extensive use of traditional fuels like fuelwood and charcoal in certain regions is due to its affordability and availability. The second most used fuels category is the combination of kerosene and gas which was found to be used by 35% of the surveyed restaurants. Both kerosene and LPG can be more cost-effective than electricity whose supply is erratic, especially with the utilisation of pay-as-go meters. They both cook faster and with proper handling they are safer than wood which can produce harmful smoke, more CO_2 emission, and fire hazards. Also, in terms of text and texture for restaurants food dishes cooked using kerosene or LPG stoves might be preferred over firewood another reason could be the Infrastructure and Setup of many restaurants might not warrant the use of fuelwood but LPG and kerosene stoves which are more portable and require less upfront investment, become the go-to choose. This coincides with the findings of Bruce et al. (2016) which reported in their work that there was widespread use of kerosene and gas as cleaner alternatives in various settings).LPG and Charcoal utilisation constituted (27%). Similarly, LPG is known for its cleanliness and efficiency as emphasized by Bailis et al. (2009) that LPG as a clean fuel and charcoal merits as a smokeless fuel while even

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though charcoal is a traditional solid fuel, it also cooks without producing smoke hence, affordability and availability could be the reason for such choice.

Reasons for the Choice of Cooking Fuel Types Among Restaurants in Maiduguri

Figure 2 presents the result on the main factors influencing the choice of cooking energy sources in restaurants in Maiduguri, Borno State. This information provides insights into the decision-making process regarding energy source selection.

Table. 2 Factors Determining Fuel Choices

Factors	**Frequency**	**Percentage**
Availability	35	19
Affordability	45	26
Cost-effectiveness	35	19
Comfortability	25	14
Health and Safety	20	11
Cultural Preference	20	11
Total	180	100

Field Survey 2023.

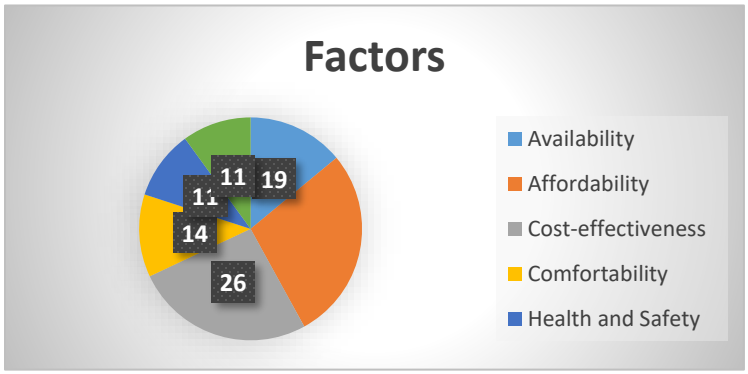

Figure 2: Factors that determine Fuel choices: Field Survey 2023

Table 2 and Figure 2 depict the reasons for the choices of fuels in the various restaurants studied in Maiduguri. The most significant factor influencing the choice of cooking fuel in Maiduguri's restaurants is affordability at (26%). This suggests that restaurant owners are price-sensitive and will opt for the most economical fuel option available. As opined by Zhang and Smith (2007) their choice directly impacts their operational costs and consequently their profitability. Closely related to affordability, cost-effectiveness (19%) indicates that restaurant owners are not just looking at the initial price but also the long-term value and efficiency of the fuel as indicated by Winkler et al. (2007) that businesses, including restaurants, often consider the long-term operational costs when selecting energy sources. Similarly, the availability of fuel which constitutes 19% is a significant concern, indicating that consistent supply/availability of fuel is crucial for restaurant operations. Interruptions in supply chains can disrupt business and lead to financial losses. This coincides with the findings of Kemausuor et al. (2011) who highlighted the importance of reliable fuel supply chains for businesses, especially in the food sector in Ghana. In terms of comfortability, (14%) of the restaurants expressed their reason for it suggesting that restaurant owners and staff prefer fuels that are easy to use and familiar. Familiarity and ease of use are essential for restaurant staff. According to Pachauri and Jiang (2008),

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restaurants in India were hesitant to switch to unfamiliar cooking fuels due to concerns about adapting their cooking methods and potential impacts on food taste. Transitioning to new fuels might require training or adjustments in cooking methods. With regards to health and safety, only 11% prioritised the cruciality of safety. This might indicate a lack of awareness about the health risks associated with certain fuels or a willingness to overlook these concerns due to other pressing factors like cost. This is in line with the findings of Pokhrel et al., (2010) which show that restaurant owners in Nepal were aware of the health risks associated with certain fuels, however, the immediate economic concerns often took precedence. In terms of cultural preference, about 10% of the restaurants indicated that it plays a role in fuel selection, indicating that traditional cooking methods and tastes influence fuel choice as revealed by Masera et al. (2000) in their study in Mexico.

Perceived Environmental Impact of the current energy sources used for cooking in restaurants.
The study assessed the information on the perceived environmental impact of the current energy sources they used for cooking in their restaurants. The result is presented in Figure 3.

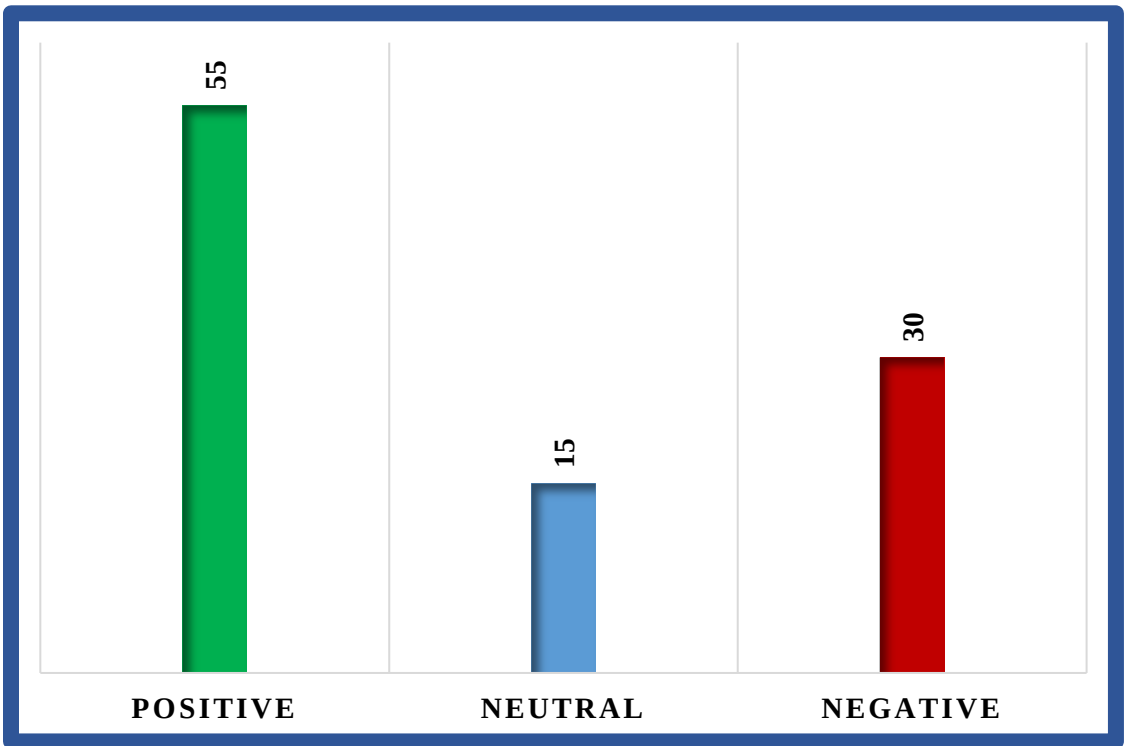

Figure 3: Perceived Environmental Impact of Restaurant's Current Energy Sources for Cooking Source Field Survey 2023

The results from Figure 3 show that about 55% of the respondents indicated they perceived the environmental impact of their restaurant's current energy sources as positive. This suggests that these restaurants believe their energy sources have minimal or beneficial environmental effects, which could imply the use of cleaner or more sustainable fuels. The implication of this is it could lead to complacency, assuming that no further improvements are needed. For instance, a study in Kenya found that households that perceived their energy sources as environmentally friendly were more likely to use cleaner fuels like LPG (liquid petroleum gas) (Mekonnen & Köhlin, 2008). Thus, positive perceptions about environmental impact often correlate with the use of cleaner energy sources and complacency. A total of 15% showed a neutral perception of the environmental impact. This could imply a barrier to transitioning to more sustainable practices because they may not see their energy sources as particularly positive or negative in terms of environmental effects, possibly reflecting a lack of information or consideration. A similar study conducted in India highlighted that a lack of awareness was a significant barrier to the adoption of cleaner cooking fuels (Rehman et al., 2010).

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About 30% believe that the energy sources they use for cooking in their restaurants have a negative environmental impact. This implies that these restaurants believe their energy sources have adverse environmental effects, which could indicate the use of less environmentally friendly fuels or practices. Recognizing the negative environmental impact of their energy sources suggests an openness to change. However, without proper guidance or incentives, these restaurants might continue using harmful fuels. This finding agrees with a study in Brazil which indicated that even when businesses recognized the negative impacts of their energy sources, economic constraints often prevented them from transitioning to cleaner alternatives (Martinot & McDoom, 2000).

Health and Safety Measures Among Restaurant and Eatery Owners in Maiduguri

This study also assessed the health and safety measures related to restaurant's energy sources for cooking. The result is presented in Figure 4.

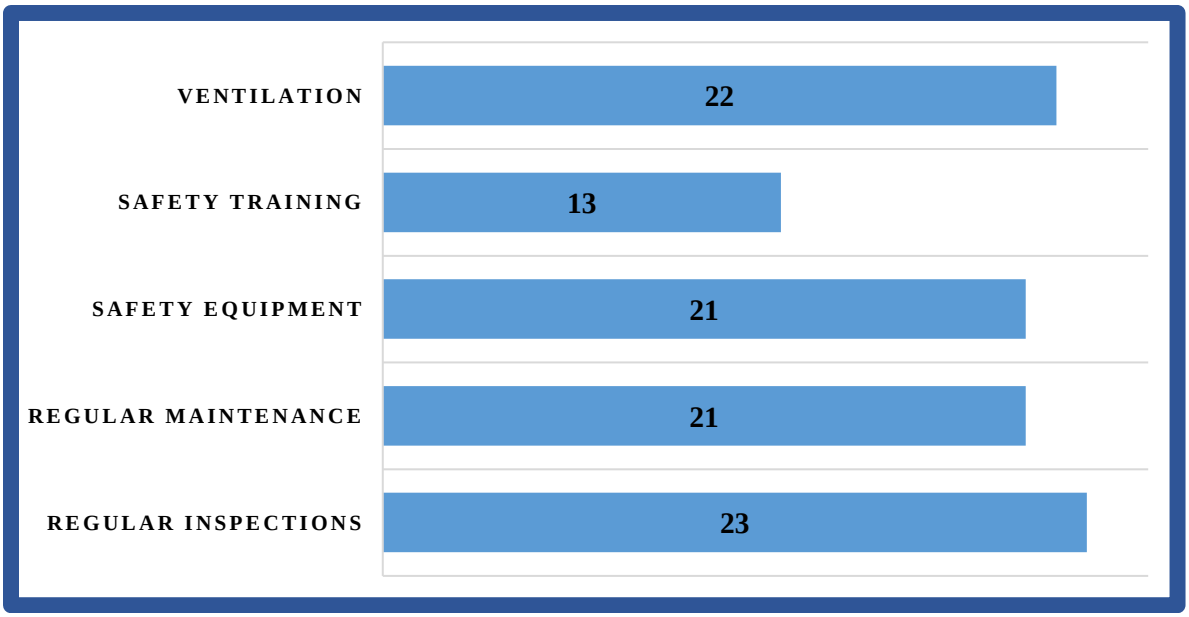

Figure 4: Health and safety measures related to restaurant's energy sources for cooking. Source field Survey 2023.

The implications of the results are since nearly a quarter of restaurants conduct regular inspections, this suggests that a significant majority might be operating without consistent checks, potentially overlooking safety and health standards. A similar finding was by Redmond & Griffith (2003) which revealed that regular inspections in restaurants were crucial for maintaining food safety standards and preventing foodborne illnesses. Similarly, regular maintenance ensures the longevity of equipment and reduces the risk of accidents as highlighted by Mortimore & Wallace, (2013) regular equipment maintenance in restaurants ensures food safety and reduces the risk of cross-contamination. However, with nearly 80% not reporting regular maintenance, there's a potential risk of equipment malfunction leading to accidents or food safety issues. Moreover, the use of safety equipment can significantly reduce the risk of accidents and injuries as shown by the study of Smith et al. (2006). However, the fact that only 21% reported using such equipment indicates potential safety vulnerabilities in many restaurants. In terms of ventilation, it is essential for maintaining air quality and reducing the risk of respiratory issues among staff as emphasized by Chiang et al., (2016) that proper ventilation in restaurants, especially those using solid fuels, reduces indoor air pollution and associated health risks. Unfortunately, with only 22% using ventilation measures, many restaurants might be exposing their staff and customers to poor air quality. Finally, safety training is crucial for preventing accidents and ensuring food safety as reported by Todd et al., (2007) in their study in Canada found out that safety training in restaurants significantly reduced the risk of foodborne outbreaks and improved overall food safety practices. Therefore, the low percentage of restaurants providing such training suggests a potential gap in staff knowledge and practices, increasing the risk of accidents and foodborne illnesses.

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Transition to cleaner Fuel.

The study also examined whether the restaurant has plans or has transited to cleaner fuels and the results are presented in Figure 5.

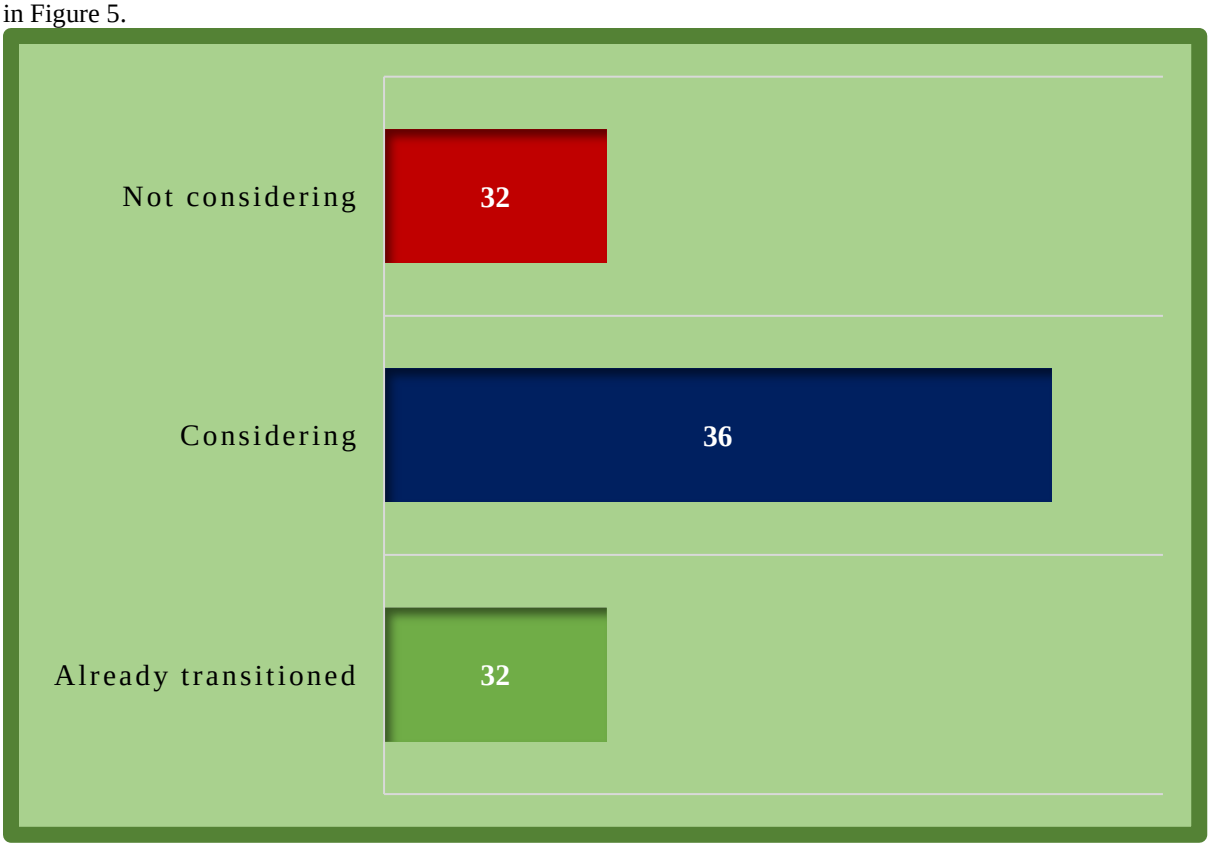

Figure 5:Transition to Cleaner Energy: Source: Field Survey 2023

Of the respondents, 32% reported that their restaurants have already transitioned to cleaner energy sources for cooking. This suggests a significant portion of restaurants are already recognizing the environmental and potential economic benefits of cleaner energy sources. This transition can lead to reduced greenhouse gas emissions, improved indoor air quality, and potential cost savings in the long run. This coincides with the study of DeWitt and Fisk (2017) which found that the restaurants in the USA that are transitioning to cleaner energy sources, such as electric or induction cooktops, are experiencing reduced emissions and improved energy efficiency. About 36% reported that they are currently considering transitioning to cleaner energy sources. The fact that over a third of restaurants are contemplating the switch indicates a growing awareness and interest in sustainable practices within the industry. However, barriers such as initial investment costs, lack of knowledge, or infrastructure might be delaying the transition. This agrees with the findings of Jones et al. (2016) which reported that while many restaurants in the UK are keen on adopting sustainable practices, challenges like upfront costs and lack of expertise can hinder the transition. A significant portion of 32% of the restaurants remain committed to their current energy sources and are not considering a transition to cleaner energy sources which might be due to satisfaction with current systems, financial constraints, or lack of awareness about the benefits of cleaner energy. This finding is in line with the findings of restaurants in India whereby many of them continue to use traditional energy sources due to their familiarity, perceived cost-effectiveness, and resistance to change, despite the availability of cleaner (Kumar & Viswanathan, 2015).

Anticipated Challenges in Transitioning to Cleaner and More Sustainable Cooking Energy Sources in Restaurants in Maiduguri

The study assessed the possible anticipated changes hindering the transition to more sustainable cooking energy sources in restaurants in Maiduguri. The results are presented in Figure 6.

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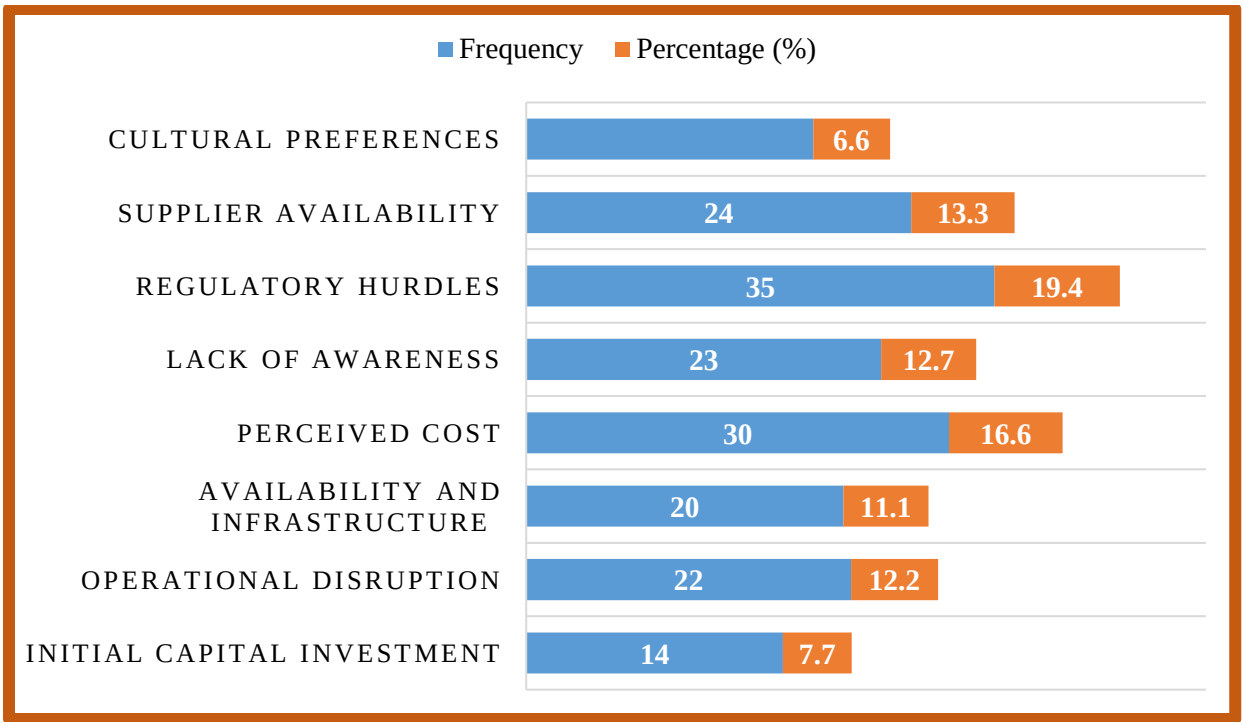

Figure 6: Anticipated Challenges in Transitioning to Cleaner and More Sustainable Cooking Energy Sources in Restaurants in Maiduguri: field Survey 2023

Figure 6 highlights the anticipated challenges that restaurants in Maiduguri may face when transitioning to cleaner and more sustainable cooking energy sources. The respondents highlighted initial capital investment (7%), operational disruption 12%, Availability and Infrastructure 11%, perceived cost 16%, lack of awareness 12%, regulatory hurdles/government policy uncertainties 19%, supply availability 13% and cultural preferences 6% as the major factors likely to pose challenges for them to transit to cleaner fuels. The implications of these findings are, that the transition to cleaner energy sources may be hindered by the upfront costs associated with new equipment or retrofitting. (Ouedraogo,2019). Changing energy sources also disrupt daily operations, potentially affecting service quality and customer satisfaction (Wagner, 2017). Similarly, the lack of infrastructure and availability deter restaurants from adopting cleaner energy sources as reported by (Chirambo,2018). Additionally, misconceptions about the costs associated with cleaner energy can be a deterrent which has been reiterated by the Energy Policy Institute (Ma, 2020) that businesses often overestimate the costs of transitioning to sustainable energy. Furthermore, information is vital when it comes to the transition to clean energy sources because Information gaps can hinder the adoption of cleaner energy sources that is why the United Nations Environment Programme has been emphasizing the role of awareness campaigns in promoting sustainable energy (Ackah, 2021). Other barriers include Nigeria's policy hurdles which have created barriers to cleaner energy adoption (Onyenucheya, 2022). Even though the country has abundant renewable energy resources significant progress the government in developing its clean energy policy such as the National Renewable Energy Action Plan (NREAP, 2015) which aims to increase the share of renewable energy in the country's energy mix to 23% by 2030 and several measures put in place to promote development and various agencies established the country is still grappling with a high upfront cost, lack of infrastructure as a result renewable energy such as electricity is still epileptic in supply and LPG is very costly these have affected reliable suppliers coupled with the influence of traditional cooking methods and cultural norms have consequently impeded the transition to cleaner energy sources.

Conclusion

The study examined cooking energy choices in Maiduguri's restaurants, emphasizing their environmental and health implications in line with SDG 7. Findings reveal a dominant use of charcoal and fuelwood due to their affordability and availability. While many restaurants recognize the environmental downsides of their energy sources, economic and awareness barriers hinder the shift to cleaner alternatives. Additionally, many establishments potentially overlook

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health and safety standards. Despite the interest in transitioning to cleaner energy, challenges like financial constraints and cultural norms persist.

Recommendations

Based on the above conclusions the following recommendations are made to various stakeholders these include government, private sector, development partners, non-governmental organisations, civil societies organizations and individuals.

1. Relevant stakeholders should introduce incentives for adopting LPG and other clean fuels in restaurants, combined with awareness campaigns about their health and environmental benefits.
2. Emphasizing affordability, relevant stakeholders should offer subsidies for sustainable cooking fuels and ensure reliable supply chains.
3. Awareness campaigns should be prioritized by relevant stakeholders, highlighting cleaner fuel benefits, and financial support mechanisms should be introduced to overcome economic barriers.
4. Regulatory bodies must enforce safety and health standards in restaurants, emphasizing regular inspections and staff training.
5. Incentive programs should be implemented to promote cleaner energy adoption in restaurants, focusing on environmental and cost-saving benefits.
6. The government should collaborate with international agencies to provide financial incentives, infrastructure, and awareness campaigns for sustainable energy practices in restaurants.

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