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Community Perspectives on the Use of Pipeline Quality Natural Gas in Tanzania. 'Embracing Blue Economy Agenda'

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A B S T R A C T

This paper presents a study on the community perspectives on the use of pipeline-quality natural gas in Tanzania conducted among students at higher learning institutions. The study employed a mixed-methods approach, including both quantitative and qualitative data collection and analysis methodologies. A standardized questionnaire for quantitative data collection and analysis was distributed online to a random sample of 207 students from four Tanzanian higher learning institutions. The study found a large knowledge gap among respondents in comprehending pipeline-quality natural gas for household heating purposes, as well as Liquefied Petroleum Gas (LPG) as per Tanzania clean cooking energy roadmap 2033. To bridge this gap and encourage the use of pipeline-quality natural gas, the study recommends raising community awareness, motivation, and understanding through various means such as focused group discussions, seminars, conferences, exhibitions, brochures, technological innovations, training and capacity-building, and diverse media platforms such as radio, TV, social media, cartoons, pictures, sketches, documentary records, and special reading and writing materials for disabled groups. Future research might look into the impacts of various awareness campaigns in promoting the use of greener energy options in Tanzania. Furthermore, studies might investigate the hurdles to adoption and how they can be overcome through focused interventions.

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1. Introduction

Natural gas, primarily methane (CH_4), has become an increasingly popular source of energy due to the rising demands for clean and environmentally acceptable energy sources (Hansen et al., 2013). Tanzania, like many other countries endowed with offshore hydrocarbon reources, has embraced natural gas as a means of achieving long-term energy security and development (TPDC, 2021). Since the commercialization of natural gas in Tanzania from Songosongo and Mnazi bays in 2004 and 2006, respectively, community uses have been limited to some electricity generation plants, fewer industrial energy sources, small-scale residential cooking energy, and in a few institutions as a source of fuel. The reported findings of around 57 trillion cubic feet (TCF) of sweet natural gas offshore Tanzania is a concerning story in terms of community expectations and overall benefits from responsible production and usage.

However, there is a profound lack of understanding about the distribution and consumption of pipeline-quality natural gas among the public, particularly university students and the community (Kamat et al., 2019). This lack of awareness has resulted in misconceptions and a reluctance to adopt cleaner energy alternatives (Destek, 2016; EIA, 2017; Manca et al., 2020; Richard et al., 2021), which is a significant issue that needs to be addressed through targeted awareness campaigns and interventions (Rodríguez-Antón & Alonso-Almeida, 2019). Recent scientific articles have highlighted the alarming environmental and ecological consequences of using traditional biomass (charcoal and wood) as primary cooking fuels in households across the four coastal districts of Tanzania, where pipeline-quality natural gas runs (Chandra, 2006; Kweka, 2022). This practice has resulted in severe deforestation, loss of natural biodiversity and flora, increased global warming, and drought (Abrahams et al., 2015; Cf, 2015; Hansen et al., 2013; TPDC, 2021). Despite the availability of pipeline-quality natural gas, the lack of awareness and knowledge about its benefits over other fossil fuels results to misconceptions, uncertainty, and a

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reluctance to adopt cleaner energy alternatives (Manca et al., 2020; Richard et al., 2021). This is a significant problem that needs to be addressed to promote sustainable development and energy mix in Tanzania (Bungane, 2018). Therefore, it is necessary to raise awareness among university students and the community about the adverse effects of biomass usage and the benefits of cleaner energy alternatives such as pipeline-quality natural gas (Bishoge et al., 2022; Kamat et al., 2019; Lukonge & Cao, 2019) as alternative to imported Liquefied Natural Gas (LPG).

Tailored community awareness campaigns and focused interventions are to be employed in educating Tanzanians about the benefits of pipeline-quality natural gas over other fossil fuels. Because, it can improve understanding and promote the adoption of cleaner energy options (Hansen et al., 2013; Rodríguez-Antón & Alonso-Almeida, 2019; TPDC, 2021). Equally, educational campaigns, seminars, and conferences, as well as the use of various media platforms, can all be used to convey knowledge about natural gas and its associated benefits and problems (Bishoge et al., 2022; Kamat et al., 2019; Landi et al., 2013). Raising community awareness while targeting university students about the adverse effects of biomass usage and the benefits of cleaner energy alternatives, such as pipeline-quality natural gas over imported LPG in Tanzania, is necessary (Abrahams et al., 2015; EIA, 2020; EIA, 2021).

This study aimed to analyze and address the community perspective on the use of pipeline-quality natural gas using a sample population from four Tanzanian higher learning institutions. The study employed a mixed-methods approach to get a thorough understanding of the research topics and to inform targeted awareness and raising efforts to support responsible natural gas consumption and production in Tanzania. In doing so, it will embrace the Petroleum Act of 2015, which was enacted in response to the need to defend public interests such as participation, ownership, governance, and expectation management. Furthermore, the study will help Tanzania achieve its Clean Cooking Energy Roadmap 2033, which aims to shift 80 % of the population to clean cooking by 2033.

2. Methodology

2.1. Research Design

The study used a mixed-methods strategy to investigate the community's perspectives on natural gas pipeline networks and their use for household applications in Tanzania. The goal of the study was to investigate the community's perspectives on natural gas pipeline networks and their uses for household applications in Tanzania. A mixed-methods strategy was used that included both quantitative and qualitative data collection and analysis methodologies. A standardized questionnaire for quantitative data collection and analysis was distributed online to a random sample of 207 students from four Tanzanian higher learning institutions. The sample distribution of the study was conducted among Dar es Salaam Maritime Institute (DMI), Dar es Salaam Institute of Technology (DIT), University of Dodoma (UDOM), and University of Dar es Salaam (UDSM) to represent the diverse student populations, allowing for the generalization of findings to the broader community.

2.2 Sampling

The sample size for the study was calculated using an 85% confidence level and a 5% margin of error as indicated in Equation 1. When the specific figure is uncertain, the standard deviation was chosen at 0.5, a conservative approach. Because of the community's overall lack of certainty, time-consciousness, and cost-cutting, it was chosen to take a sample size from the general population. To meet study objectives, sampling approaches have the advantages of speedier data gathering and being cost-effective (Gogtay, 2010; Schmidt et al., 2018). Equation 1 was used to calculate the sample size:

$$sample\ size = \frac{(Z-scores)^2 \times stdDev \times (1-stdDev)}{(m\arg in\ error)^2} \quad (1)$$

Using a z-score of 1.44, corresponding to an 85% confidence level, the representative sample size was calculated as:

$$= \frac{(1.44)^2 \times 0.5 \times (1-0.5)}{(0.05)^2} = 207 \quad (2)$$

The sample of 207 students in Tanzania were determined to be a good representation of university students studying oil and gas studies as well as other programs that need awareness of natural gas consumption via pipeline networks. More than 207 respondents were considered for the survey to ensure that more than 100% of the target population was included. The sample in Table 1 is representative of the diverse student populations, allowing for the generalization of findings to the broader community.

Table 1. Sample distribution of the study.

Key Respondents	Population Distribution	Number of Samples	Percentage (%)
DMI	56.93	57	27.54
DIT	50.05	50	24.15
UDOM	50.05	50	24.15
UDSM	50.05	50	24.15

3. Results and Discussion

3.1. General description of individuals who responded to the survey

The main objective of this study was to investigate the community's viewpoint on the uses of natural gas pipelines in Tanzania as compared to other dominant LPG and biomass. To achieve this, the study used a sample population from four higher learning institutes in Tanzania. The survey gathered demographic information from 252 respondents. Most of the sample (72.9%) falls within the age range of 18-24, with males (75.9%) being the predominant gender. The most common field of study among the respondents was engineering (85.4%), followed by other disciplines (5.6%) and applied science (4.4%). The Dar es Salaam Marine Institute had the highest number of respondents (62.3%), followed by the Dar es Salaam Institute of Technology (12.7%), the University of Dodoma (13.1%), and the University of Dar es Salaam (11.1%). The survey results suggest that the sample population consisted primarily of young, male engineering students from the four Tanzanian higher learning institutions surveyed. Most respondents were enrolled in the Dar es Salaam Marine Institute, and these demographic characteristics may impact their perspectives on natural gas pipeline networks and household usage.

3.2. Knowledge of different types of gases and their utilization

The 94% of respondents use natural gas for cooking, while only 6% use other energy sources like charcoal and firewood. 94.8% of respondents believe that natural gas is an environmentally beneficial and clean energy source.

91.7% of respondents think that natural gas can be transported and distributed through a pipeline network for home and commercial applications. 41.3% of respondents are aware of a pilot case study on the use of pipeline-quality natural gas in some households in Mikocheni, Tanzania.79% of respondents are aware that Tanzania has been producing commercial natural gas since 2004.94.8% of respondents know that natural gas can be produced from both marine (offshore) and land (onshore) as indicated in Figs 1-2.

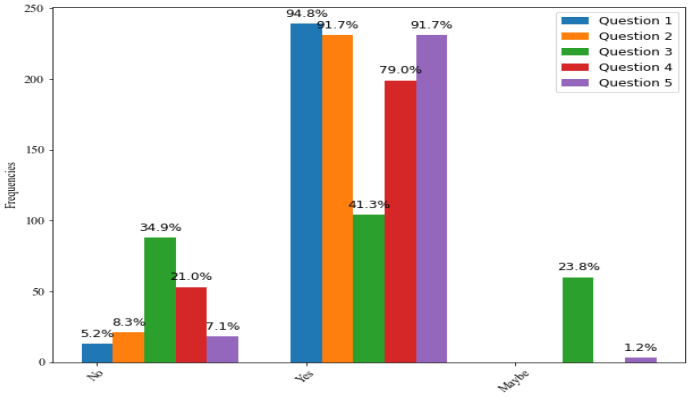


Fig. 1. Knowledge of different types of gases and their utilization.

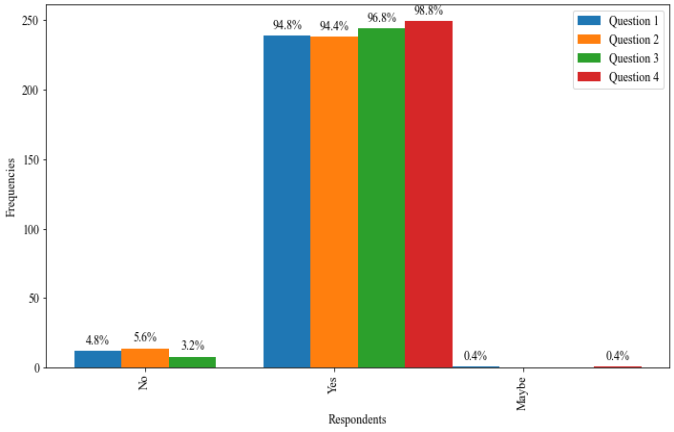


Fig. 2. Knowledge of different types of gases and their utilization.

Most respondents use natural gas for cooking, and there is a limited use of other energy sources like charcoal and firewood. Respondents have positive perceptions of natural gas as an environmentally beneficial and clean energy source. Respondents believe that natural gas can be transported and distributed through a pipeline network for domestic and commercial purposes. That is good move to Tanzania clean cooking energy roadmap 2033. Most respondents are aware of commercial natural gas production from both offshore and onshore since 2004, as indicated in Figs 1-2.

3.3. Survey results on gas conversion and natural gas discovery in Tanzania

The data presented in Fig 3 show information about the usage of different gas conversions for domestic cooking and other energy sources, as well as the location of the major discovery of natural gas in Tanzania. According to the survey, the most frequently used gas conversion for domestic cooking and other energy sources is Liquefied Petroleum Gas (LPG), which accounts for 37.7% of the responses. This is followed by Compressed Natural Gas (CNG) at 26.2% and Liquefied Natural Gas (LNG) at 23.8%. Pipeline quality Natural gas and Natural Gas Liquid are the least commonly used conversions, with 7.9% and 3.6%, respectively. As per reported information, the major discovery of natural gas in Tanzania is found in offshore Indian Ocean that align with respondents (62.7%) while small portion represented by minority (31.7%) is onshore. Only 4.8% indicated that there was no major discovery of natural gas in Tanzania.

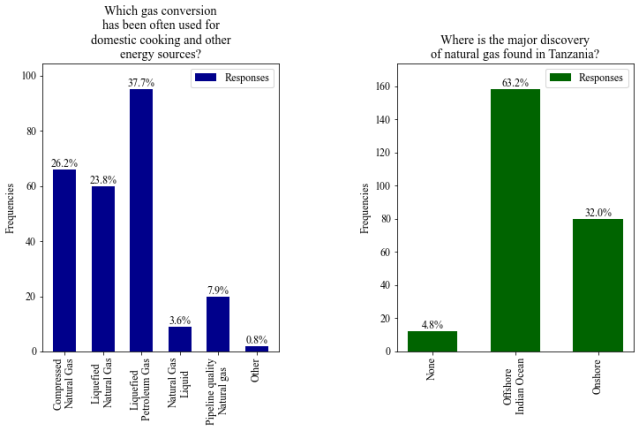


Fig.3. Survey results on gas conversion and natural gas discovery in Tanzania.

Based on the survey results, Liquefied Petroleum Gas is the most commonly used gas for domestic cooking and other energy sources among the respondents. This suggests that Liquefied Petroleum Gas is likely the most accessible and affordable option for households in the survey region. Compressed Natural Gas and Liquefied Natural gas were also popular choices, indicating that these gases may be viable alternatives to Liquefied Petroleum Gas in certain situations.Regarding the major discovery of natural gas in Tanzania, the survey found that the majority of respondents (62.7%) believed that it was discovered offshore in the Indian Ocean. This suggests that offshore exploration and production activities may be more prominent in Tanzania than onshore activities. However, a significant proportion of respondents (31.7%) believed that the major discovery was onshore, indicating that there may still be significant natural gas reserves on land in Tanzania. It is worth noting that 4.8% of respondents indicated that there was no major discovery of natural gas in Tanzania, which may reflect lack of awareness or knowledge about the country's natural resources.

4. Conclusion

The study highlights the need for raising awareness and understanding among Tanzanians about the benefits of using pipeline-quality natural gas as a clean and affordable energy source. To bridge the knowledge gap and encourage the adoption of natural gas pipelines, the study recommends various means such as focused group discussions, seminars, conferences, exhibitions, brochures, technological innovations, training, and capacity-building, and diverse media platforms such as radio, TV, social media, cartoons, pictures, sketches, documentary records, and special reading and writing materials for disabled groups. By implementing these recommendations, Tanzania can contribute to achieving the United Nations Envision 2030 objective, which includes people with disabilities, and transition to a dependable, high-quality, clean, and environmentally friendly energy source with lower carbon footprints.

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